RECORD
of the
1988 ANNUAL CONVENTION
of the
BRITISH WOOD PRESERVING
ASSOCIATION

Cambridge
June 28th – July 1st, 1988

Issued by the
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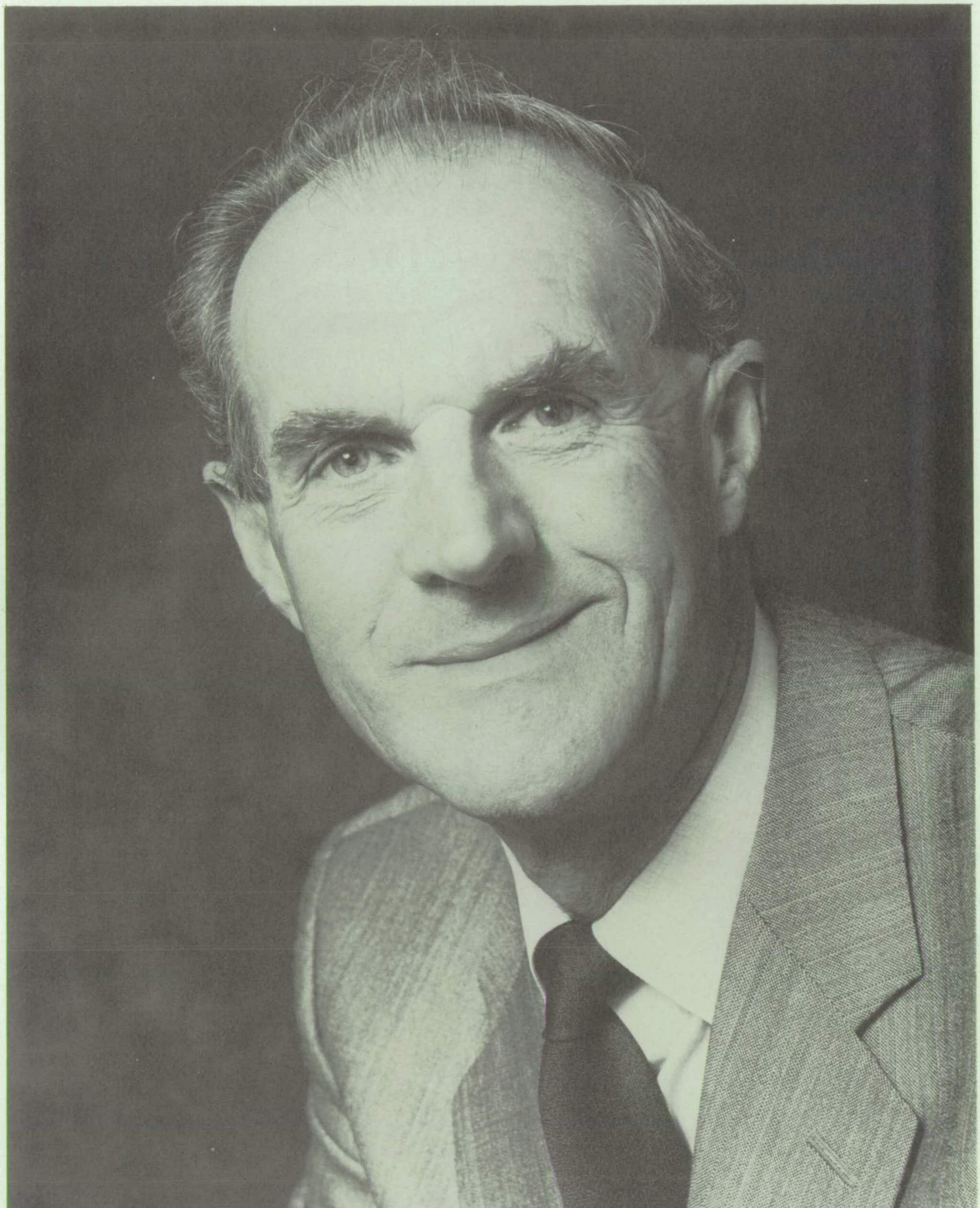

E. A. Hilditch
President of the British Wood Preserving Association

The British Wood Preserving Association

BUILDING NO. 6, THE OFFICE VILLAGE, 4 ROMFORD ROAD,
STRATFORD, LONDON E15 4EA

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BRITISH WOOD PRESERVING ASSOCIATION

The British Wood Preserving Association is a scientific and advisory association.

It is a body which collects information on the preservation and fireproofing of timber and the methods of applying preservatives and fire retardants; it sponsors scientific research into the use of preservatives and fire retardants, and makes available to all enquirers the results of its researches by the publication of leaflets, a technical advice service and specialist lectures. It is completely impartial in its outlook and in the advice it gives. Among other objects it aims at making known the advantages of using preserved timber in the interests of the consumer and the national economy.

MEMBERSHIP: Amongst the members are

Learned societies and research bodies at home and overseas.
Architects, surveyors, builders, etc.
Manufacturers of all types of preservatives and fire retardants.
Users of timber.
Firms operating all forms of treating plant.
Specialists in the remedial and curative treatment of timber *in situ.*
Manufacturers of plant.

COMMITTEES

In the working of its committees close liaison is maintained with Government Departments, as well as with the principal consuming industries.

On the Council there are representatives of learned societies, scientific bodies, principal consumers, architects and consultants, as well as manufacturers and those who specialise in preservative treatment of timber.

Other Committees deal with technical matters, finance, membership and environmental problems.

On several of these Committees there are representatives of the nationalised industries, consuming industries, and organisations such as Princes Risborough Laboratory, T.R.A.D.A. and the Health and Safety Executive.

SERVICES

It offers a free advisory service on all problems connected with timber preservation.
It publishes a technical manual, issues leaflets dealing with practical problems and the latest developments in research.
It holds an Annual Convention at which specialist papers are presented by experts from all over the world.
It publishes in book form a Record of the Annual Convention containing copies of the papers, etc.
It issues free of charge to all members a News Sheet.
It maintains a panel of lecturers whose services are available on request.
It organises exhibitions to show the value of preservation.
It arranges visits to the works of manufacturers and treaters.
It represents the industry on a number of international committees connected with timber preservation.

FINANCES

It should be appreciated that the Association depends entirely on subscriptions and special contributions from its members. This, of course, enables it to remain completely independent and at the same time to maintain its impartial and scientific approach to all problems.

CONTENTS

OPENING ADDRESS BY THE PRESIDENT
MR. E. A. HILDITCH

Ladies and Gentlemen, we come to the opening of the 1988 Convention of the British Wood Preserving Association. We are fortunate in having a good representation from across the world attending this Convention. We have something like 180 delegates. I say, "something like" because even up to five o'clock yesterday we were getting extra bookings and we were getting people cancelling. If David Scobie knows exactly where we stand, then he is more in touch than I am.

We have 50 delegates from overseas countries and this represents one of the very important aspects of the Association: the internationalisation of the Association. This is represented not only in the delegates here, but in the programme that we have in front of us. Five out of the eight speakers this year are from overseas. In particular four of them are from Europe. This represents one of the important technical and commercial – especially commercial – developments in front of us in this country in the coming years: the move from parochial, nationalistic barriers to pan-Europe, a greater Europe.

We have many other problems in front of us as an industry, and two of these are equally represented in the papers before this Convention. They relate to Health and Safety Regulations, and in particular the way they are going to be administered in relation to industrial products. The final aspect of the Association's development which is represented in the papers, is the increasing interest in damp-proofing. Tomorrow afternoon one of the main papers is indeed on damp-proofing.

It is far too early in the day to toast anything, but if it were appropriate to toast something I would give you a good Conference, lively debate and good food for thought and for the stomach. Ladies and Gentlemen, the 1988 Convention is now open.

B.W.P.A. ANNUAL CONFERENCE 1988

TREATMENT OF STEAM-CONDITIONED PINE POLES WITH COPPER NAPHTHENATE IN HYDROCARBON SOLVENT

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R. W. HEIN, *Mooney Chemicals, Inc., USA*

INTRODUCTION

According to Minich and Goll (1984), copper naphthenate (CuNap) was suggested as a potential wood preservative by von Wolniewicz as early as 1889 and had been discussed in detail by Charitschkow in 1909. Up to 1948, considerable work was carried out with naphthenic acids and their salts, most notably copper. In terms of wood preservation, most of this work had centered on the efficacy of this preservative system (Vicklund 1947; Tamblyn, et al. 1947; Berry and Carter 1941, 1945; Baechler 1947; Richards and Addoms 1947; Bryson 1936, 1937; Smith 1938; Gilbreath 1943; Von Schrenk 1946). Currently, the American Wood Preservers' Association has reapproved copper naphthenate as a preservative and has set various analytical standards for copper naphthenate (Committee P-5 1987). Retention standards for various commodities are under active consideration. Unfortunately, there is a dearth of information on treatment mechanics, preservative gradients, and treating solution characteristics using this preservative system.

Preliminary treatment data generated from a series of four charges were presented to the AWPA in 1986 (Barnes 1986). Water removed by steam/vacuum was comparable to that found in industrial practice, 80 kg/m^3 in this instance. End-sealed pole sections were treated using 205 kPa initial air pressure and a maximum pressure of 1034 kPa using CuNap in No. 2 fuel oil amended with 10% KB-3 cosolvent (P9 type A). Two charges were treated at ambient temperature and two at 82°C. These initial data are shown in Table 1. Assay results from borings were normalised to a 0.8% Cu (as metal) treating solution concentration and the gradients were plotted (Fig. 1). The solution strength used to treat the fourth charge was increased to see the effect of higher concentration on the gradient shape.

The data in Table 1 indicate that adequate treatment may be obtained when treating steam-conditioned pine poles at ambient temperature. The lower copper content of the kickback[1] and vacuum drip solutions indicates the removal of copper from the treating solution by wood. The percent reductions in copper between the initial treating solutions and the effluent (kickback and vacuum drip) solutions averaged 16% and 23% for the ambient and 82°C charges, respectively. This may indicate that heating promotes the fixation of copper in the wood, and that this effect is more pronounced with higher treating solution concentrations, as was the case for the charge treated with a 1.4% treating solution.

The copper gradients in Fig. 1 are similar in shape to each other. This would indicate that neither heating nor increasing the treating solution concentration had much effect on gradient shape. These data are compared with published pentachlorophenol (penta) gradients (Kelso and Parikh 1976, Rogers and Kelso 1958) for steam-conditioned southern pine treated at 82°C. As shown in Fig. 2, there is essentially no difference between the shape of the composite copper gradient and the penta gradients when compared on an equivalent solution basis[2].

This preliminary study led to the pilot plant work described in this paper. The purpose of this study was to determine appropriate treating parameters for the empty-cell treatment of southern pine with CuNap carried in hydrocarbon solvent, including the effects of initial and post-treatment conditioning cycles. In addition, questions regarding the fate of the treating solution and effluent streams were addressed.

RAW MATERIAL PROPERTIES

Material Preparation

Selected trees of loblolly pine (*Pinus taeda*) were harvested from the Starr Memorial Forest located near Starkville, Mississippi, cut into nominal 2.4 m pole stubs, and debarked immediately. They were transported to the Mississippi Forest Products Laboratory, dipped in a commercial anti-sapstain formulation, and placed under non-drying conditions until used. The nominal pole stub diameter was 20 cm. Prior to steam-conditioning and treatment, the stubs were allowed to air-season for one to two weeks except where noted. Stubs were then sectioned into matched 1.2 m halves and the central disk between halves was reserved for the determination of initial moisture content and specific gravity (oven-dry weight, green volume basis).

Preservative Solution

A nominal 0.8% (Cu as metal) treating solution was prepared from an 8% (Cu) CuNap concentrate (M-Gard™ S-520[3], Mooney Chemicals, Inc., Cleveland, Ohio) and No. 2 fuel oil with no cosolvent. This aliphatic oil met all requirements of AWPA Standard P9 for hydrocarbon solvent, type A, with the exception of penta solvency. The distillation characteristics of the oil are shown in Table 2 along with AWPA minimum standards.

Conditioning Cycles

Pole stubs were steamed for each treatment charge. After the application of a 30 min initial vacuum, the stubs were closed-steamed using the following cycle: break vacuum by increasing the temperature to 118°C in one hour; steam at 118°C for a minimum of one hour per 25 mm of sapwood plus one hour; and apply a final vacuum for one to two hours until no condensate accumulates in the condensate receiver. The steaming temperature was maintained via steam coils in the bottom of the cylinder. After steaming, the stubs were removed from the cylinder, weighed, and allowed to cool to or slightly below the target treating temperature before returning them to the cylinder for treatment.

Pole stubs designated air-dried were allowed to air-dry under cover until their moisture content at a depth of 50 mm was less than 30% as determined with an electrical moisture meter.

Treatment Cycle

A typical Rueping empty-cell process was used to treat all charges. An initial air pressure of 205 kPa was placed on the charge unless otherwise noted. Preservative solution, preheated to the desired treating temperature (ambient, 60°, 71°, 82°, and 93°C), was introduced into the cylinder. After the cylinder was filled, the pressure was increased to the maximum pressure of 1034 kPa in 30 minutes unless otherwise noted. Pressure was applied through a filled scale tank on a weighing platform, thus allowing for the computation of the gross injection curve. Temperature was maintained using steam coils in the bottom of the treating cylinder. After reaching the desired

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[1] *Kickback, as used in this paper, is defined as the treating solution forced out of the treated wood by trapped gases expanding as the pressure is reduced.*

[2] *Equivalent solution retentions were calculated by dividing the assay retentions by the treating solution concentrations used.*

[3] *The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. Such use does not constitute an offical endorsement or approval by the Mississippi Forest Products Lab or Mississippi State University of any product or service to the exclusion of others which may be suitable.*

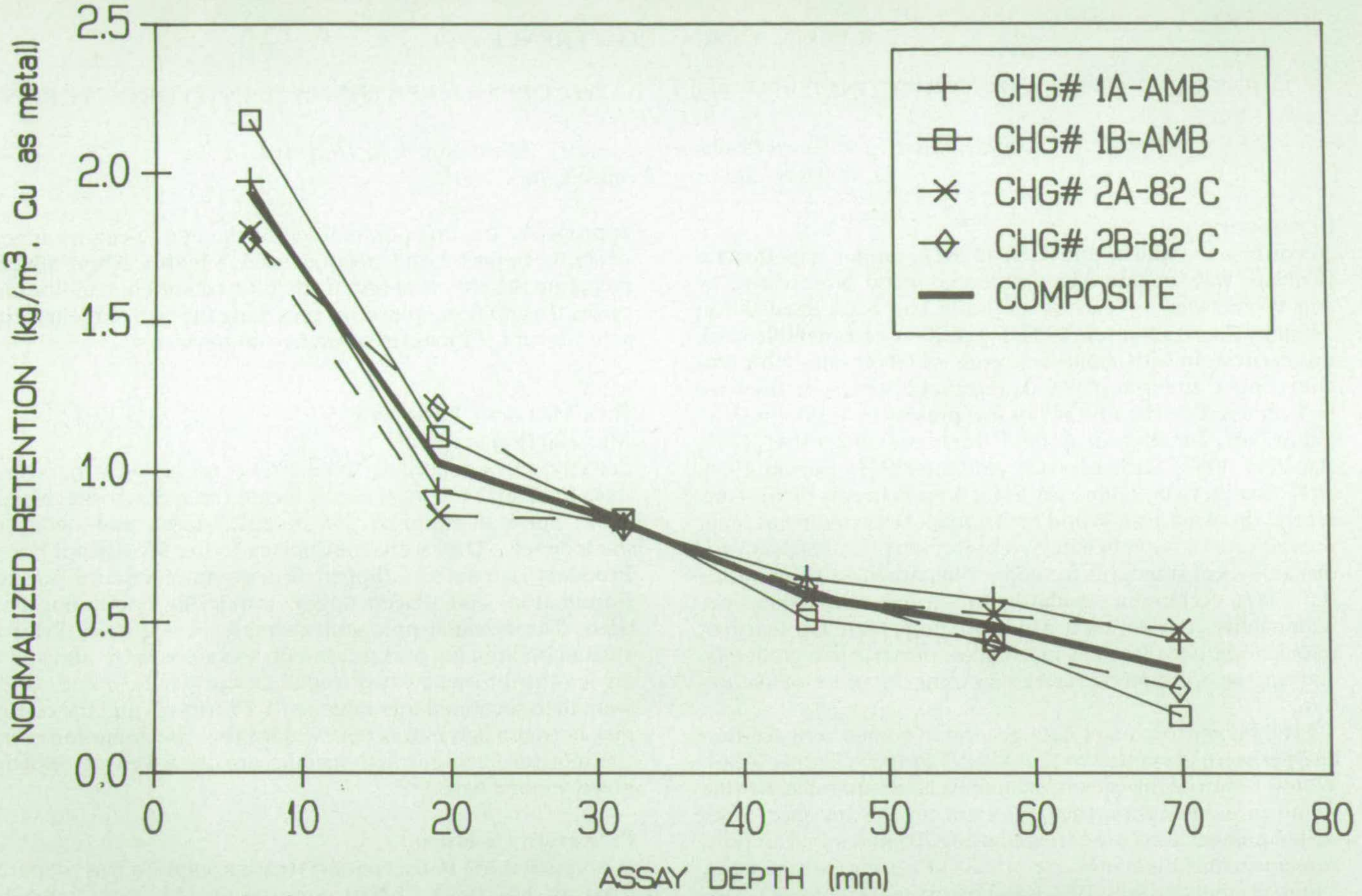

Fig. 1. Gradients normalised to 0.8% (Cu, as metal) treating solutions for steam-conditioned pine treated with copper naphthenate in P9 type A solvent.

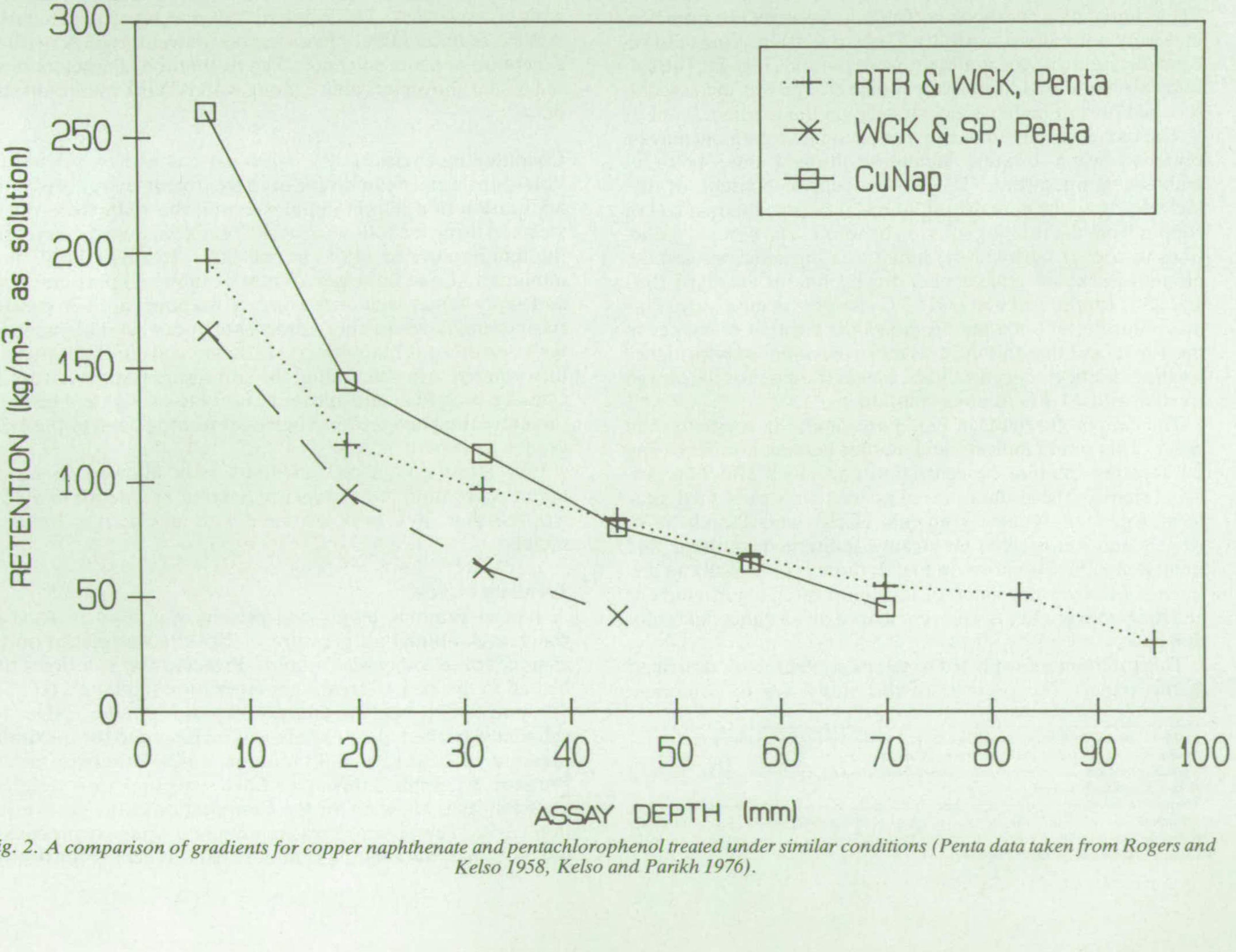

Fig. 2. A comparison of gradients for copper naphthenate and pentachlorophenol treated under similar conditions (Penta data taken from Rogers and Kelso 1958, Kelso and Parikh 1976).

target gross retention, the pressure was reduced until the initiation of kickback. The preservative was then returned to the working tank after which the cylinder was vented to atmospheric pressure and the kickback was collected and weighed. For most charges, a final vacuum of one to two hours at maximum intensity (−88 kPa) followed by collection and weighing of the vacuum drip completed the cycle. Other post-treatment conditioning cycles are described below. Net retention was determined by weight gain.

A sample of the working tank solution was taken for analysis prior to returning the kickback and vacuum drip to the working tank. Samples of this solution along with those of the original solution, kickback, and vacuum drip were analysed as described below. A series of trial charges was used to establish the best nominal initial air pressure, target gross injection, and rate of pressure increase.

Post-treatment Thermal Conditioning

In addition to the simple vacuum applied after treatment, two thermal post-treatment conditioning schedules were used. In the first instance, designed as a fixation cycle, the filled cylinder was vented to atmospheric pressure, kickback was allowed to occur into the bulk treating solution, and the solution was heated to 93°C for two hours prior to the removal of preservative solution to the working tank. A final vacuum completed this treatment. This schedule (Fig. 3) corresponds to the MCI Process patented by Hein and Kelso (1987).

The second schedule involved two charges each of air-dried and steam-conditioned stock. A 30 min initial vacuum was applied, followed by a two-hour final steaming period. The steaming cycle consisted of raising the temperature to 118°C in one hour followed by direct steaming at 118°C for one hour. A final vacuum completed this treatment. After treatment and final conditioning, all sections were bored for assay as described below. Borings were taken within one month of treatment.

Solution Analyses

Solution samples were analysed for copper content by x-ray fluorescence using an Asoma Model 8620 analyser. These data were cross-checked by atomic absorption spectrometry (A.W.P.A. Standard A-11) using wet ashing procedures (A.W.P.A. Standard A-7). The solutions were also analyzed for acid number using the proposed A.W.P.A. Standard A-13 (Report of Committee P-5 1987).

Retention Determination

Each 1.2 m pole stub was bored to the pith on third-points around the circumference of the stub at longitudinal distances of 30 cm, 60 cm, and 90 cm from the end of each stub. Borings were segmented into the following zones for analysis: 0-13, 13-50, 50-75, and 75-100 mm from the surface. Similar zonal segments from all stubs in a charge were combined for analysis. An additional boring from the mid-point of each stub was taken. The A.W.P.A. assay zone (13-50 mm) was taken from this boring and separated into earlywood and latewood components for analysis. Assay procedures for Cu as metal similar to those described above were employed for the wood analyses.

TABLE 2

Distillation characteristics of the hydrocarbon solvent

Amount Distilled (%)	*IBP*	*10*	*20*	*30*	*40*	*50*	*60*	*70*	*80*	*90*
Distillation Temperature (C)	210 211	235 236	247 250	260 260	271 271	170 282	292 293	304 304	318 319	338 341
Avg.	211	236	248	260	271	282	293	304	319	339
A.W.P.A., P9 Type A (min)						254				307
No.2 Fuel Oil, 1985 Avg. of 36 Southeastern US Refineries						268				322

Sludge and Corrosion Determination

Laboratory sludge tests and laboratory and pilot plant corrosion tests were conducted. The sludge tests were conducted by refluxing preservative solutions and water in the presence of mild steel and wood for 14 days at an average temperature of 116°C. Water (14 g total) was added dropwise over the first two days of the refluxing period to 300 g of preservative solution containing a 32 g mild steel coupon and eight pine blocks measuring 10 × 19 × 19 mm. Two aromatic (Medium Aromatic, Shell Oil; Hi-Sol 400, Ashland) and two aliphatic (No. 2 diesel; 510 oil, Pennzoil) solvents meeting the A.W.P.A. P9-Type A standard were used to make 1% (as metal) CuNap and 7% pentachlorophenol solutions. After the refluxing period, the solutions were centrifuged and filtered and the sludge and water were determined (Am. Soc. Test. Mat. 1985). Corrosion was determined by weight loss.

An additional laboratory corrosion test was conducted by submersing a mild steel coupon in 165 g of aqueous preservative for 14 days at 100°C. The following solutions were evaluated: (1) 1% Cu in P9A solvent; (2) 75 g of 0.5% Cu, 75 g of 60/40 commercial grade creosote, 15 g of water; (3) as (2) except 75 g of 5% penta in P9A solvent rather than creosote; and (4) as (2) except 75 g of 5% penta in P9A solvent rather than Cu. After exposure, the corrosion was determined by coupon weight loss.

For the pilot plant corrosion test, 30 corrosion coupons, measuring 25 × 50 mm, were fabricated from carbon steel. Fifteen coupons each were placed in the treating cylinder and the working tank for the duration of this study. The corrosion rate was determined by weight loss.

TABLE 1

Summary of the initial study charge data for steam-conditioned pine treated with copper naphthenate in P9-type A solvent

			Retention		*Solution Analyses*				*Change in Cu from Initial*		
Charge #	*Volume Treated (m^3)*	*Water Removed (kg/m^3)*	*Solution*	*Cu, as metal (kg/m^3)*	*Initial*	*Final*	*Kickback (% Cu, as metal)*	*Vacuum Drip*	*Final (%)*	*Kickback (%)*	*Vacuum Drip (%)*
AMBIENT											
1A	0.015	65.6	142.4	1.2	0.877	0.881	0.770	0.743	0.5	-12.2	-15.3
1B	0.015	89.6	124.8	1.1	0.882	0.874	0.736	0.717	-0.9	-16.6	-18.7
82C											
2A	0.016	59.2	134.4	1.1	0.818	0.810	0.624	0.759	-1.0	-23.7	-7.2
2B	0.017	104.0	150.4	2.2	1.459	1.382	0.972	1.044	-5.3	-33.4	-28.4

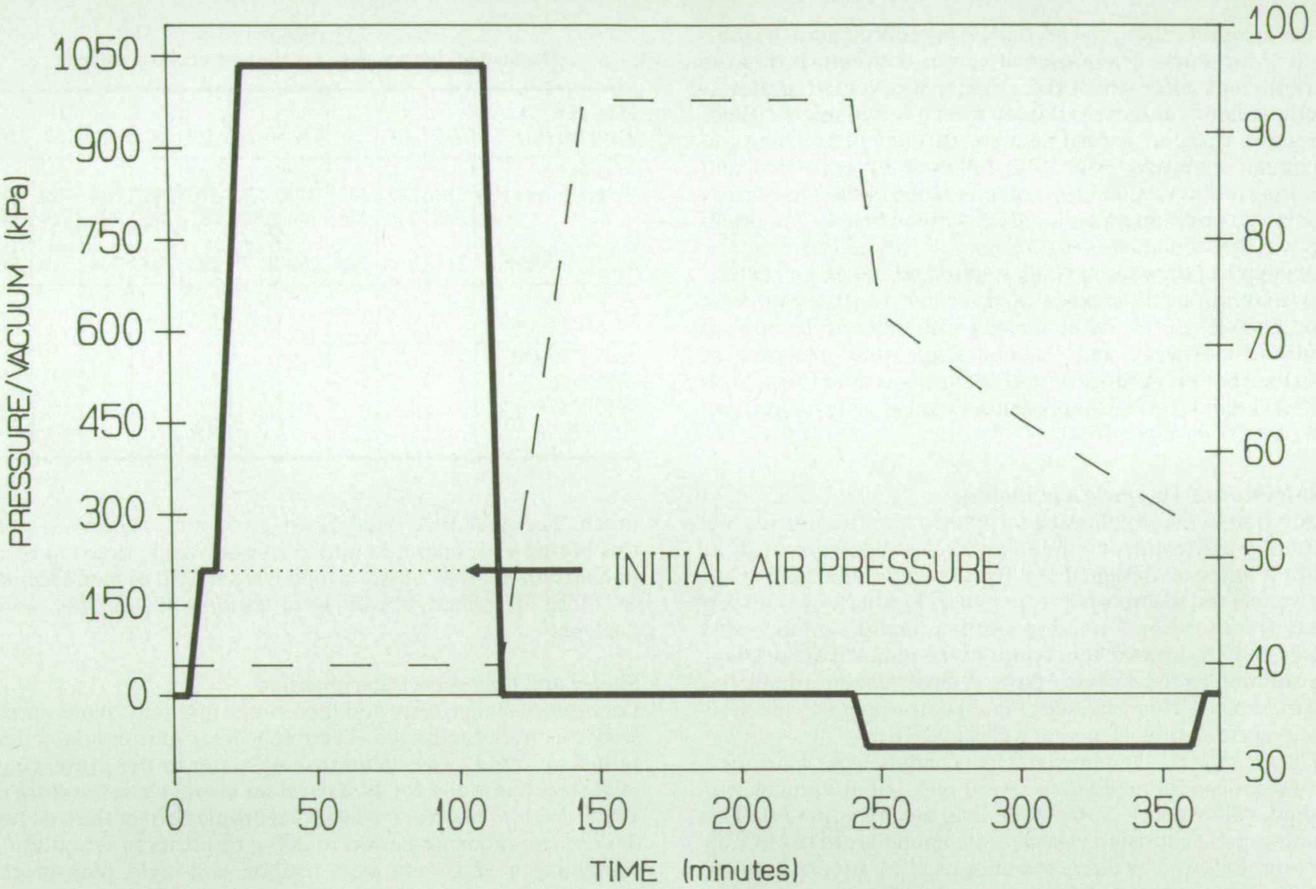

Fig. 3. Typical Rueping empty-cell cycle with a final fixation bath (M.C.I. Process). [Pressure indicated by solid line]

RESULTS AND DISCUSSION

A series of five trial charges (see Table 3) was conducted in order to optimise treating variables. Target net retention was 128-160 kg/m^3 of CuNap solution, corresponding to the nominal range of solution used by most U.S. producers of poles treated with penta in oil. Variables included in this preliminary study included initial air pressure, target gross retention, and rate of pressure increase. Four charges were treated at 71°C, while one was treated at 66°C. Increasing the initial air pressure to 275 kPa increased treatment time and resulted in a lower net retention than in charges treated at 205 kPa initial air pressure. Based on the trial charges, an initial air pressure of 205 kPa was used in the subsequent detailed study. All subsequent charges were treated to a target gross retention of 224 kg/m^3 or refusal, whichever came first. A summary of the charge data is given in Table 4. A total of 38 pilot charges, including trial runs, were treated.

Effect of Temperature and Initial and Post-treatment Conditioning Gross Injection Curves

The effect of temperature on the gross injection curves can be seen in Fig. 4. These curves are fitted from the experimental data, with R^2 values ranging from 83.1% to 91.6%. Gross and net retentions as affected by treating temperature and post-treatment conditioning are shown in Fig. 5 for the steam-conditioned charges. Increasing the temperature generally led to higher injection rates, while in charges subject to a final vacuum only, the ratio of net:gross injection was unaffected by treatment temperature. The effect of temperature can be seen more clearly in Fig. 6, in which the gross injection after 60 min of pressure for various treating temperatures is plotted.

Final steaming tended to remove more preservative from the treated stock. Little difference in the net:gross ratio was noted for charges treated at ambient conditions and subjected either to a final vacuum or a fixation period.

TABLE 3

Summary of trial charge data for steam-conditioned southern pine treated with copper naphthenate in hydrocarbon solvent

Initial air pressure (kPa)	*Time to max pressure (min)*	*Target gross injection (kg/m^3)*	*Time to target injection (min)*	*SpGr*[1]	*Moisture Content After Steaming (%)*	*Solution Retention (kg/m^3) Net*	*Gross*	*Net: Gross Ratio (%)*	*AWPA Ret. (kg/m^{3}cu)*	*No. of Charges*
205	30	224	160	0.525	47	177.2	224.2	79	1.7	1
205	30	256	100	0.422	43	201.9	262.8	77	2.0	1
275	1	256	110	0.530	28	179.5	256.5	70	2.0	1
275	30	256	165	0.394	70	148.2	257.0	58	1.5	2

[1] Specific gravity – oven-dry weight, green volume basis

TABLE 4
Summary of charge data for steam-conditioned and air-dried southern pine treated with copper naphthenate in hydrocarbon solvent

Treating Temp	*Final Conditioning Cycle*	*SpGr*[1]	*Moisture Content*		*Solution Retention*		*Net: Gross Ratio (%)*	*Time to*		*AWPA Ret. (kg/m³Cu)*	*No. of Replicate Charges*
			Initial (%)	*Steamed (%)*	*Net (kg/m³)*	*Gross (kg/m³)*		*Gross (min)*	*160 kg/m³ (min)*		
Steam-conditioned charges											
93 C		0.487	44	43	174.0	225.7	77	63	31	1.6	3
82 C		0.472	48	46	152.6	225.6	68	94	55	1.6	5
82 C	Steamed	0.494	57	34	151.8	233.9	65	100	32	1.6	2
71 C		0.464	67	61	162.7	225.2	72	94	38	1.5	4
60 C		0.466	51	47	161.9	208.0	78	154	69	1.4	4
60 C	Fix	0.455	79	68	134.0	177.4	75	133	75	1.6	4
60 C-Green[2]	Fix	0.437	115	95	55.7	141.8	39	120	–	0.6	2
Ambient (38 C)		0.494	62	56	131.7	169.9	77	155	89	1.6	2
Ambient	Fix	0.459	48	44	161.6	223.0	72	145	53	1.6	2
Avg. steam-conditioned		0.474	57	50	153.8	211.1	73	117	54	1.4	
Air-Dried Charges											
Ambient		0.494	–	28	155.5	209.3	74	140	57	1.4	2
Ambient	Fix	0.460	–	26	91.5	230.2	40	90	32	1.2	1
82 C	Steamed	0.442	–	32	106.5	244.8	44	35	20	1.3	2
Avg. Air-dried		0.465	–	28	117.8	228.1	53	88	36	1.3	

[1] Specific gravity – Oven-dry weight, green volume basis.
[2] Values not included in steam-conditioned averages.

The net:gross ratio was lowest for those charges with very high moisture content, and for those charges with lower moisture content that had undergone a final "expansion" step (final steaming or fixation bath).

The effect of temperature on the gross and net injection is shown in Fig. 7. Both retentions increased with increasing temperature, with gross injection being more greatly affected. Moisture content at treatment had the greatest effect on injection, as is clear from Fig 8. In general, increasing the temperature resulted in shorter treatment times. It is interesting to note that, depending on temperature, the press time for steam-conditioned charges treated with CuNap ranges from two to five times that required for treating steam-conditioned pin, with penta in hydrocarbon solvent (Kelso and Parikh 1976). For air-dried stock, the time required is about double that for penta solutions at 82°C. This implies that commercial pressure periods may need to be lengthened when using CuNap solutions in order to get an adequate gross injection. A comparison of injection times for two gross injection levels can be seen in Fig. 9.

Fitted gross injection curves for those steam-conditioned charges treated by the MCI Process are shown in Fig. 10. This figure clearly illustrates the effect of moisture content. The stump-green, steam-conditioned charges yielded the lowest gross and net retentions. The difference between the ambient and 60°C charges is attributed to the higher moisture content for the charges treated at 60°C.

Gross injection curves for air-dried stock are shown in Fig. 4. With air-dried stock, increasing the treating temperature significantly reduced the time-to-gross. A comparison of net and gross retentions for air-dried and steam-conditioned stock is shown in Fig. 11 for stock treated under similar conditions. Significant here is the much lower net retention for air-dried vs. steam-conditioned stock, both treated at ambient temperature and subjected to a final fixation period. The "expansion" effect of the fixation period is much more significant for the air-dried stock. This is attributed to the larger volume of air in the air-dried stock compared with steam-conditioned material.

Preservative Gradients

All preservative gradients were normalised to an 0.8% Cu, as metal, treating solution for comparison on an equivalent basis. Normalised preservative gradients for steam-conditioned stock are shown in Fig. 12 for the various temperatures. Aside from the 93°C charges, treating temperature had no consistent effect on the gradient shape. Gradients for fixed charges are compared with their unfixed counterparts in Fig. 13. These gradients would indicate that the use of a fixation period has no significant effect on the shape of the resultant gradients. However, fixed charges yielded slightly higher gradients. As expected, the gradient for the stump green steam-conditioned stock is much lower than the other gradients. The application of a final steaming period tended to flatten out the gradient in the inner zones for steam-conditioned stock, while having little effect on the gradients for stock initially air-dried (Fig. 14).

Air-dried stock tended to have flatter, more linear gradients than steam-conditioned stock. The fixation period tended to flatten the gradient in the inner zones for both seasoning methods. The closeness of the two air-dried gradients is surprising, especially in light of the low net retention for the fixed material.

Effect of Temperature and Fixation on Treating Solutions

The effect of treating temperature/fixation on the treating solution characteristics is shown in Table 5 for the steam-conditioned charges. Fixation had the advantage of reducing the change in copper concentration and acid number of the resultant vacuum drip. Changes for kickback could not be measured for MCI Process charges since the kickback was taken into the bulk treating solution and was not separated. However, it can be seen that there is no substantial difference in the decrease in % Cu before and after treatment between the fixed and unfixed charges at 60°C (see Table 5). Similarly, there is no difference in acid number. The fact that copper concentration is reduced in the vacuum drip and kickback indicates that copper is being fixed. Were no fixation to occur, the copper concentration of the kickback and vacuum drip should

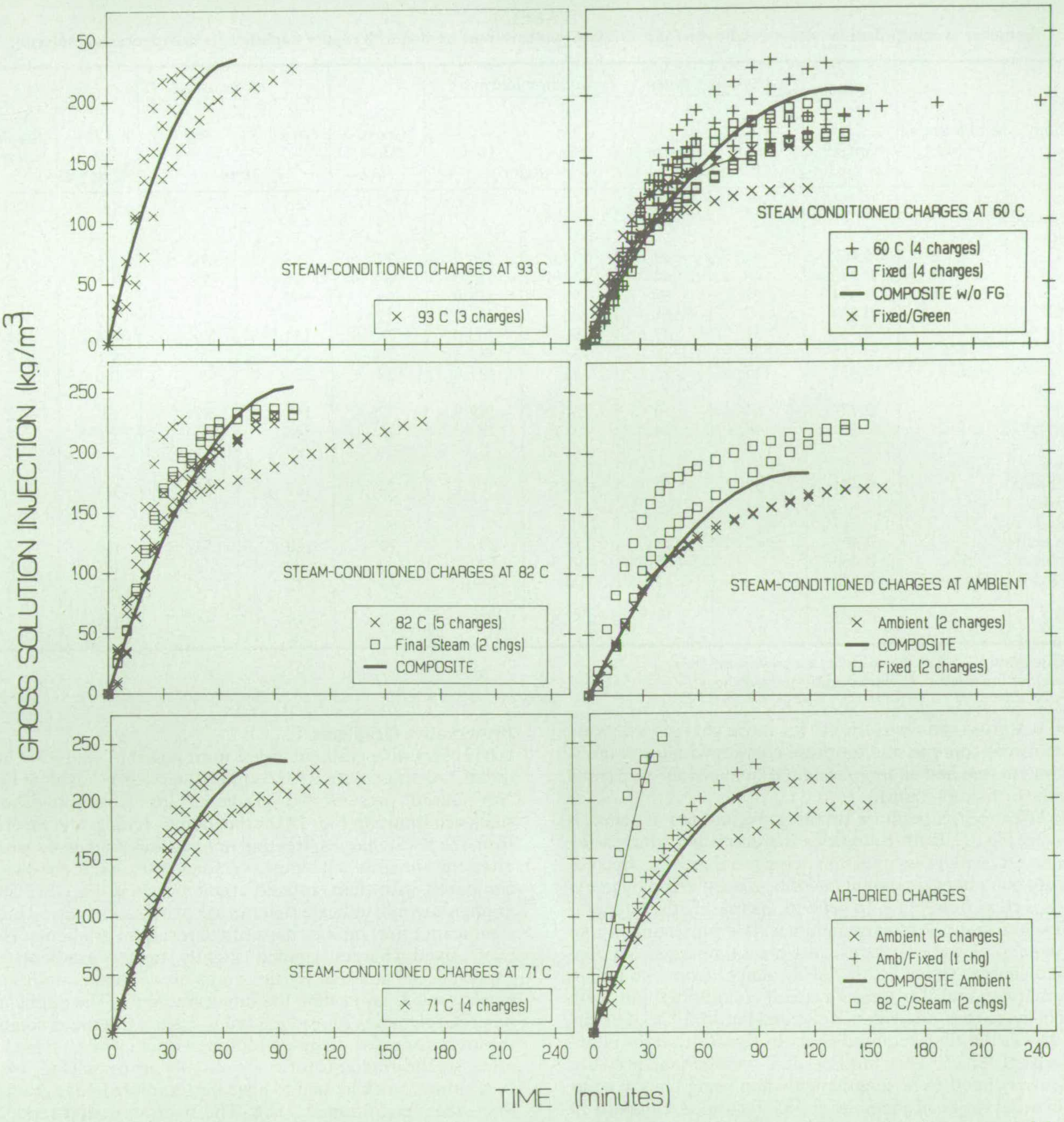

Fig. 4. Effect of treating temperature on the gross injection curves for steam-conditioned southern pine treated with copper naphthenate in hydrocarbon solvent.

be identical to that found in the treating solution. It has been suggested that build-up of naphthenic acids in the stock treating solution after recycling the solution could lead to corrosion. However, the values obtained in this study are sufficiently low so as to indicate no potential corrosion problems. Corrosion considerations are discussed later.

Increasing the treating temperature generally led to greater changes in copper concentration and acid number in the resultant kickback and vacuum drip. These data suggest that by treating with CuNap at lower temperatures and by using a post-treatment fixation schedule, reductions in copper concentration and increases in acid number can be minimised.

For air-dried charges, fixation had about the same effect on the copper concentration or acid number of the vacuum drip (Table 5) that it had on the steam-conditioned charges. Increasing the treating temperature led to smaller reductions in copper concentration and increases in acid number of the resultant kickback. Values for the vacuum drip were similarly changed.

The following general observations can be made. Increasing the treating temperature with steam-conditioned stock led to greater changes in the copper concentration and acid number, while the reverse was true with air-dried stock. For charges treated at 82°C, steam-conditioned charges had greater percent changes in copper concentration and acid number than did air-dried charges. In reviewing these data, it should be noted that the apparently large percentage increases in acid value may be misleading. The acid number of the naphthenic acid without the copper is on the order of 200. Therefore, an increase in acid value from two to five is an increase of 1% to 2.5% in absolute terms.

Fixation Mechanism

It is hypothesised that in wood treated with CuNap, a portion

TABLE 5
Treating solution analyses for charges treated with copper naphthenate in No. 2 fuel oil

	(%) Cu				*Acid Number*			
Treating Temperature/ Final Conditioning	*Before*	*After*	*Kickback*	*Vacuum Drip*	*Before*	*After*	*Kickback*	*Vacuum Drip*
STEAM CONDITIONED CHARGES								
93°C	0.795	0.801	0.408	0.453	1.41	1.47	5.86	5.55
	% Change		–49	–43			314	292
82°C	0.762	0.755	0.533	0.503	1.67	1.67	4.82	5.09
	% Change		–30	–34			189	205
82°C/Steamed	0.727	0.749	0.464	0.526	3.39	3.29	6.52	6.27
	‰ Change		–36	–28			92	85
71°C	0.792	0.789	0.537	0.505	1.53	1.59	4.63	4.80
	% Change		–31	–35			203	214
60°	0.780	0.768	0.613	0.547	1.67	1.67	3.98	4.56
	% Change		–21	–30			138	172
60°C/Fixed	0.771	0.751	–	0.659	2.74	2.80	–	4.08
	% Change		–	–15			–	49
60°C/Fix-Green	0.751	0.735	–	0.640	2.73	2.80	–	4.12
	% Change		–	–15			–	51
Ambient	0.737	0.740	0.620	0.566	3.06	3.08	4.18	4.73
	% Change		–16	–23			+37	55
Ambient/Fixed	0.723	0.709	–	0.660	3.17	3.24	–	3.95
	% Change		–	-9			–	25
AIR-DRIED CHARGES								
82°C/Steamed	0.723	0.707	0.698	0.640	3.04	3.04	3.31	3.87
	% Charge		–3	–11			9	27
Ambient/Fixed	0.786	0.789	–	0.700	2.56	2.42	–	3.28
	% Change		–	–11			–	28
Ambient	0.755	0.756	0.632	0.613	2.74	2.86	4.16	4.23
	% Change		–16	–19			52	54

of the copper is reacted with the wood substance, probably via a stoichiometric exchange mechanism with the uronic acids of the hemicelluloses. This is demonstrated by calculating the changes in concentrations of copper and acid in the initial treating solution vs. the kickback. Using the data for steam-conditioned stock treated at 93°C in Table 5 as an example, the initial copper concentration of 0.795% yielded a value of 0.408% Cu in the kickback, a difference equivalent to 0.061 meq of Cu fixed per gram of kickback. The corresponding increase in acid number (1.41 to 5.86) is equivalent to 0.079 meq of acid generated per gram of kickback. Thus, for every 61 meq of Cu fixed, 79 meq of acid is generated. The reason the average ratio of Cu:Acid in the kickback (Table 6) is less than one (0.74) is perhaps due to acids extracted from the hot, moist wood. The Cu:Acid ratio is close to one (0.94) for the ambient charges, which may indicate that less naturally occurring acid is extracted at 38°C. These data suggest a stoichiometric exchange mechanism. Symbolically, one may write the following scheme:

$Cu(Nap)_2$ + Wood-OH $\rightarrow$
Wood-O-CuNap (or CuNap [Wood-O-complex]) + HNap

One may calculate the total copper retention from the net retention plus the copper fixed from the kickback. Using the data from the 93°C charges.

Net retention
= 174.0 kg/m^3 solution × 0.795% Cu = 1.4 kg/m^3 Cu
Fixed retention
= (225.7 kg/m^3 - 174.0 kg/m^3) × (0.795% - 0.408%)
= 0.2 kg/m^3
Total (by assay) = Net + Fixed = 1.4 + 0.2 = 1.6 kg/m^3.

This result agrees with the A.W.P.A. retention value. Similar data are shown in Table 6 and Fig. 15 for all charges in which kickback was measured. For steam-conditioned charges in which the kickback was weighed, the weighed kickback and vacuum drip were subtracted from the gross retention determined from scale tank readings. This resultant net retention was compared with the net retention obtained from the weight gain data. The two values agreed within an average of 0.2%, indicating that the injection data were very reliable and that little water was removed after the end of the pressure period. This comparison is shown in Fig. 16.

Also shown in Table 6 are the values for the fraction of total copper fixed at the various temperatures. These data show that fixation is increased by increasing temperature. The effect of temperature can be estimated by assuming a linear rate and calculating the degree of fixation on the basis of a common time. Using a time of 60 min yields the values shown in Table 6. Plotting the fraction of total copper fixed vs. temperature yields the logarithmic plot shown in Fig. 17. These data would lend credence to the chemical reaction(s) of some of the copper with wood, rather than mere physical absorption as is the case with penta-petroleum solutions. Continuing research should provide more insight on the fixation mechanism involved with this preservative system.

Earlywood/Latewood Relationships

Average earlywood (E.W.) and latewood (L.W.) retentions are shown in Table 7 for the A.W.P.A. assay zone for the various combinations of initial and final conditioning schedules and treatment temperatures. Data for w/w retentions are calculated on the basis of earlywood density of 329.6 kg/m^3 and a

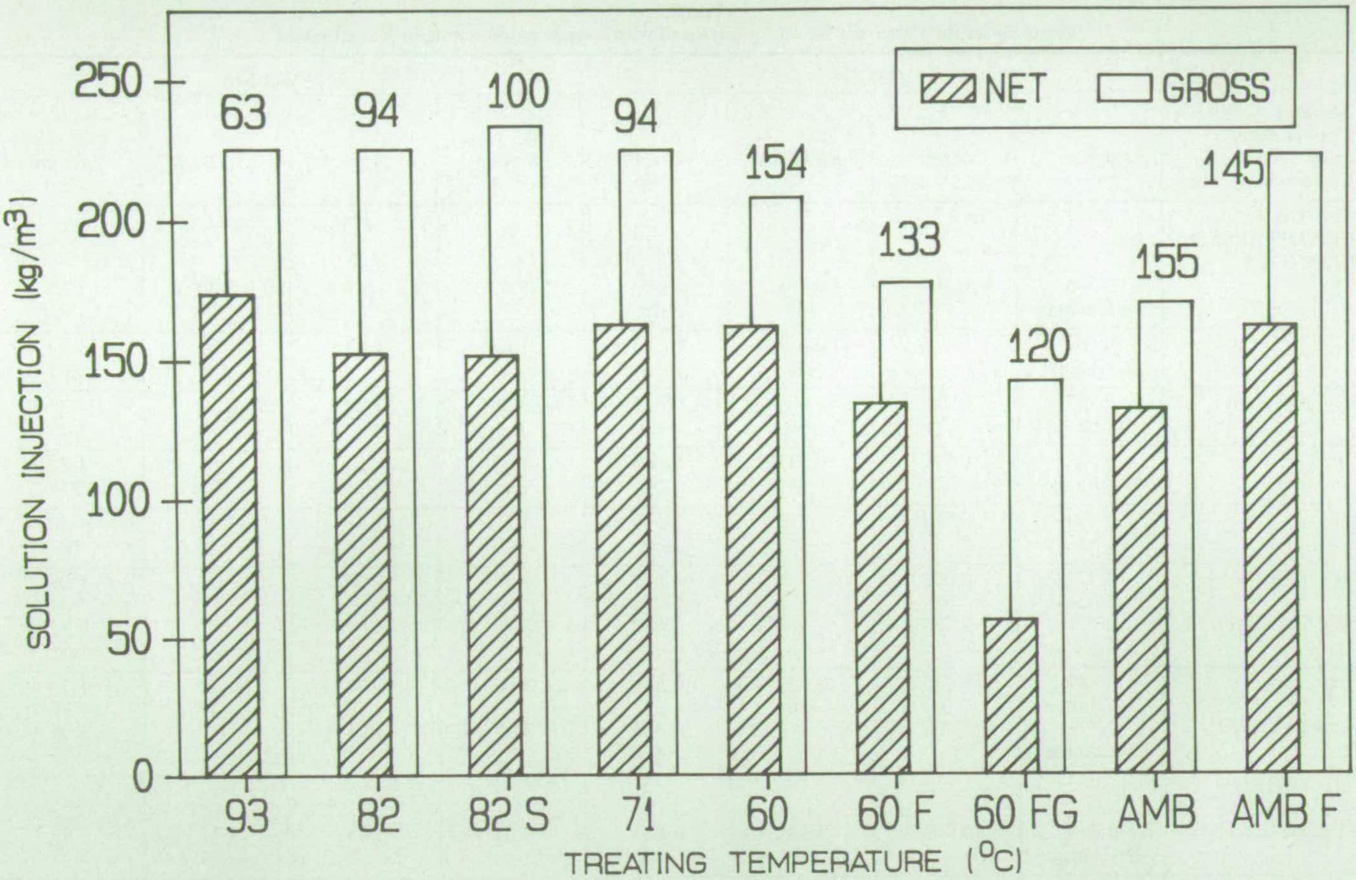

Fig. 5. A comparison of gross and net injections for steam-conditioned southern pine (S = final steaming; F = final fixation bath; G = stock treated stump green; AMB = ambient temperature [38°C]; numbers on bar tops equal length of pressure period in minutes).

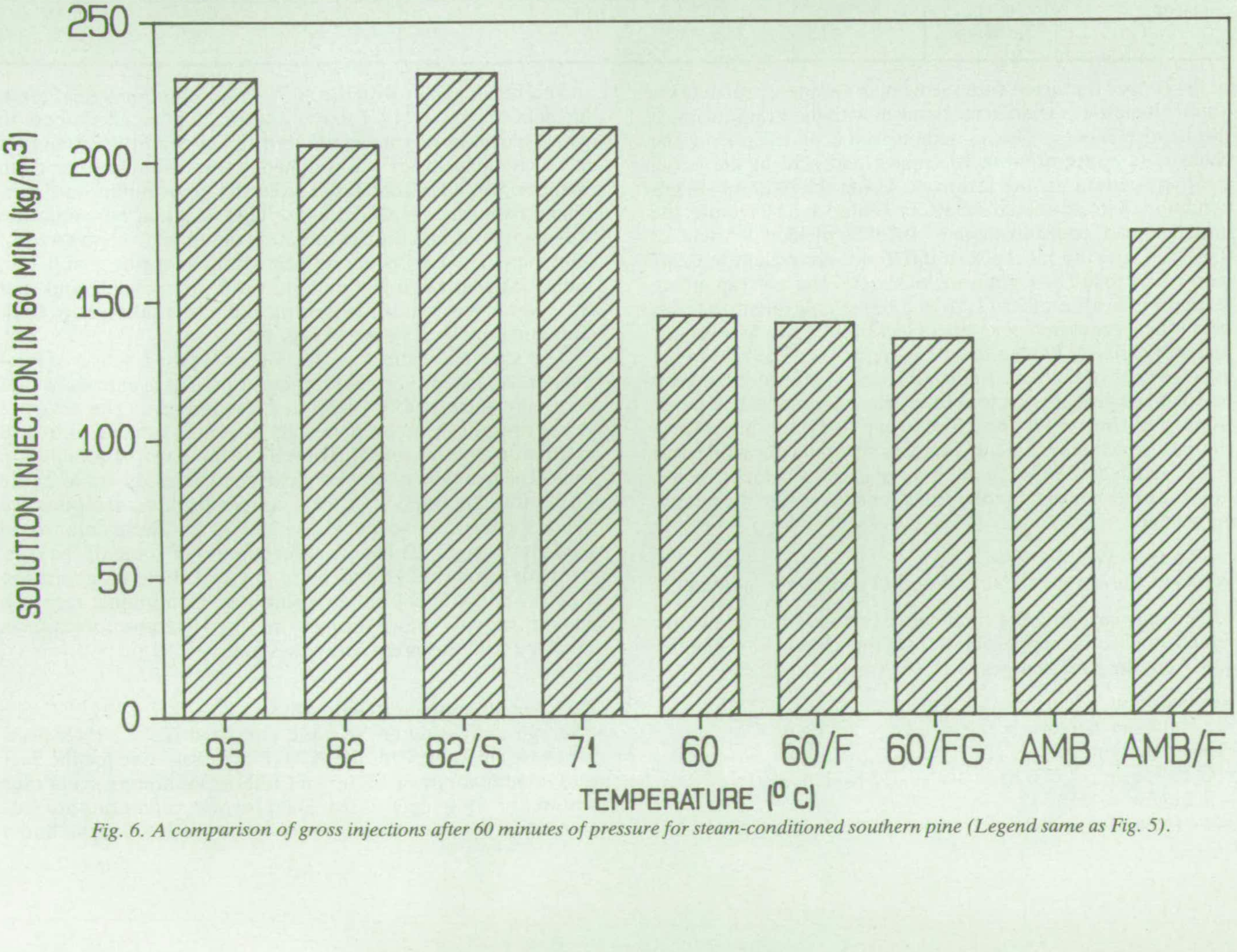

Fig. 6. A comparison of gross injections after 60 minutes of pressure for steam-conditioned southern pine (Legend same as Fig. 5).

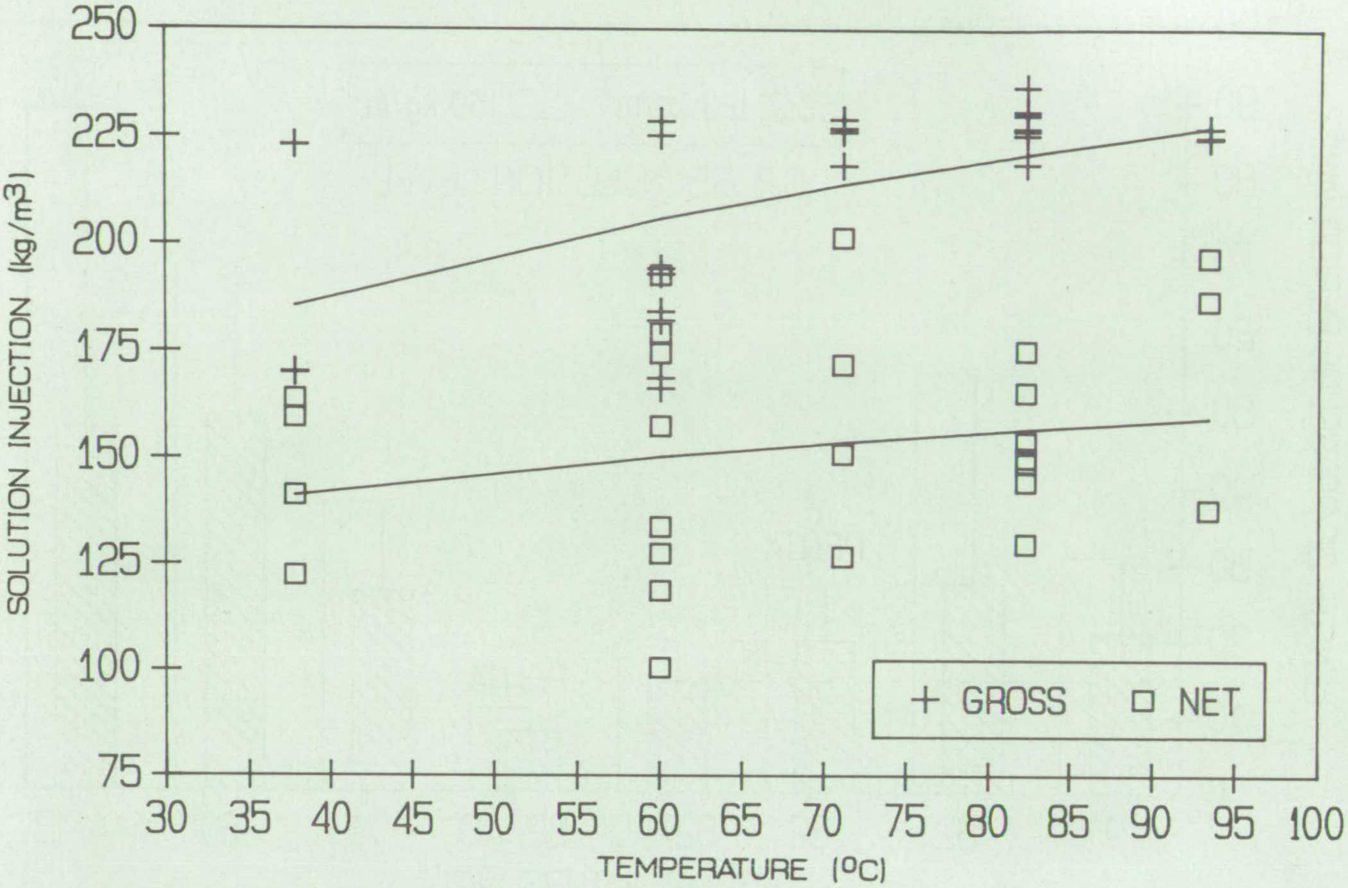

Fig. 7. The effect of treating temperature on the gross and net injections.

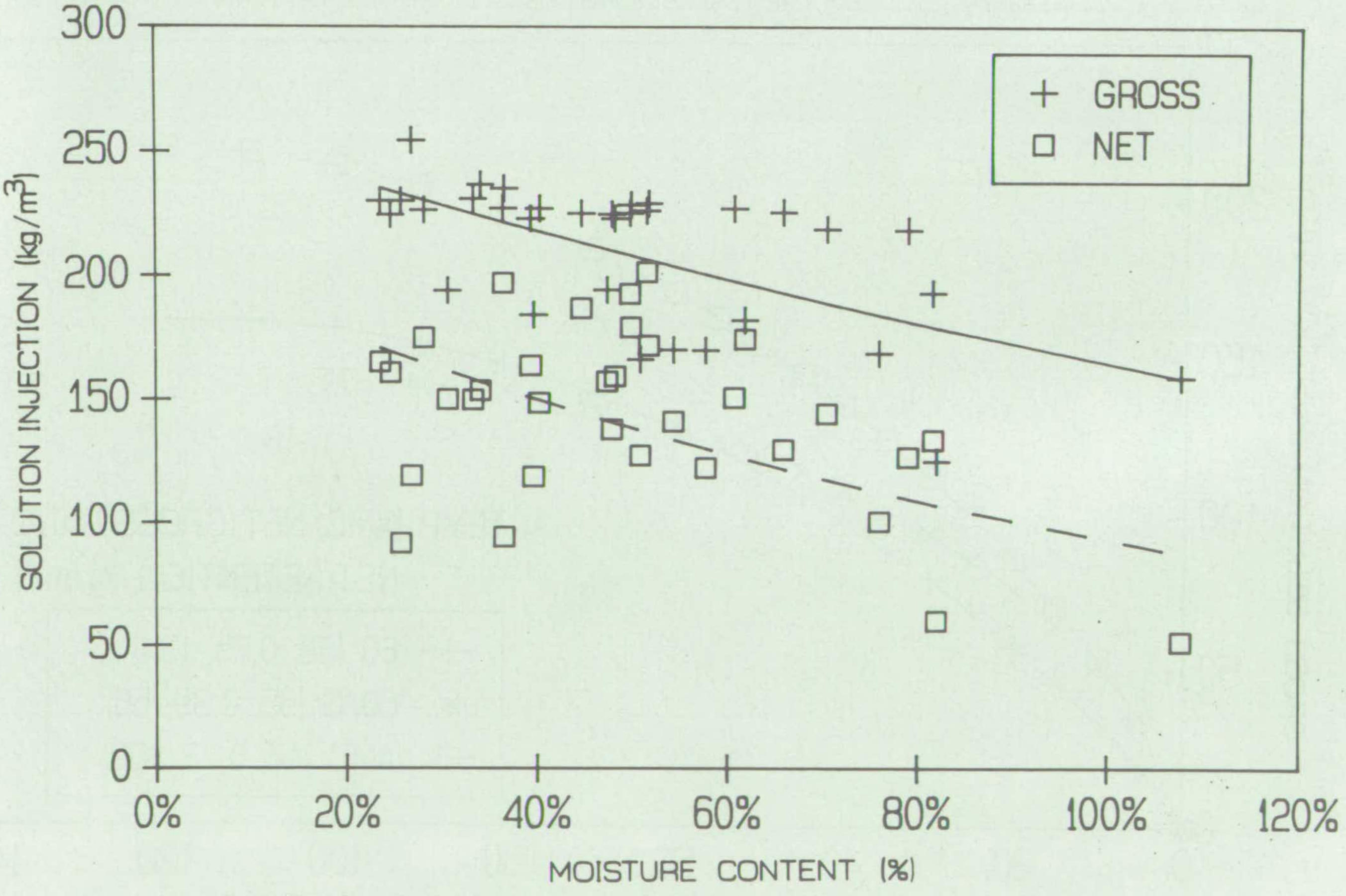

Fig. 8. The relationship between preservative injection and moisture content at the time of treatment.

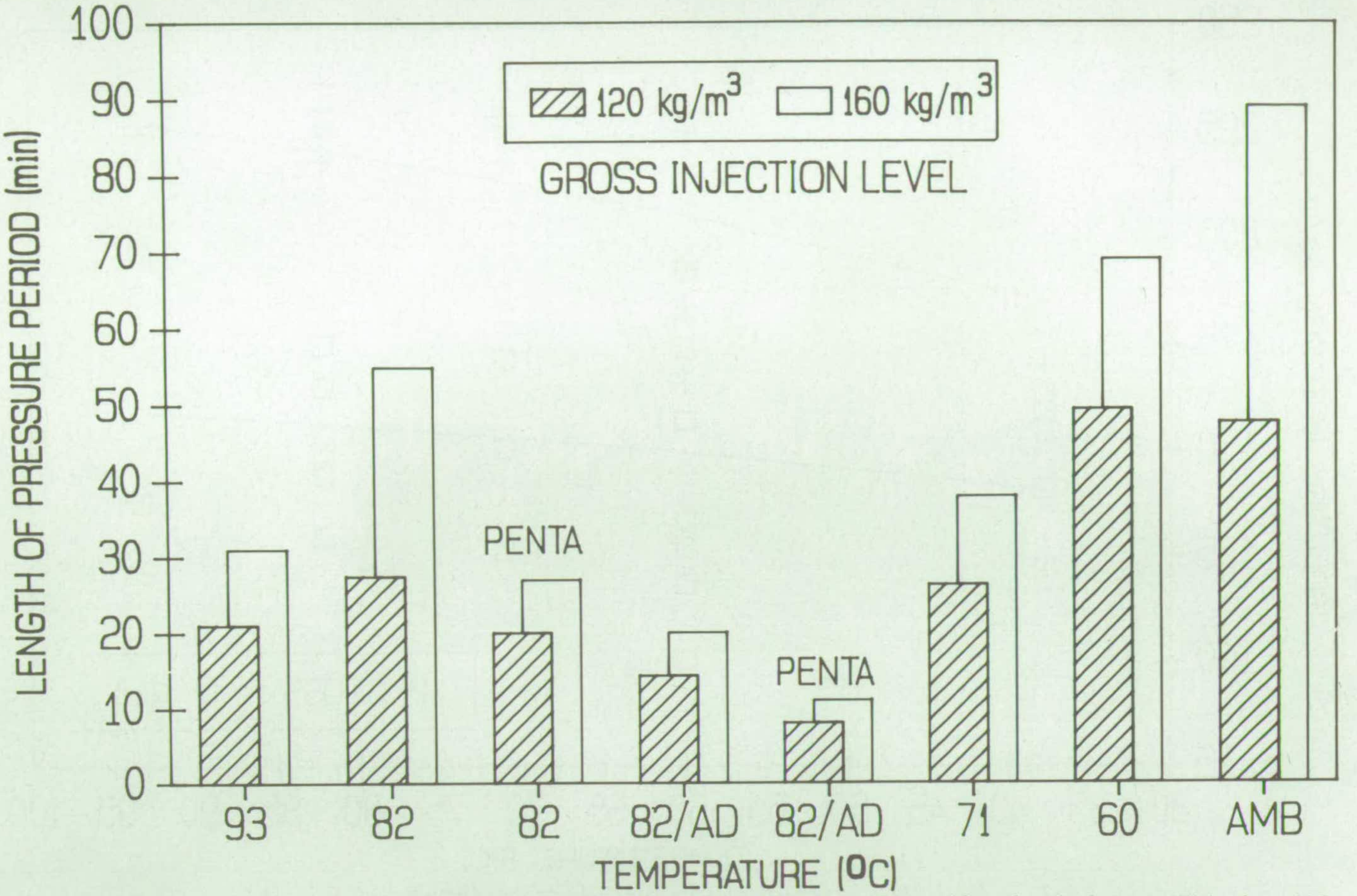

Fig. 9. A comparison of treating times at equivalent gross injections for copper naphthenate and pentachlorophenol solutions in P9A solvent (AD = air-dried stock, all others are steam-conditioned; AMB = ambient temperature; pentachlorophenol data from Kelso and Parikh 1976).

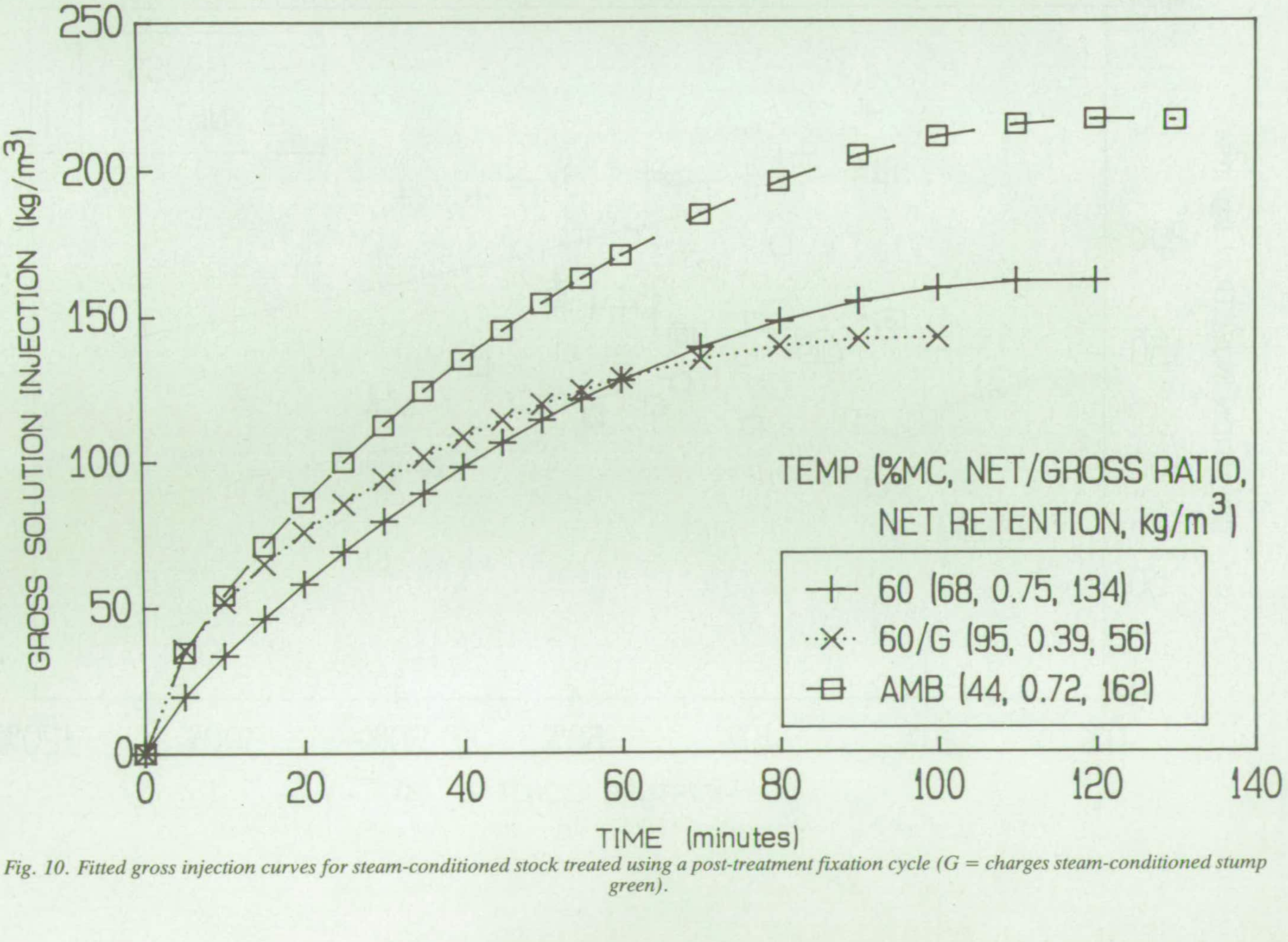

Fig. 10. Fitted gross injection curves for steam-conditioned stock treated using a post-treatment fixation cycle (G = charges steam-conditioned stump green).

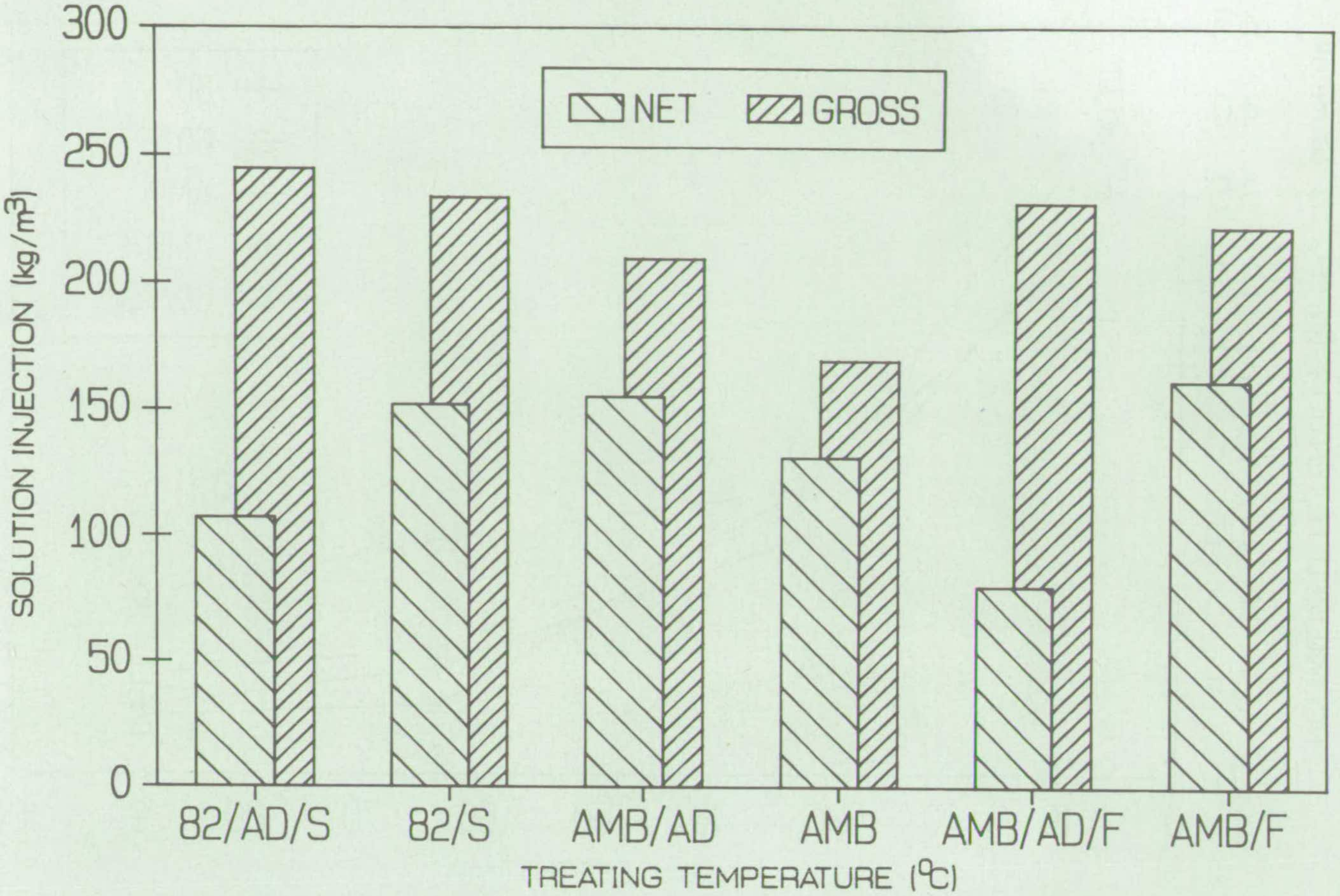

Fig. 11. A comparison of the gross and net solution retentions for air-dried and steam-conditioned stock treated under similar conditions (AD = air-dried, all others are steam-conditioned; S = final steaming period; AMB = ambient temperature; F = final fixation period).

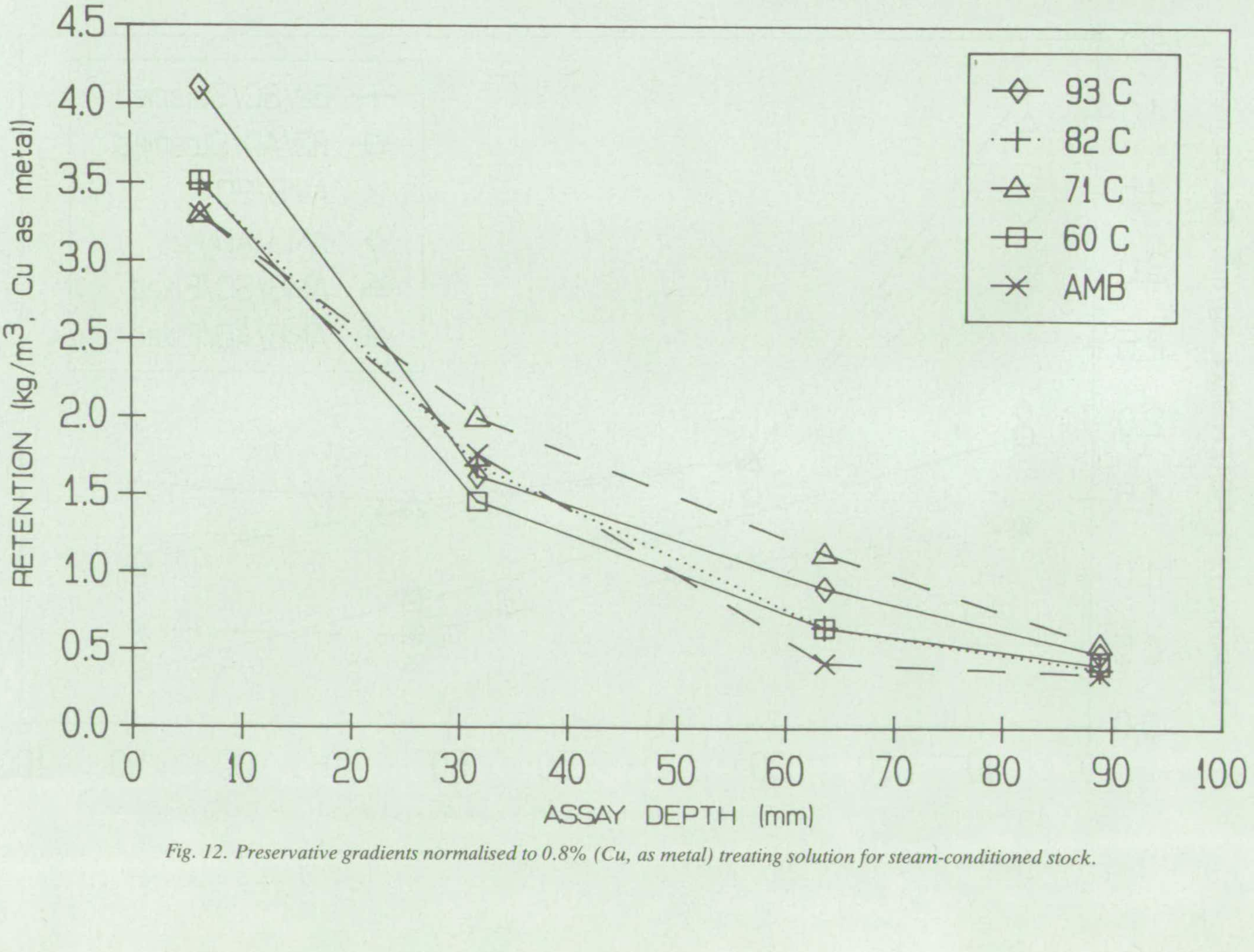

Fig. 12. Preservative gradients normalised to 0.8% (Cu, as metal) treating solution for steam-conditioned stock.

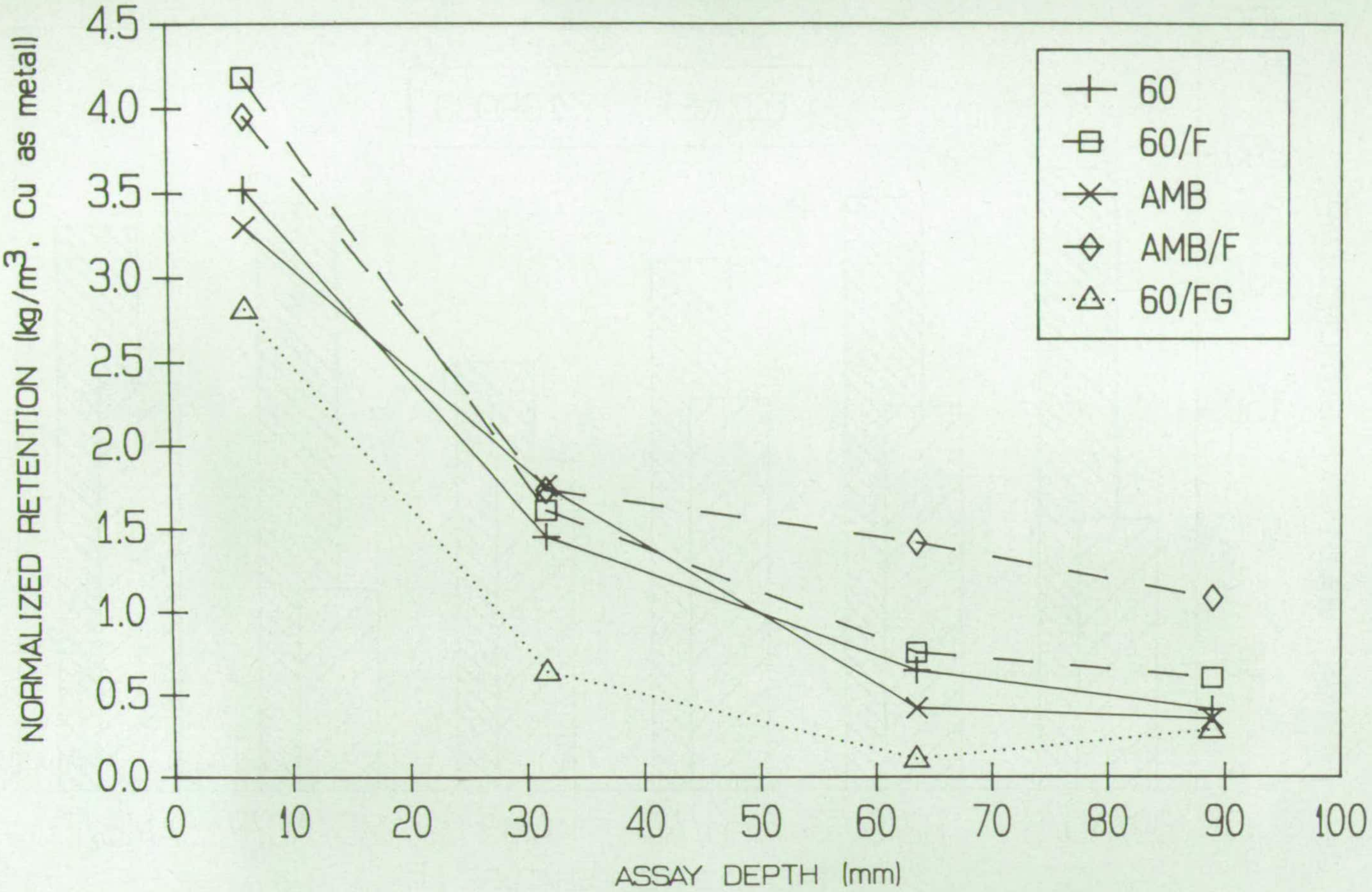

Fig. 13. A comparison of normalised gradients for steam-conditioned stock treated using either a conventional Rueping cycle alone or with a post-treatment fixation period.

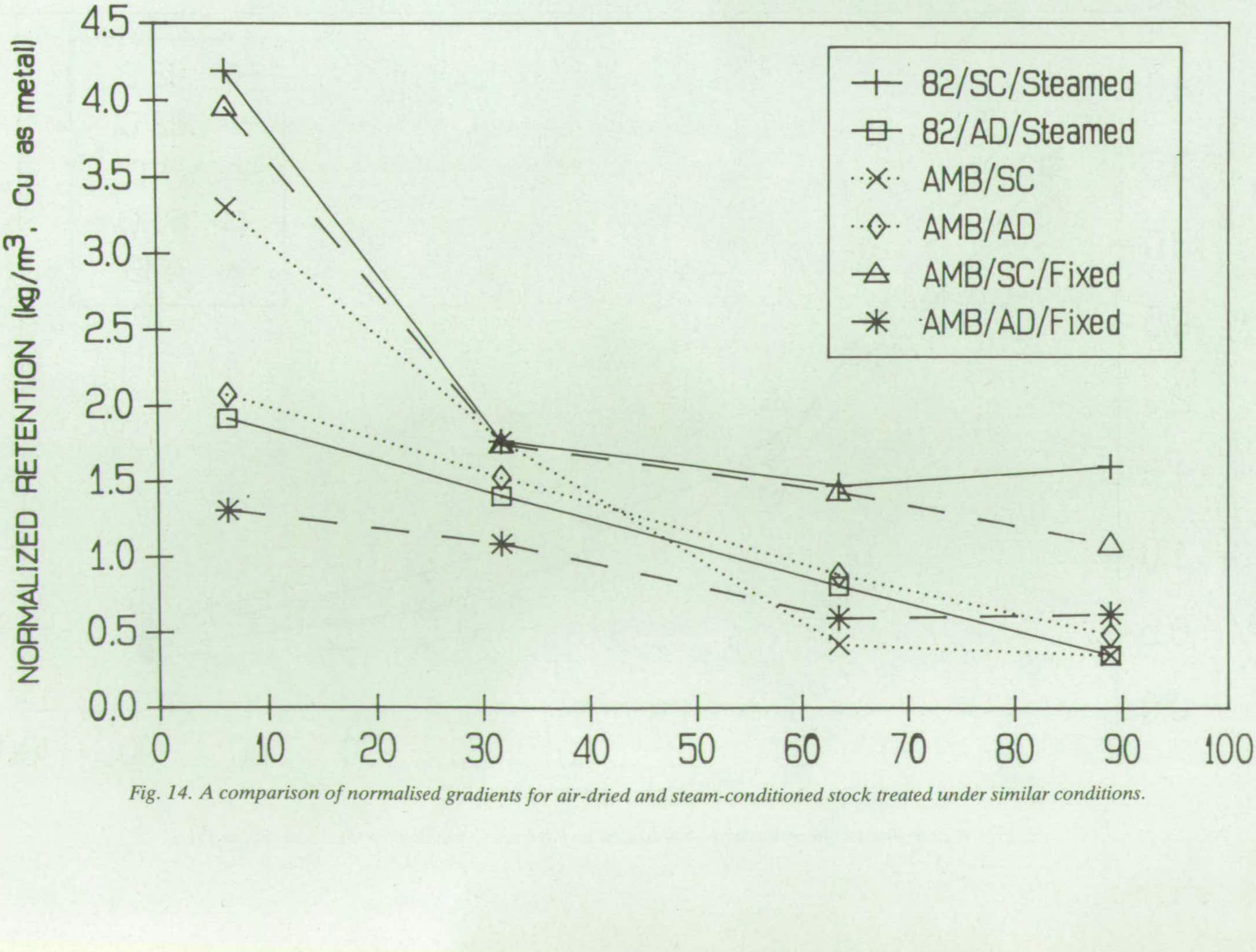

Fig. 14. A comparison of normalised gradients for air-dried and steam-conditioned stock treated under similar conditions.

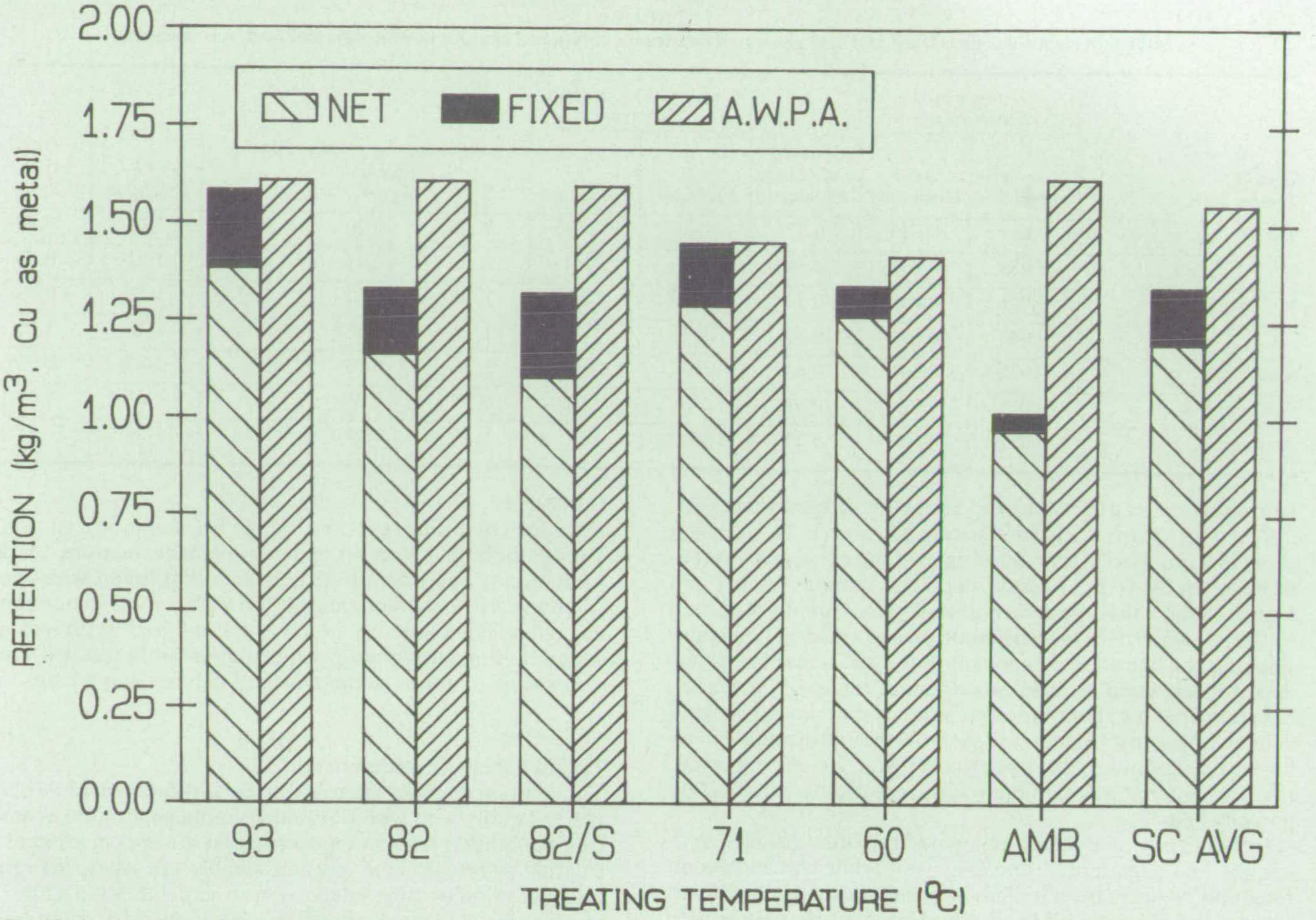

Fig. 15. A comparison of the copper retentions obtained from considerations of the fixation mechanism and the assayed values for the A.W.P.A. assay zone.

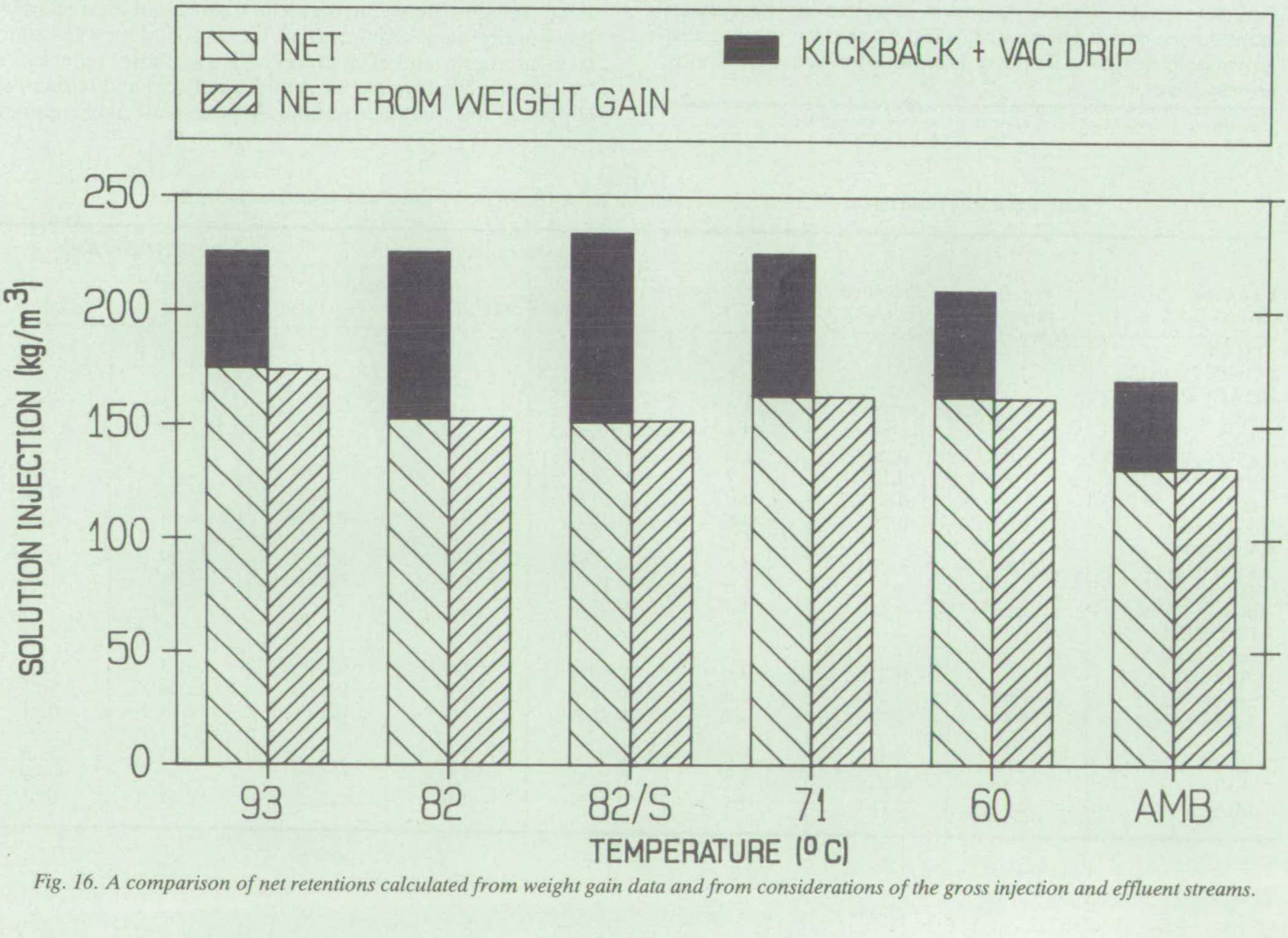

Fig. 16. A comparison of net retentions calculated from weight gain data and from considerations of the gross injection and effluent streams.

TABLE 6
Milliequivalents of copper fixed and acid generated for steam-conditioned charges in which the kickback was measured

	meq/g of kickback for			*% of Total Copper fixed Based on:*		*Net Cu + Cu Fixed = Total (Kickback) (kg/m^3, Cu)*				
Treating Temperature	*Copper Fixed*	*Acid Generated*	*Ratio of Cu/Acid in Kickback*	*Kickback*	*Vac Drip*				*AWPA Retention*	*Total/ AWPA Ratio*
93C	0.061	0.079	0.77	48.6	43.0	1.38	0.20	1.58	1.61	0.98
82C	0.036	0.056	0.64	30.1	34.0	1.16	0.17	1.33	1.61	0.83
82C/Steamed	0.041	0.056	0.74	36.5	27.9	1.10	0.22	1.32	1.59	0.83
71C	0.040	0.055	0.73	30.8	34.9	1.29	0.16	1.45	1.45	1.00
60C	0.026	0.041	0.64	21.4	29.9	1.26	0.08	1.34	1.42	0.95
Ambient (38C)	0.018	0.020	0.91	15.8	23.2	0.97	0.04	1.01	1.62	0.63
Average	0.037	0.051	0.74	30.5	32.1	1.20	0.14	1.34	1.55	0.87

latewood density of 779.2 kg/m^3. These data are shown graphically in Fig. 18. In this figure, the ring position (E.W. or L.W.) assay in kg/m^3 (as Cu) is plotted against the net assayed retention for the A.W.P.A. assay zone. The data in Table 7 and Figure 18 show that the preservative is preferentially absorbed by the latewood over the earlywood on a w/v basis. The steeper slope for the latewood component shows an increasing preference for latewood vs. earlywood as net retention increases. Several variables affect the w/w values, but the available void volume (porosity[4]) generally governs the absorption of oilborne preservatives, as illustrated in Fig. 19. As expected, moisture content at treatment was the greatest factor affecting porosity (Fig. 20).

It should be noted that the latewood retention closely parallels the "no preference" line (Fig. 18), while the earlywood retention diverges from it. This indicates a capacity limitation for earlywood compared to latewood implying that a pole with a high E.W./L.W. ratio should be harder to treat to high solution retentions. This observation requires further experimental verification because of its implication for treating fast-grown pole stock and its possible application to other oilborne preservatives.

Corrosivity

Data for corrosion rates and sludge formation are shown in Table 8 for both laboratory and pilot-plant evaluations. Sludge formation is equivalent to or less than that found with penta solutions. The corrosion rates shown with CuNap solutions are negligible compared to penta solutions and represent no danger to standard treating plant equipment. In fact, CuNap is a corrosion inhibitor commonly used in lubes and greases.

Treating Plant Considerations

The solution analyses discussed above indicate that hot CuNap reacts rapidly with wood, resulting in the generation of some free naphthenic acid and a decrease in the copper content of treating solutions. One may reasonably ask what this result might have on treating solutions in an actual treating plant. To answer this concern, a model was developed based on a fictional treating plant with the characteristics shown in Fig. 21. After 16 consecutive charges, the treating solution volume in the working tank requires fresh make-up solution in order to treat another round of 16 charges. This scenario represents the "worst case" in terms of the build-up of acid and reduction of copper in the treating solution. A more reasonable approach

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[4] *Porosity was calculated on the basis of the equations given in Siau (1984).*

TABLE 7
Earlywood (EW) and latewood (LW) coppe retentions for southern pine treated with copper naphthenate

			Average Retention				*LW/EW Ratios*	
			Earlywood		*Latewood*			
Treatment Group	*Avg. Net (kg/m^3)*	*Retention (w/w)*	*(kg/m^3)*	*(w/w)*	*(kg/m^3)*	*(w/w)*	*kg/m^3 basis*	*w/w basis*
STEAM-CONDITIONED CHARGES								
93C	1.6	0.25%	0.9	0.29%	2.0	0.26%	2.12	0.90
82C	1.6	0.25%	0.8	0.25%	2.0	0.26%	2.49	1.05
82C/Steamed	1.6	0.26%	1.0	0.30%	1.9	0.24%	1.89	0.80
71C	1.5	0.22%	0.7	0.22%	1.9	0.24%	2.55	1.08
60C	1.4	0.23%	0.8	0.24%	1.8	0.24%	2.32	0.98
60C/Fixed	1.6	0.26%	0.8	0.25%	2.1	0.26%	2.45	1.04
60C/Fixed/ Green	0.6	0.11%	0.5	0.16%	1.2	0.15%	2.29	0.97
Ambient	1.6	0.23%	0.6	0.19%	1.7	0.22%	2.75	1.16
Ambient/Fixed	1.6	0.25%	0.8	0.24%	2.1	0.27%	2.68	1.13
AIR-DRIED CHARGES								
Ambient	1.4	0.21%	0.6	0.18%	1.5	0.20%	2.53	1.07
Ambient/Fixed	1.0	0.20%	0.6	0.19%	1.0	0.13%	1.54	0.65
82C/Steamed	1.3	0.23%	0.7	0.21%	1.5	0.19%	2.16	0.91
MAX	1.6	0.26%	1.0	0.30%	2.1	0.27%	2.75	1.16
AVG	1.4	0.22%	0.7	0.23%	1.7	0.22%	2.31	0.98
MIN	0.6	0.11%	0.5	0.16%	1.0	0.13%	1.54	0.65

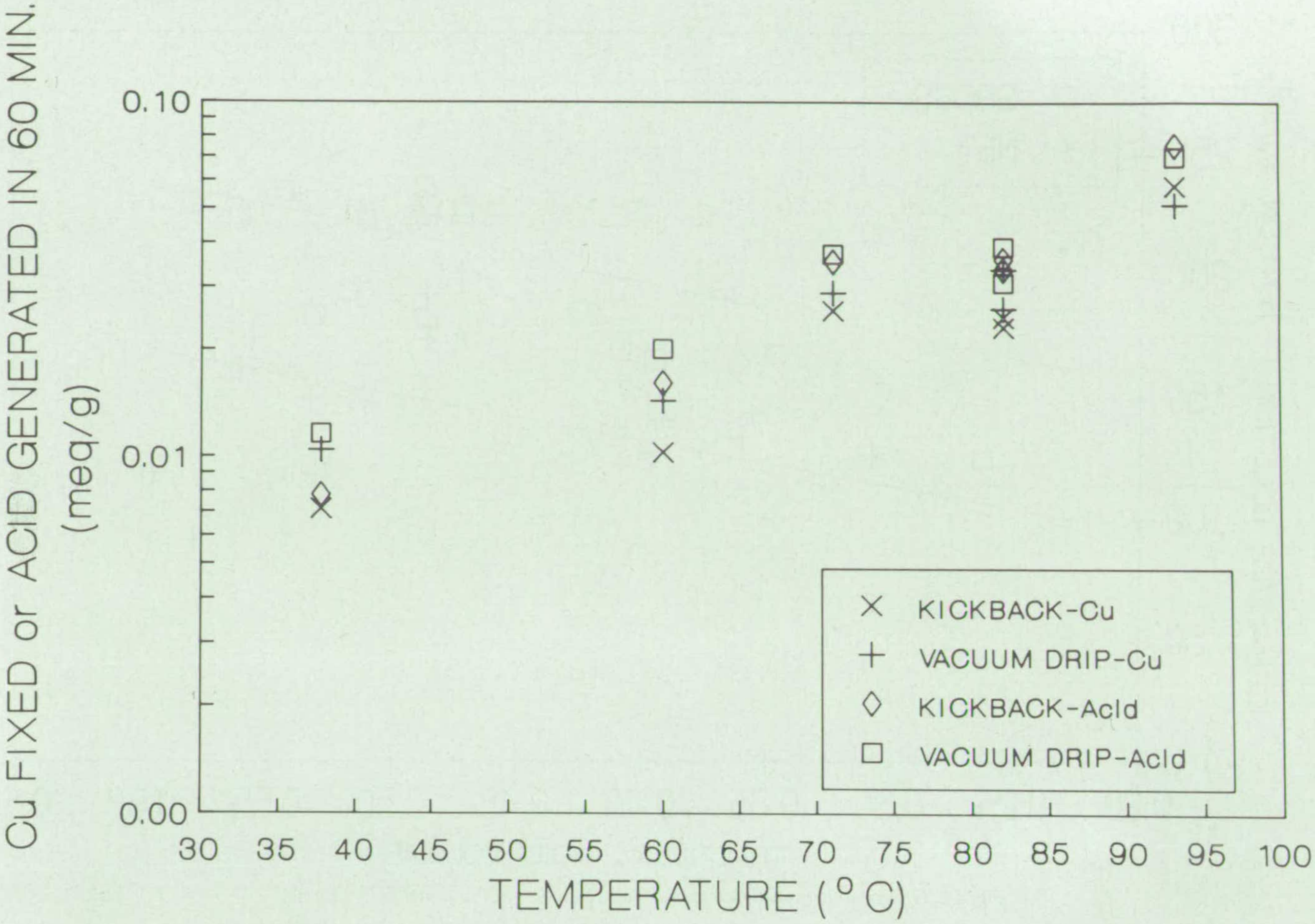

Fig. 17. The effect of temperature on the copper fixation and acid generation.

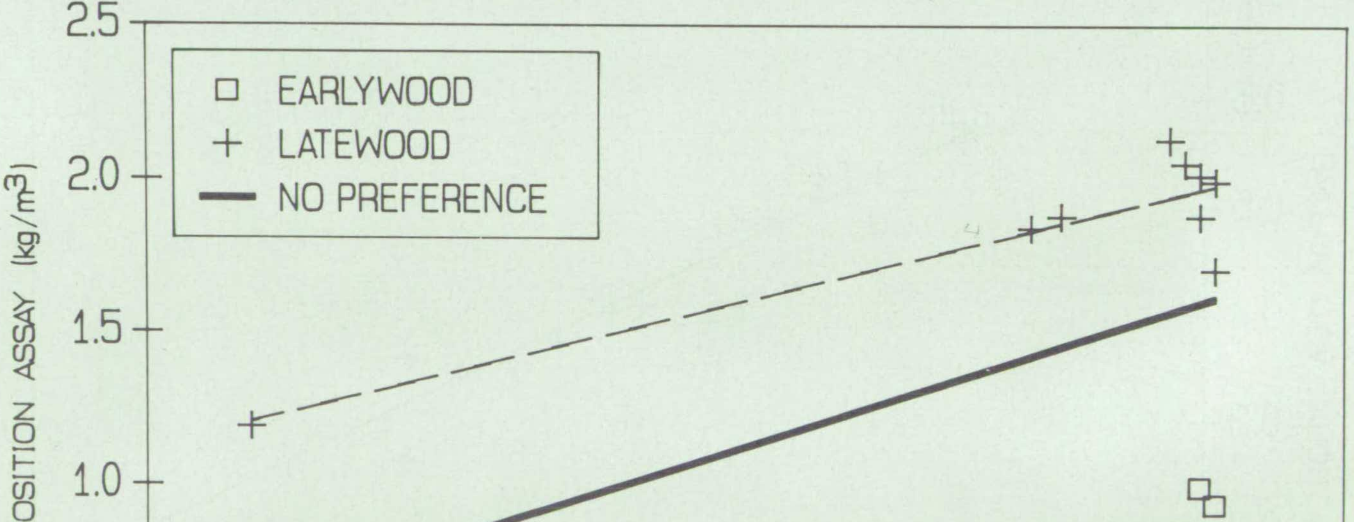

Fig. 18. The relationship between ring position (earlywood or latewood) assay (w/w basis) and net retention in the A.W.P.A. assay zone (w/v basis).

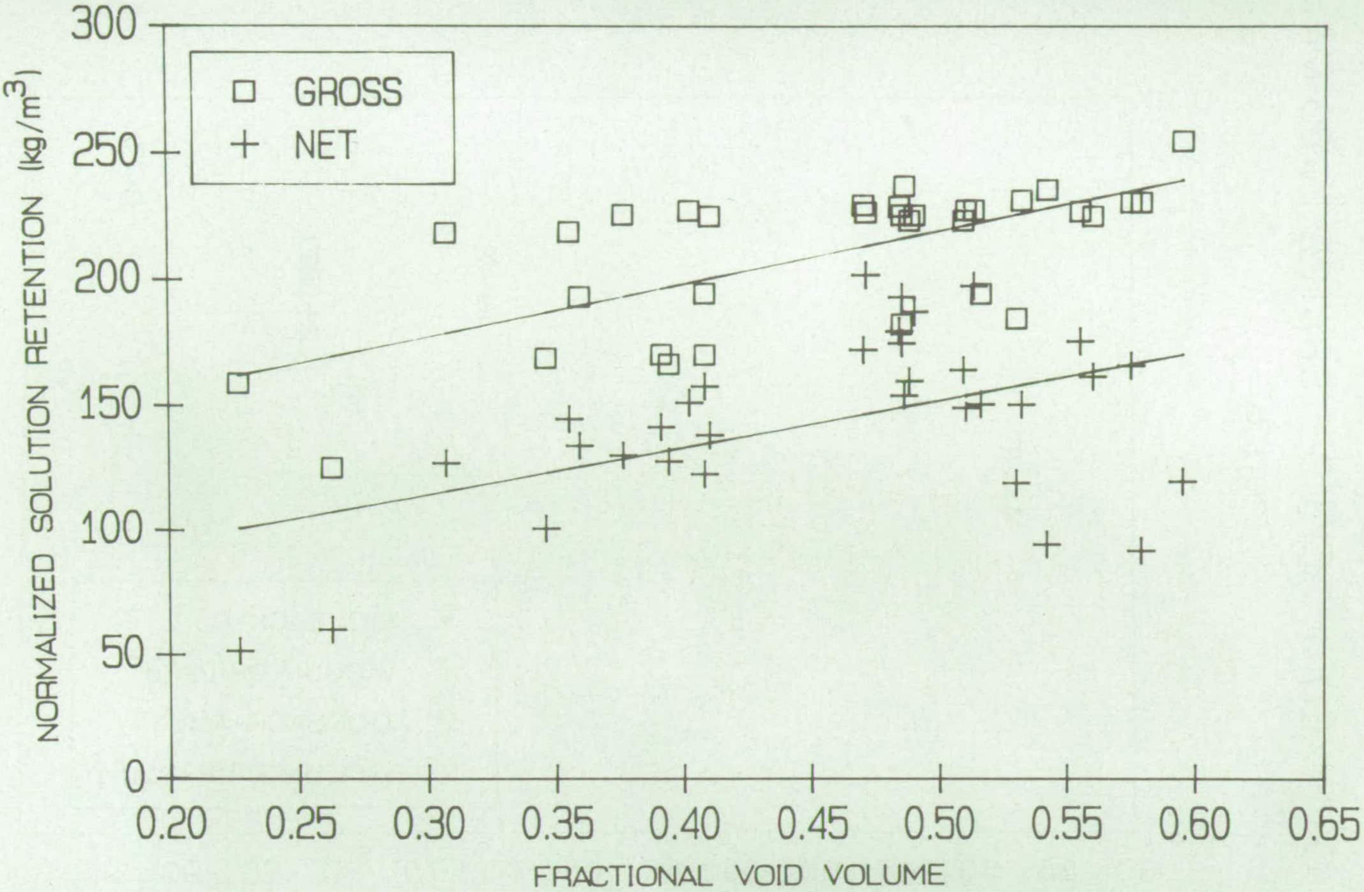

Fig. 19. Gross and net solution retentions as a function of fractional void volume.

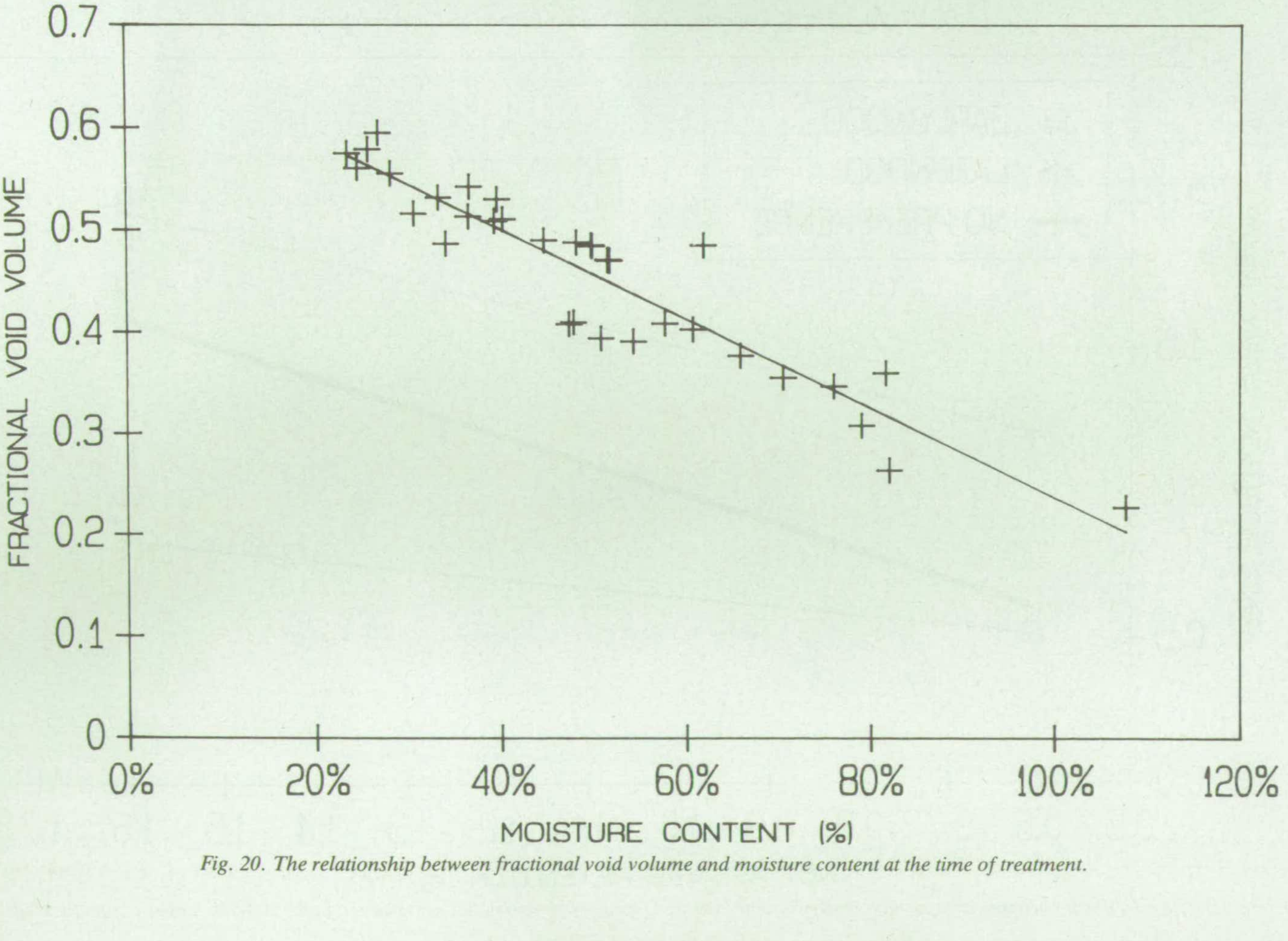

Fig. 20. The relationship between fractional void volume and moisture content at the time of treatment.

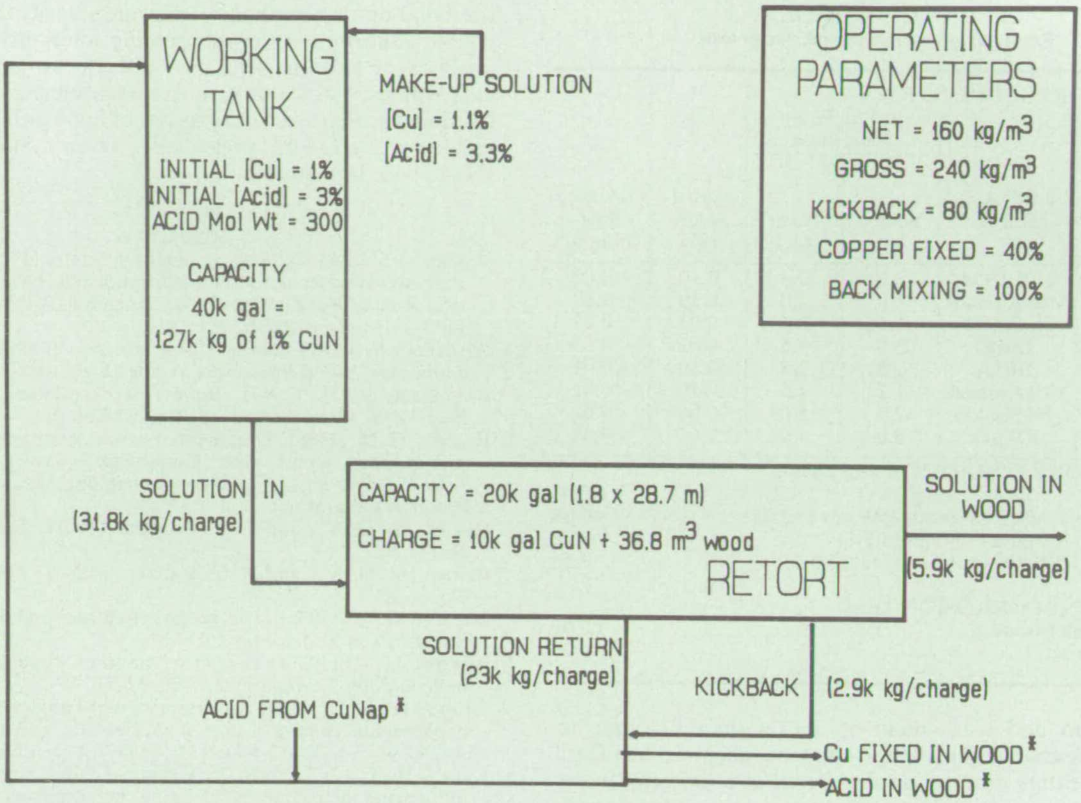

*Fig. 21. Model for a theoretical treating plant treating steam-conditioned southern pine with copper naphthenate in No. 2 fuel oil. (*Not in mass balance, only in material balance by virtue of Cu and acid concentrations)*

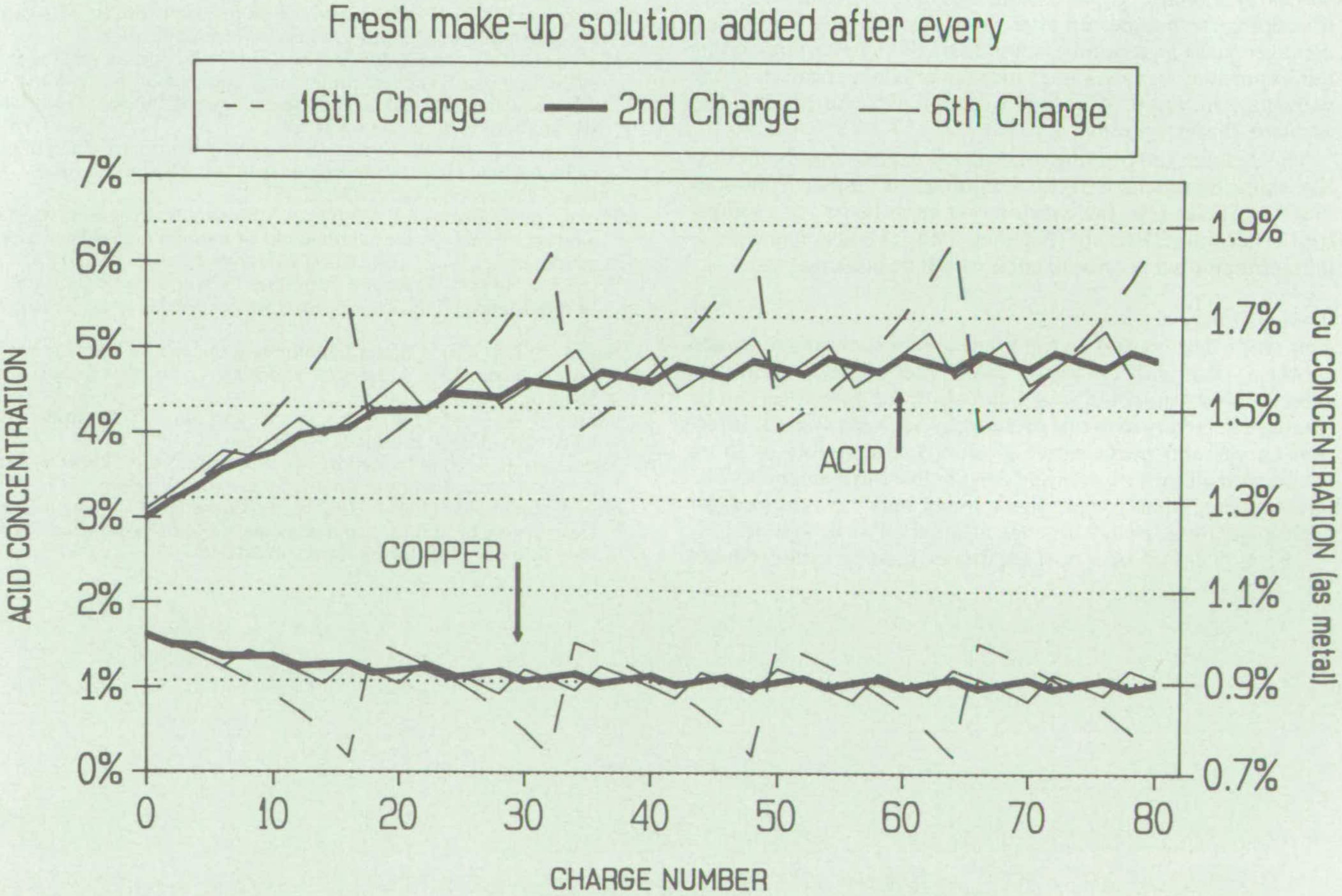

Fig. 22. Fluctuations in acid and copper concentrations in the working tank as affected by the frequency of the addition of fresh make-up solution.

TABLE 8

Results from corrosion and sludge tests

LABORATORY SLUDGE TESTS					
		B. S. & W. by Centrifuge			
Preservative	*P9A Solvent*	*Sludge (cc)*	*Water (cc)*	*Filtered & Dried Sludge (%)*	*Corrosion Rate (mmpy)*
7% Penta	510 Oil	3.0	3.5	0.10	0.02
7% Penta	Med Aromatic	6.0	4.0	0.30	0.60
7% Penta	Hi-Sol 400	1.5	3.5	0.03	0.03
7% Penta	Diesel	3.0	7.5	0.02	0.05
1% CuNap	510 Oil	2.5	2.5	0.30	<0.01
1% CuNap	Med Aromatic	1.2	4.5	0.10	<0.01
1% CuNap	Hi-Sol 400	2.0	5.0	0.06	<0.01
1% CuNap	Diesel	8.0	4.0	0.03	<0.01
LABORATORY CORROSION TESTS					
1% CuNap					<0.01
0.5% CuNap + 60/40 Creosote + Water (5:5:1)					<0.01
0.5% CuNap + Penta + Water (5:5:1)					0.28
5% Penta + 60/40 Creosote + Water (5:5:1)					0.56
PILOT PLANT CORROSION TEST					
Working Tank Location					<0.01
Retort Location					<0.01

would be to add fresh make-up more often in order to minimize the changes in acid and copper concentrations. Data for three treating options, adding fresh make-up after every second, sixth, or sixteenth charge, were generated for a nominal year of production (approximately 315 charges or 11,590 m^3). These data are shown in Fig. 22 for the first 80 charges. The steady-state maximum acid concentration is 6.3% for the 16-charge scenario, 5.3% for the six-charge option, and 5.0% for adding fresh make-up after every two charges. These percentages yield acid numbers less than 13. The corresponding minimum steady-state values for copper concentrations in the working tank are 0.74%, 0.86%, and 0.89% for the 16-, six- and two-charge options.

The fact that the treating solution has excess naphthenic acid has some beneficial effects. Unpublished results from soil-block and stake tests have shown that naphthenic acids control copper-tolerant *Poria* sp. (Nicholas 1988). Hence, an increase in naphthenic acid concentration would be advantageous.

CONCLUSIONS

This study has focused on the treatment of steam-conditioned southern pine with CuNap in No. 2 fuel oil. The data have shown that steam-conditioned and air-dried pine poles can be treated effectively with this preservative/solvent system. Injection curves and preservative gradients comparable to those found with oilborne systems in current use were obtained. The data indicate that longer press times may be required for CuNap solutions than with conventional oilborne systems.

The application of a post-treatment fixation cycle reduces the build-up of naphthenic acids and retards the decrease of copper concentration in the treating solutions. Based on the analyses of treating solutions, effluent streams, and wood assay values, a stoichiometric exchange mechanism for copper fixation was suggested. Corrosion of mild carbon steel is negligible when using this preservative system. Sludge formation should pose little problem.

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DISCUSSION ON PAPER 1

Chairman: The President

The President: Thank you very much, Professor Barnes. The paper is now open for questions. Have we any questions? I have a lot but than I am prejudiced where copper naphthenate is concerned. What about the rest of you?

Dr. Richard Murphy (Imperial College): Thank you for the paper, Mike. You mentioned that you might need longer pressure periods for the naphthenate. Do you think that is because there is no co-solvent as there is in the penta treatments?

Professor Barnes: It may well be, Richard. I do not know that I would say that categorically, but that, in fact, may well be. Of course, the molecules are different and you are getting some friction in the system because you are getting some chemical reaction that you are not getting with penta. What that would have to do with I think is only conjecture, but certainly the co-solvents may play an important part.

The President: Would you affect the molecular size which could be near a thousand to affect this?

Proffesor Barnes: In terms of what?

The President: In terms of both Dr. Murphy's question and indeed in terms of your kickback, the concentration changes?

Professor Barnes: Perhaps; that is possible.

Mr. E. M Pearce (Fosroc Ltd): In your paper you did not indicate whether you had re-established the toxic values for copper naphthenate. My question is, what is your comment regarding the New Zealand situation where they have re-assessed copper naphthenate and have decided to withdraw it as an approved preservative.

Proffesor Barnes: I believe we had a discussion on that last night. It is a good point. I think that they are premature, I really do. The fact that you do have copper tolerant fungi that might attack wood containing copper preservatives is not a reason, given the data that we now have, to pull something like copper naphthenate out. The fact that we are generating the free naphthenics and getting some protection against the *Poria* which we did not expect would say to me that they are premature.

The threshold values that have been set for pole stock in the States are .06 pcf for copper as metal for the low hazard areas, being the northern U.S. and Canada, and 0.13 pcf copper as metal for the high hazard areas. There is some problem with north Florida where they have quite a few copper tolerant fungi. Producers of copper naphthenate in the U.S. now are not suggesting that copper naphthenate treated poles be used in north Florida. But as far as pulling copper naphthenate off the market is concerned, as they have done in New Zealand, I think perhaps they are premature. I think a comment should be made about the carrier system. In the right carrier system it is an extremely efficacious preservative. The work we are doing now in the laboratory with *Poria* reveals that the oils are very critical. A lot more critical than perhaps we thought.

Dr. D. G. Anderson (Hickson World Timber): The situation in New Zealand is quite different from the situation that Mike has been talking about. We are talking about light oil alias pre-treatments in low concentrations. As I understand it, from the information I have received from New Zealand, there are questions being asked about the retentions that they have set which were historically very low in New Zealand anyhow. They have raised that and they have withdrawn it from high hazard areas but not from low hazard areas.

There is also debate going on about what on earth is copper naphthenate because some of the GLC traces and GL CNS I have seen from New Zealand make one suspect that some things which are called naphthenic acid are just not naphthenic acid. The contents of two ethyl hexamillic acid lead one to doubt the intentions of the suppliers possibly, because under A.W.P.A. standards there should be no synthetic acids added to naphthenic acid for manufacture in copper naphthenate. So you are talking about a very, very different animal than may be the case in a country like New Zealand.

Professor Barnes: That is a very good point, David. I do not think any of us would propose light organic solvent type treatments with what we know about oils right now. It is like the problem with Cellon process penta. Again the carrier system is critical. I thank you for your comment about the difference in synthetic and natural occurring naphthenics. In fact, the A.W.P.A. standards require you not to use any of the synthetic materials. They are all natural crudes and quite a different beast when you look at natural versus synthetic. Our stake data shows that. Neodecanoic will go out very quickly, and any of the other synthetics will go out fairly quickly compared with copper naphthenate using refined crude.

Dr. Aanderson: Just another interesting point there. In New Zealand there was very little evidence of any cyclical acid. I think acid is supposed to have a content of . . .

The President: It is a very high proportion of . . .

Dr. Anderson: . . . cyclical acid. The New Zealand data did not detect that by mass spectroscopy. They really are in a quandary. They do not really know what to do.

The President: I have some knowledge of the New Zealand problem. I do not know the analyses that you are referring to but if they did not detect some significant content of saturated cyclic acids than it was naturally derived naphthenic acid. Depending on which synthetics were used and the ratio, you are just dealing with a totally different beast. The consequent differences in the equivalent weights, when you start talking about weight ratios of 30 per cent, 40 per cent, you convert them to molecular ratios, it is almost getting to be 80 per cent non-naphthenic.

Mr. J. David (Catomance): I have two small points. The first is that pentachlorophenol reacts fairly readily with proteins and so I would not be surprised to see it retained in a somewhat different way from copper naphthenate. Secondly, I think timber generally could be considered something like a chromatographic column, if you care to think about it hard enough. So I am not very surprised when you have different results from early and late wood simply because of the packing density of the cellulose within the structure. However, the third point, which is the serious one, is what about the toxicity of naphthenic acids and how do you get clearance in the United States for a naturally occurring material of infinite variability and some relationship to carcinogenic chemicals; a well established hazard?

Professor Barnes: Of course, this paper did not deal with that, but they have essentially set a standard, which limits acid number for the naphthenics. As far as the carcinogenic material is concerned, who knows what the E.P.A. is going to do. I really have no way to second guess our Environmental Protection Agency and what might happen in terms of the nature of the crudes.

Mr. David: But what you are saying though is that naphthenic acid is more precisely defined than perhaps in New Zealand?

Professor Barnes: Yes, absolutely. When A.W.P.A. set the standard, they were very specific about what they wanted to do. They did not want synthetics at all, and so they set up a number to be sure that we got the allocyclic, and they changed the definition slightly so we had to go to the naturally occurring material rather than to the synthetics.

Mr. Anderson: The use of the term “naturally occurring” is a slight misnomer. We are still talking about a synthetic material which is a by-product from a cracker, as I understand it. It is naturally occurring if you consider crude oil as naturally occurring, yes, but it has still gone through a chemical process.

THE PRESIDENT: But a chemical process of extraction not of conversion.

MR. ANDERSON: Yes, all right.

THE PRESIDENT: It is naturally occurring in crude petroleum and indeed that is where it first came to light in nineteenth century, the Russian examination when they were examining chemicals available from the Buku crudes.

MR. ANDERSON: But the content of the compound varies greatly depending on where the crude comes from.

THE PRESIDENT: Oh, indeed, yes. First of all, you have got a natural variation from oilfields. I mean there are many oilfields in which there is negligible naphthenic acid. You than have a further variation due to fractionation, if you like, during the refining process because it would normally be extracted after the primary distillation from either kerosene or the diesel fracture. Is that correct?

PROFESSOR BARNES: Yes, I believe so.

MR. M. GREENACRE (Laporte Group, Australia): Have you done any studies on the availability of naphthenic acid which could be suitable for this application in terms of supply, and have you done any cost comparisons with, say, creosote and C.C.A.?

PROFESSOR BARNES: I have not done any, nor have I done any studies at all on supply, but the suppliers in the market place would probably take care of that. It is more costly than, say, penta, with which it is being compared. In fact, a lot of the problems with trying to set standards were due to the fact that we tried to set standards based on penta, as, say one-eighth or one-tenth of that of penta, which was a mistake initially. It worked out that those ratios were particularly cost competitive with pentachlorophenol. It is slightly more expensive than penta. What the ratio is, I do not know. Perhaps someone in the audience would have a better feel for the economics. However, it is going to be more costly in one respect, and less costly in another. One can use fuel oil without going through the co-solvent business. You just use straight diesel rather than having to have it amended with the still-bottom effluent streams like KB3. So you may get a plus there, but it is likely to be more expensive than penta, I believe.

MR. GREENACRE: There is just one other point I should like to make. It is our experience in Australia with copper naphthenate that you certainly have to use epoxy linings to the storage tanks to prevent corrosion.

THE PRESIDENT: It could be the synthetic acid.

MR. GREENACRE: I was surprised to see your statement that copper naphthenate is, in fact, an inhibitor because certainly, in our experience, it is very corrosive especially where you have water droplets trapped underneath the sludge in storage tanks.

THE PRESIDENT: If it is at all relevant, in our factory we use mild steel tanks for storing naphthenic acid and stainless steel tanks or lined for storing synthetics.

PROFFESOR BARNES: We have had no problem at all. We checked to see if we were picking up extra water when we went through this fixation cycle at the end, to see whether we were getting extra water coming out of the wood which would, in fact, give us a sludge. We had a little sludge in the bottom, as you might have with any oil system, but nothing significant.

MR. GREENACRE: Where the solution is constantly moving you have got no problem but Davis of Queensland Forestry did quite a study on this aspect of corrosion, and if the material is stationary in the tank for a length of time, and water is trapped underneath the sludge, then you do get electrolytic activity which results in a neat hole in the bottom of the tank and the consequent problems.

DR. JOHN MORGAN (Princes Risborough Laboratory): I was very surprised to see the colour of those poles. I mean, I had come to grow up to believe that anything treated with copper was green, in the end at least. Can you tell me whether the treatment solutions also changed colour or whether their composition was affected.

PROFESSOR BARNES: Yes. There was a slight drop in copper in the treating solutions if you look at them initially and afterwards. I checked them without adding back the kickback and the vacuum drip, and there was a slight drop in copper between the initial and what went back to the working tank, but very slight.

The colour of the actual treating solution was not as green as I thought it would be. Of course, part of that was due to the kind of oil that was used but, as you, I was very surprised to see the rather pleasant brown colour. If you look very closely at those poles you can pick up a green tinge to them, but just to look at them from across the room you would say those are brown like a penta and oil pole. I was quite surprised myself. Once they were fixed they tended to be perhaps a little greener on close inspection, but again, unless you were looking for that you would not be able to pick that up.

THE PRESIDENT: Is that suggestive of something in the wood that you were using. You will normally see that colour, John, if you put copper naphthenate on red cedar.

MR. MORGAN: This was pine sap.

THE PRESIDENT: Yes, I know.

D. D. S. BELFORD (Private Member): I should like to congratulate Professor Barnes on a most excellent paper. My question is, how do the copper naphthenate treated poles stack up against termite attack compared with creosote, C.C.A. or penta treated material.

PROFESSOR BARNES: We have no data on actual poles yet in ground. Our stake tests indicate that there is good efficacy against termites. When you write those things, eventually when you put out the numbers, you really do not care whether it was decay, or certainly the consumer would not care whether it was decay or termites. If it is graded a '4' on our scale, which would be nearly failed, they do not care whether it's decay or termites.

We are not seeing that. There was some question asked as to whether we would have protection against insects and certainly it looks like we did. Again, part of that is going to be eventually tied up in the oil that you use. When some of the data that Darrel Nicholas, Lee Gjovik, and others of us are generating in a co-operative study with the Electric Power Research Institute comes to the fore, I think you are going to see that oils and their characteristics play an even more important part sometimes than the biocide. You can treat southern pine in our part of the world full cell with nothing but oil and go five years on stakes before you ever get any attack.

MR. L. D. A. SAUNDERS (Fosroc Ltd.): In the first of the graphs in which you related gross uptake to moisture content you represented a relationship as a straight line extending back down to about 15 per cent moisture content. Were you surprised not to get a flattening off below fibre saturation point?

PROFESSOR BARNES: No, because the data were skewed towards the higher side. We just took what we had on the air dried material. The study really was not looking for that. We probably did not have enough data points down there to pick anything up. So that does not surprise me, no. If, in fact, you did not see a levelling out one might be very surprised if you were doing a study to look at that, but we were not particularly looking at that. I think it is an absence of data really rather than any real effect.

THE PRESIDENT: I think I should like, before we come to a close, and we are rapidly approaching a close, to get a Chairman's question in, and it is almost a triple question. So far as I am aware this is the first suggestion that I have come across of a chemical fixation mechanism between copper naphthenate and timber. We do normally consider it to be age resistant, to be leach resistant but more because of its chemcial nature, because it is, itself, of low volatility and it is water insoluble. So the first quesiton is, do you plan any further work to decide the exact nature of the fixed copper naphthenate? The second quesiton is, have you done any biological comparison of the fungal resistance of timber which has and has not been conditioned, because it does seem to me that the conditions that you are subjecting the copper naphthenate to are more conductive to decomposition, to a replacement perhaps of the naphthenic acid by the naturally occurring acids in the timber, rather than any chemical fixation to the timber substance itself. Perhaps allied with that, have you done analysis of the acids that are built up in the solution to determine whether they are naphthenic acids or whether they now are timber acids.

PROFESSOR BARNES: The answer to the last two questions is 'No'. Unfortunately, this is a funny sidelight now – my technician had all the solutions in bottles and asked "Can we do away with these?" and I said, "Yes, we can do away with them". The very next week I said, "We should have run those through and looked for acetic acid to see what we were generating from the wood". So we have not done that, nor have we done any biological testing.

We are planning to explore fixation more. Part of that will be done industrially at Mooney Chemicals and part of it is on-going now. They are doing some infra-red analyses and things like this to try to get an angle on fixation and to see whether or not the hypothesis is correct. So that is where we stand on that.

THE PRESIDENT: Thank you. Do we have any further questions *(No response)*. Conveniently, therefore, that brings us to about three minutes after our allotted time, which is just the right way to finish things. It remains for me to thank Professor Barnes for presenting a most excellent paper to open up this Convention. I would ask you to join me in the usual round of applause. *(Applause)*.

B.W.P.A. ANNUAL CONFERENCE 1988

DEADLINE 1992 FOR THE WOOD PRESERVATION INDUSTRY

by DR. G. VAN STEERTEGEM *General Secretary of the Western European Institute for Wood Preservation*

Contents

Deadline 1992 for the wood preservation industry

1. The idea of creating a single European market is not a new one. In fact, the Treaty of Rome (which established the European Community), signed in 1957, spelled this goal as:

"The Community shall have as its task, by establishing a common market and progressively approximating the economic policies of Member States, to promote throughout the Community a harmonious development of economic activities, a continuous and balanced expansion, an increase in stability, an accelerated raising of the standard of living and closer relations between the States belonging to it."

2. In spite of this early vision, a true common market does not yet exist. However, the creation of this single market now gains momentum. Indeed, the adoption of the "Single European Act" reflects the *renewed political will* of the Community to complete, within a given timeframe, the aims of the original Treaty in stating that "the Community shall adopt measures with the aim of progressively establishing the internal market over a period expiring on December 31, 1992. The internal market shall comprise an area without internal frontiers in which the free movement of goods, persons, services and capital is ensured . . ."

This "deadline 1992" will certainly affect the wood preservation industry. In this lecture, a short review will be given of its most important incidences.

I. THE EUROPEAN COMMUNITY

The 12 Member states – 321 million consumers

3. The European community was formed in different stages and consists of:

- the original member states: Belgium, France, the Federal Republic of Germany, Italy, Luxemburg and the Netherlands;
- Denmark, Ireland and the United Kingdom which joined on January 1, 1973;
- Greece, which joined on January 1, 1981;
- Portugal and Spain, which joined on January 1, 1986.

Together, these States count *321 million inhabitants,* which makes the European market larger than the one of its main competitors, the U.S.A. and Japan. Although it is very difficult to quantify the benefits of the opening of this market, it is expected that it will allow business to flourish on a large scale.

The institutions of the European Communities

4. In the Community's *decision making-process,* three institutions play an important role:

- the Commission of the EEC consisting of 17 members, appointed by agreement between the member governments. The commission is the guardian of the Treaties, the executive arm of the Communities, the initiator of Community policy and the exponent of the Community interest in the Council;
- the European Parliament, consisting of 518 directly elected members (France 81, the Federal Republic of Germany 81, Italy 81, United Kingdom 81, Spain 60, the Netherlands 25, Belgium 24, Greece 24, Portugal 24, Denmark 16, Ireland 15 and Luxemburg 6). The Parliament holds a strong position in the budget process, keeps constant watch on the Commission's doings and plays an important role in the new legislative process in the EEC;
- the European Council, which is made up of representatives of the Governments of the 10 Member States. Each government normally sends one of its Ministers. The Foreign Minister is regarded as his country "main" representative, but Ministers for Agriculture, Industry, Environment, Economic affairs, . . . also meet frequently for specialised Council meetings. Its membership thus varies with the subjects down for discussion. The Council decides on areas of great importance. It is assisted by a Permanent Representatives Committee, which comprises the "ambassadors" of the Member States to the Communities and prepares the work of the Council.

The Single European Act

5. The Commission's task should in the future be made easier by the adoption of this Act, which replaces the unanimity requirements with decisions *by qualified majority* as regards measures which have as their object the establishment and functioning of the internal market. The qualified majority doesn't apply to fiscal provisions, to those related to the free movement of persons nor to those relating to the rights and the interests of employed persons.

The principle of a vote by qualified majority implies that a decision can be taken if there are 54 votes in favour (out of 76 possible votes: France 10, the Federal Republic of Germany 10, Italy 10, United Kingdom 10, Spain 8, Belgium 5, the Netherlands 5, Greece 5, Portugal 5, Denmark 3, Ireland 3 and Luxemburg 2). It is meant to overcome the difficulties of the unanimity requirement, which has made any decision a complex and lengthy process.

6. Other important articles of the Single European Act, which came into force on July 1, 1987, related to the internal market are:

- art 100 A § 3: "the Commission, in its proposals concerning health, safety, environmental protection and consumer protection, will take as a base a high level of protection";
- art 100 A § 4: "if, after the adoption of a harmonization measure by the Council, a member state deems it neces-

sary to apply national provisions on grounds of major needs (re-environment or working environment), it shall notify the Commission of these proposals. The Commission shall confirm the provisions involved after having verified that they are not a means of arbitrary discrimination or a disguised restriction on trade between Member States";

- art 100 B § 1: "during 1992, the Commission shall, together with each Member State, draw up an inventory of national laws, regulations and administrative provisions . . . which have not been harmonized. The Council . . . may decide that the provisions in force in a member state must be recognised as being equivalent to those applied by another Member State".

The new Community decision-making process

7. The *Single European Act* also introduces following new co-operation procedure between the Commission, the Council and the European Parliament, for the decision-making process in the EEC;

(a) The Council, acting by a qualified majority on a proposal from the Commission and after obtaining the opinion of the European Parliament, shall adopt a common position.

(b) The Council's common position shall be communicated to the European Parliament. The Council and the Commission shall inform the European Parliament fully of the reasons which led the Council to adopt its common position and also of the Commission's position.

If, within three months of such communications, the European Parliament approves this common position or has not taken a decision within the period, the Council shall definitively adopt the act in question in accordance with the common position.

(c) The European Parliament may within the period of three months referred to in point b, by an absolute majority of its component members, propose amendments to the Council's common position. The European Parliament may also, by the same majority, reject the Council's common position. The result of the proceedings shall be transmitted to the Council and the Commission.

If the European Parliament has rejected the Council's common position, unanimity shall be required for the Council to act on a second reading.

(d) The Commission shall, within a period of one month, re-examine the proposal on the basis of which the Council adopted its common position, by taking into account the amendments proposed by the European Parliament.

The Commission shall forward to the Council, at the same time as its re-examined proposal, the amendments of the European Parliament which it has not accepted, and shall express its opinion on them. The Council may adopt these amendments unanimously.

(e) The Council, acting by a qualified majority, shall adopt the proposal as re-examined by the Commission.

(f) In the cases referred to in points c, d and e, the Council shall be required to act within a period of three months. If no decision is taken within this period, the Commission proposal shall be deemed not to have been adopted.

(g) The periods referred to in points b and f may be extended by a maximum of one month by common accord between the Council and the European Parliament.

The representation of industry

8. The realisation of an internal market in 1992 implies that a lot of decisions will be taken which will have a major effect on the industrial activities. Industry can try to influence the decisions, through lobbying:

- *on a national level,* by informing the government of the Member State or the local Member of Parliament of its interests (as a company or as a national federation);
- *on a European level,* by presenting its needs to the EEC Commission or to the European Parliament.

9. The Western European Institute of Wood Preservation (WEI) aims to be the representative European business association of firms active in the field of wood preservation by vacuum and pressure techniques. One of its major objectives is to represent the wood impregnation industry in discussions on a European level and to defend the common point of view of this industry.

WEI is a member of the European Confederation of woodworking industries, Cei-bois, which major objective is to determine and to defend the interest of the European woodworking industries with the EEC. Both organisations are *accredited interlocuters* of the Commission and other European bodies, such as for instance the European Committee for Standardisation.

II. EUROPE WITHOUT FRONTIERS

Completing the internal market for 1992

10. Taking up the challenge, the Commission published a *"White Paper"* in June 1985, setting out the necessary programme together with a clear timetable. It attempts to identify all the existing barriers which justify the continuing existence of frontier controls and which prevent the functioning of the market and it puts forward over 300 legislative proposals required for their removal.

The removal of all barriers to trade

For convenience, the measures that need to be taken have been classified under three headings in the White Paper:

- the removal of physical barriers;
- the removal of fiscal barriers;
- the removal of technical barriers.

11. The most obvious example of the first category of barriers are customs posts at frontiers. Indeed, most of the citizens would regard the frontier posts as the most visible example of the continued division of the Community and their removal as the clearest sign of the integration of the Community into a single market.

The objective is to remove all controls at internal frontiers by 1992, by:

- ending the systematical police control on entry in or exit from Member States, replacing it by spot-checking;
- increasing the use of the European-model passport;
- replacing all separate forms for goods that cross frontiers by a single form called the "Single Administrative Document";
- abolishing the transport quotas, in order to allow hauliers to operate freely throughout all Member States.

12. The *removal of fiscal barriers* may well be contentious and this despite the fact that the goals laid down in the Treaty are quite explicit and that important steps have already been taken along the road of approximation. This being so, the harmonization of the fiscal legislation is an essential and integral element in any programme for completing the internal market. The Commission however recognises that the approximation of indirect taxation will give rise to considerable problems for some Member States and that, as a consequence, it may be necessary to provide for derogations.

13. While the elimination of physical and fiscal barriers might be the most visible sign of the creation of the single market in

the eyes of the general public, it would be a nonsense to abolish the obstacles found at present at frontiers and to simply continue with the technical obstacles. Those "hidden" obstacles are especially important for industry, though many also hamper the free movement of people (differences in educational approach, obstacles in the field of rights of establishment for the self-employed, the different frameworks for trademarks, patents and copyright law, . . .).

Free movement of goods

14. It is through the elimination of *technical barriers* that the Community will give the large market its economic and industrial dimension, by enabling industries to make economies of scale and therefore to become more competitive.

Indeed, different national production standards and regulations mean that many products are separately manufactured to separate standards for each separate country. They add extra costs, distort production patterns, increase unit costs, increase stock holding costs and discourage business co-operation.

In itself the development of national standards and regulations has been constructive and helpful in guaranteeing that products provide a minimum level of safety for the consumer and that they can often act as a disguised form of national protection against similar goods imported from other Member States where different standards are in force.

15. For many years the Community has attempted to eliminate these barriers by establishing a *Community standard.* However, the process of elaborating and adopting harmonization directives proved difficult and years were spent trying to reach agreement on technical matters of a single product. The Commission therefore decided to follow a new approach, based on two pillars:

- the directive 83/189 EEC preventing the erection of new barriers;
- the resolution of the Council of May 7, 1985 and the White Paper reflecting the principles of the future technical harmonization directives.

Preventing creation of new obstacles

16. In order to prevent the erection of *new barriers,* directive 83/189/EEC now requires all Member States to communicate to the Commission all draft technical regulations for industrial products so that the Commission can examine them prior to their adoption in national law. Upon notification, the Directive requires Member States (other than in special cases such as urgent reasons relating to the protection of public health or safety) to suspend the adoption of technical regulations:

- automatically for a period of three months;
- for a period of six months when the Commission or another Member State raises a serious objection;
- for a period of 12 months dating from the initial communication, when the Commission decides to initiate Community legislation in the field covered by the draft national legislation.

The directive thus enables the Commission and the other Member States to play an important role in *national* production standards and regulations.

When a Member State enacts a technical regulation without notifying the draft to the Commission, the regulation thus adopted is unenforcable against third parties.

The new approach to technical harmonization

17. The new approach does not mean that there should be the same rules everywhere, but that goods should be able to move freely within the Community, the general principle being that if a product is *lawfully* marketed in one Member State, there is no reason why it should not be sold *freely* throughout the Community. Indeed, the objectives of national legislation, such as the protection of human health and life and of the environment, are more often than not identical. The harmonization approach of the commission is therefore based on the following principles:

- a clear distinction will be drawn in future internal market initiatives between what is essential to *harmonize* and what may be left to *mutual recognition* of national regulations and standards;
- legislative harmonization will in future be restricted to laying down *essential* health and safety *requirements* which will be obligatory in all Member States. Conformity with this will entitle a product to free movement;
- harmonization of industrial standards by the elaboration of *European Standards* will be promoted to the maximum extent, but the absence of European standards should not be allowed to be used as a barrier to free movement. During the waiting period, while European Standards are being developed, the mutual acceptance of national standards, with agreed procedures, should be the guiding principle.

18. In the specific area of testing and certification procedures an initiative is launched to bring about within the Community mutual recognition of tests and certification so as to avoid the wasteful duplication of tests, which in some sectors is the rule rather than the exception.

In order to do so, the Commission issued a set of documents:

- General criteria and recommendations on the competence of certification bodies;
- General criteria and recommendations for laboratories and accreditation bodies;
- the future organisation of European testing and certification.

The latter includes a review of the EEC approach to give concrete form to the political agreement on the mutual recognition by the Member States of the EEC.

This approach implies:

- the setting up of sectorial committees which would have to negotiate agreements on *mutual recognition of testing and certificates;*
- the setting up of the "European Council for certification and testing", which would serve as a forum for exchange of experiences;
- an administrative support of the different activities by Cen/Cenelec.

III. EEC ACTIONS RELATED TO WOOD PRESERVATION INDUSTRY

EEC directive on construction products

19. One of the most important actions within the framework of the "new approach" for the elimination of technical barriers to trade by the end of 1992, is the proposal for a Council directive on the approximation of the laws, regulations and administrative provision of the Member States relating to *construction products.*

This draft directive:

- deals with the family of "construction products" instead of individual components;
- defines the essential requirements for a construction (mechanical resistance and stability, fire safety, hygiene, health and environment aspects, user safety, protection against noise, energy economy) instead of describing all properties in full detail;
- states that a construction product is fit to trade if it can be proved that the product, when used in a construction, enables the latter to satisfy the relevant essential requirements;
- sets up different procedures of direct certification that a product complies with the essential requirements (certification of conformity by an approved body, certification of

factory quality management by an approved body, type examination by an approved laboratory, manufacturer's declaration of conformity);

- introduces the idea of equivalence of national standards in a transition period, provided that the EEC has checked that these standards comply with the essential requirements;
- asks the European Committee for Standardization, Cen, and the European Union of technical agreements, UEATC, to work out more detailed performance type technical specifications;
- introduces two EEC conformity marks (based on certification by an approved body or based on manufacturer's declaration) which shall certify conformity with the relevant standard or technical approval;
- states that products bearing the E-mark will have the right of free movement within the single market.

20. Within the framework of this directive, the Commission charged Cen to establish European standards (before June 30, 1989) on:

- classes of hazard to biological attack for timber structures;
- performance requirements for the protection of wood in timber structures in relation to hazard classes;
- test methods for preservatives against biological attacks.

The Technical Bureau of Cen decided to allocate these tasks to its *technical commission 38* "Durability of wood and wood based products". Tc 38 met in Paris on April 12 and 13, 1988 and decided to create five working-groups, which will have to make proposals for the next meeting in October 1988, on:

- the definition of hazard classes (chairman, Ms. Romeis, Centre Technique du bois et de l'ameublement – France);
- classification of wood species in function of their natural durability (chairman Prof. Willeitner, Bundesanstalt für Forst- und Holzwirtschaft – Germany);
- performance requirements for treated timber (chairman Mr. J. Jermer, Swedish Wood Preservation Institute – Sweden);
- performance requirements for wood preservatives (chairman probably Dr. Bravery, Princess Risborough laboratory – UK);
- field testing out of soil contact (chairman probably Dr. Bravery, Princess Risborough laboratory – UK).

The national standardisation institutes of every member country of Cen (12 EEC member countries + Austria, Finland, Norway, Sweden and Switzerland) could nominate 1 (or maximum 2) delegate(s) per working group.

21. Furthermore, the EEC asked a group of experts to prepare a European reference document on the unified rules for the calculation of timber structures. This document, called *Eurocode 5,* gives the rules to be followed to incorporate, assemble, apply or install products in constructions, in order to achieve the objectives set by the essential requirements and in particular relating to mechanical strength of structures. This Eurocode will be officially presented at a seminar on September 14, 15 and 16, 1988 in Luxemburg.

EEC directives on chemicals

22. Within the Direction General XI "Environment" and the Direction General III "Internal market and industrial affairs" of the Commission, different working groups are studying the classification and labelling of dangerous substances and preparations.

Different components of wood preservation products are on the list of *substances* to be studied on the basis of their potential carcinogenic, mutagenic or teratogenic properties. The procedure followed by the EEC consists of different steps:

- a Member State makes a proposal for the classification and the labelling of a substance;
- this proposal is discussed in what is called the "National experts Group for the Classification and Labelling of C/M/T substances";
- if there are differences in opinion concerning the effect of the discussed substances, the National Experts call for the scientific advice of a super-expert group on the matter;
- with this advice, the National Experts formulate their proposals to the "Technical Progress Committee", which decides on the labelling by qualified majority.

This procedure is now followed for a lot of *pesticide* ingredients, for *arsenic* and arsenic compounds, for a large number of *heavy metals* and their compounds and also for coal tar distillation fractions, such as creosote.

23. The classification of *preparations* is ruled by the "general preparations directive" which was accepted by the Council at its meeting of December 18, 1987. In summary, the directive imposes precautionary measures on preparations, which are similar to the precautions for the dangerous substances they contain. However the directive 78/631 on pesticides, imposing labelling on their packaging, remains operative. This implies that pesticides are not subjected to the Gpd, but it will be examined within some years if this exclusion can be maintained.

24. Apart from classification and labelling of dangerous substances and preparations, there is also an EEC directive imposing restrictions on the *marketing and use* of certain dangerous substances and preparations. The directive 76/769:

- aims at protecting the general public and particular persons using such substances and preparations, at restoring, preserving and improving the quality of human life and at protecting the environment of substances which have characteristics of ecotoxicity or which could pollute the environment;
- states that the dangerous substances and preparations listed in its annexes may only be placed on the market of used, subject to the conditions specified in these annexes. These restrictions do not apply to marketing or use for research and development or analysis purposes;
- was adapted seven times in the meantime, in consequence of this, limitations were being imposed on 12 dangerous substances and preparations.

A proposal for a Council directive amending for the eighth time directive 76/769 was submitted by the Commission to the Council on February 4, 1988. This proposal puts restrictions on the marketing and use of 10 substances and preparations, including mercury, *arsenic*- and *organostannic* compounds.

Two other proposals will be submitted in 1988, including limitations on *pentachlorophenol.*

As far as the last substance is concerned, the proposal of the Commission (which was prepared by an expert group Wei formed part of) was published in the Official Journal of the EEC of May 4, 1988.

According to this proposal, the marketing and use of pentachlorophenol and its compounds in concentrations equal to or greater than 0.1 per cent by mass is forbidden, except:

- for the treatment of wood in industrial installations;
- for the impregnation of heavy-duty textiles in industrial installations;
- as a synthesizing and/or processing agent in industry.

25. The decision to include pentachlorophenol on the list of substances for which restrictions on the use will be imposed on an EEC level, was partly due to the notification of a decree by the German authorities, according to the *directive 83/189.*

The Federal Republic of Germany intended to impose a comprehensive ban on pentachlorophenol (Pcp) on pentachlorophenol sodium (Spcp), on preparations containing more than 0.5 per cent Pcp or Spcp and on products (including treated wood, textiles and leather) containing more than 5 mg/kg Pcp or Spcp.

Different Member States reacted to this German reglementation. On the basis of these reactions, the EEC decided to object against the new regulation and to work out an EEC directive on the subject. In so doing the German authorities cannot impose their regulation before June 10, 1988.

It is to be expected that the wood preservation industry will be confronted with a lot of this type of notifications in the near future.

EEC directives related to environment

26. Following the Seveso accident, the EEC directive 82/501 on "the major accident hazards of certain industrial activities" was issued. Following the Sandoz incident at Basle, the directive was adapted on March 19, 1987, putting greater emphasis on environmental aspects. According to this directive, the storage of more than 500 kg of a product based on arsenic pentoxide is considered hazardous. This means that a lot of wood treating plants working with arsenic salts have to:

- notify the competent authorities information relating to the preservative, relating to the installation and relating to the possible major accident situation;
- inform the competent authorities as soon as a major accident occurs, provide them with information about the circumstances of the incident, about the emergency measures taken, about the steps envisaged to alleviate the medium- and long-term effects of the accident and about the steps taken to prevent any recurrence of such an incident.

The legislation arising from the EEC directive is now in its final stages of enactment in most of the Member States.

27. As far as the *pollution of surface waters* is concerned, the framework directive 76/464 of May 4, 1976, on the pollution caused by certain dangerous substances into the aquatic environment, stipulates that the EEC can impose emission standards and lay down quality objectives. According to this directive, "Member States shall take the appropriate steps to eliminate pollution of waters by dangerous substances in List I and to reduce pollution by dangerous substances in List II".

Most of "List I" substances were already the subject of a directive or of a directive proposal. This is the case for aldrin, dieldrin, endrin, hexachlorocyclohexane, its isomer lindane and pentachlorophenol.

Chromium is considered as the guiding substance for the activities of the Commission on List II substances. In its initial draft of December 1985, the Commission proposed to link water hardness and allowed chromium concentration. In the adapted proposal of February 1988 however, the principle of this relation is dropped and a new absolute limit concentration is introduced (2 milligrams total chromium/litre industrial or cooling water discharge).

Research programmes financed by the EEC

28. The EEC can give important financial support to *industrial research* in the field of wood technology, through following programmes:

- BRITE (Basic Research in Industrial Technologies for Europe). Under the first call for proposals in 1985 only two of the 100 projects were in the wood sector: "Non-destructive evaluation of wooden transmission poles" and "CAD-CAM technology for the furniture industry";
- European research programme on materials (Raw materials research – Subprogramme "wood as a renewable raw material"). Under the first programme, which ran for four years and terminated on December 31, 1985 and under the second programme which is running now, different subjects related to wood preservation and improvement treatments were studied. Surprisingly, the draft of the Commission document on the third action programme 1989-1992 hardly took account of the existence of a wood preservation industry at all. However, due to a well co-ordinated action, the Commission had to draw back its proposal and the new draft will probably contain a specific chapter on wood preservation;
- SPRINT (Innovation and technology transfer). This programme was launched in 1986 and is now in its experimental phase.

29. These programmes and their financial implications prove that the EEC really wants to do something, but one has to notice that the direct participation of the wood preservation industry to these activities was very limited, up to now.

There are, of course, reasons for this, such as the fact:

- that industry (mostly consisting of small and medium sized companies – the so-called SME's) is not always informed about the different possibilities;
- that the research orientation of SME's is often difficult to reconcile with co-operating with direct competitors, with research institutes or with foreign partners;
- that SME's often fear that research institutes, with which they would have to collaborate, may be insufficiently interested in obtaining direct applicable results,

but industry has to overcome its reserves against these problems as it has to secure its future and to provide the *technical basis for the changes* it faces.

GENERAL CONCLUSIONS

30. At the end of the day, the implementation of the programme related to the creation of an internal market will certainly result in an increase of intra-Community trade in the sector of treated timber and wood preservatives, which has been relatively nationalistic and protectionistic up to now.

It could also result in an increasing consumption of treated timber, if the necessary marketing efforts are made to convince people all over Europe of the real benefits of treated timber. The considerable differences in per capita of consumption of treated timber over the 12 Member States (the United Kingdom being by far the leading country in this respect) proves that *a market increase is certainly possible.*

The integrated market of 321 million people therefore *offers prospects, but doesn't bring certainties.*

31. In order to prepare itself to 1992, the wood preservation industry should:

- *think* systematically *on a European basis.* National markets may be familiar and comfortable for companies, but they cannot offer the stimulus to growth that access to an integrated market can provide;
- be very *attentive* to the process of *international harmonization* of standards and technical specifications, which is going on for the moment. In the next few years fundamental decisions will be taken which will determine the requirements for the next decade(s);
- *increase* its *lobbying* activities on a national and a European level (Commission and European Parliament). Otherwise, the sector will be confronted with directives it cannot fulfil;
- *extend* international *collaboration.* While companies still tend to consider other companies, making the same goods in their country as colleagues but companies making the same goods in other countries as competitors, the removal of the national frontiers will imply that there can only be either colleagues or competitors in 1992!

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DISCUSSION ON PAPER 2

Chairman: Dr. F. W. Brooks

THE CHAIRMAN: Thank you very much, Guy, for a beautifully clear account. Anybody who can get four or five laughs out of Europe is not lost for eloquence. I have to say that it is unfortunate for all of us that Guy has to leave fairly soon this afternoon. It is unfortunate for Guy that he is not able to stay and enjoy Cambridge and relax a little and it is unfortunate for us because it does mean that any questions that you do have will have to be asked now; you do not have any further informal opportunities. With that introduction, I will throw the subject open for discussion. Will you give your name and your affiliation and I will give the first right of reply to John Evans if he wishes to take it!

MR. JOHN EVANS: No, thanks.

MR. E. M. PEARCE (Fosroc Ltd.): Can I congratulate you, Guy, on a clearly navigated pass through the mixture and maze of legislation which is coming out of Brussels. There is one area where you did not give any indication of the way we should go and that is the harmonisation of the health approval bodies that control what products we can and cannot use in our countries. How do you see the EEC reconciling those differences?

DR. G. VAN STEERTEGEM: That is a very difficult question. In fact, the "new approach" I was talking about implies that the commission in Brussels will not deal itself with technical problems. Approval could be considered as such a technical problem. The "new" approach of Brussels is "we make the policy and we ask Cen to solve the technical problems, by harmonising standards, by proposing systems for approvals, . . . and so on".

Cen Tc 38 is in charge of Eurostandards for treated timber. I was in Paris at the first meeting of Cen Tc 38 and I have to say that we were not very specific about approval schemes. But we created five working groups, the fourth of which should solve the problem of performance requirements for wood preservatives. So, I personally hope that working group 4 will come forward with proposals about how to organise the approval of preservatives within the EEC. However, I'm not quite sure whether the chairman and the members of Wg 4 share this opinion.

However, I hope that these things can be settled on the level of Cen, where industry is well represented. We should not wait for a proposal of the Commission of the European Communities, because it will be proven very difficult to change it when we cannot agree with this proposal.

DR. JOHN MORGAN (Princes Risborough Laboratory): Could I follow up that issue because, as I understood you to say, Dr. Van Steertegem, you thought that it was the task of Cen Tc 38 to pick up this issue of environmental problems and safety with wood preservatives, but I do not really see how it can, because Cen Tc 38 is a standardisation body and it is concerned with methods of test, and there is no way that I can see that issues of safety and environmental acceptability can be tackled in this way. These are issues which come out of experience in individual countries and I would have thought they would have been quite separate from standardisation. I wonder whether you could clarify that a bit.

DR. G. VAN STEERTEGEM: I fully agree on your point that it is very difficult to handle the problem of toxicology on the level of standardisation.

Let us put things straight. I think it is the first task of Wg 4 to work out European standards on efficacy testing for wood preservatives (as far as they are not available yet), to determine pass and fail criteria for these tests and to work out a list showing which tests the wood preservative has to undergo, according to the hazard class in which it will be used. If that is realised by Wg 4, I think already major parts of the problems are solved, leaving the environmental and toxicological aspects.

I think that 1992 makes no sense when every member state has the right to rule on every dossier on wood preservatives and comes with a "Yes" or "No" decision on its approval on the basis of environmental or toxicological arguments. If this would be the case, we will be confronted with situations that products are allowed in country A and forbidden in country B. This would be the most obvious trade barrier we could imagine! I think that, in that case, the EEC-commission in Brussels will certainly try to do something about it.

I therefore hope, or should I say hoped, that, within Cen, we could come forward with a proposal about how to organise these toxicological and ecotoxicological evaluations. This could then be used as a guidance by the Commission (or another committee) for a decision on a case by case basis.

If we do not do anything or ignore the problem, it could well be that the Commission gets nervous about the wood preservatives and decides to deal with the sector in a separate directive. I am not convinced that this would be a good solution, as I do not know what would be the content of such a directive!

DR. D. G. ANDERSON (Hickson World Timber): I should just like to add that I support in principle what Guy is saying on the need for some kind of harmonisation. I think the problems I can see in this are really that with toxicological packages being very much the intellectual and technical property of the companies which generated that information. One of the problems that we are faced with in the European context is the differences between the countries in how they handle that information and how much confidentiality there is.

I think the U.K. system which we have now got to between the B.W.P.A. and the F.E.P.A. and the C.P.R.E. is probably approaching a reasonably good model for what ought to be applied. I am not saying that there is not a similar system operating in Holland, as an example, but it concerns me that in Germany, in particular, we do not have a clearly defined system whereby we can be assured that the information we are giving to the authorities is retained confidentially. I do not believe there is a role to be played by quasi-bodies such as I.F.B.T. in approving products in Germany. If a body is going to approve products then it must be a Government body and it must be a body which is retaining confidentiality. So that is a particular issue.

I think the question could be asked as whether the B.W.P.A. should be reacting positively to what Guy has said and, as a proposal, I think the Technical and Environment Committee should be considering how we, as an organisation, should be responding to our Government in the U.K. and thereby through to the EEC with our proposals on how we would like to see this particular issue handled. I, personally, agree with John Morgan: I do not think it is a Cen issue. I think it goes beyond the Cen technical aspirations.

MR. DAVID FREEMAN (Guaranteed Protection Trust): So far the discussion has been about the approval of products. I should like to ask a question whether it is envisaged that an E-mark will apply also to services and, if so, what the implications are for the remedial treatment section of the timber preservation industry, particularly for timber treatment in situ?

DR. G. VAN STEERTEGEM: E-marks are foreseen in the Construction Products Directive as a kind of passport for the trade of construction products. The definition given for a construction product is very large. A construction product is a product which is incorporated in a permanent manner in construction works, be it a building or a work of civil engineering. So, in fact, I do not see a lot of products which, at one stage or another, could not be incorporated in a work of civil engineering.

However, even with that large definition of building products, I do not see a treatment or a service being considered a product within the meaning of the directive. So, I very much doubt that it was the intention of the Construction Products Directive to give E-marks to, for instance, services.

DR. HUBERT WILLEITNER (Institute fur Holzbiologie und Holzschutz): I have just a brief comment on the remarks of David Anderson about the confidential handling of data in Germany. I think the I.F.B.T. handles very confidentially all the data they receive especially on the efficacy of wood preservatives. The health and safety aspects are dealt with in Germany by the Bundesforschungsanstalt, the Federal Health Organisation, and they are always obliged to handle things confidentially.

DR. ANDERSON: I should just like to clarify the position. My implication was who are the members of the Committee in the I.F.B.T. and which companies do they work for.

DR. WILLEITNER: We have two parts to the I.F.B.T. There is the real Approval Committee which consists only of neutral members who do not belong to companies and all confidential data is discussed there. Then we have an Advisory Committee to which members of industry also belong. However, all data which you give to the I.F.B.T. on the basis of the approval system is not discussed in the channel committee but only in the Approval Committee itself, which is confidential.

DR. ANDERSON: Yes, I understand.

DR. A. VALCKE (Janssen Pharmaceutica N.V.): I found it an excellent presentation, Guy, but we have been discussing several times within a group of companies developing active ingredients the issue of registration of these active ingredients within Europe. It is our feeling that these active ingredient producers stand a little bit in the cold, because it seems as if we are going away from frontier barriers to a specific need for each country.

I will be a little bit more specific. It is our feeling that, as happens in the plant protection field, because many of these active ingredients are also applied to the plant protection field, that where we have a G.I.F.A.P. organisation and, on a broader scale G.M.P.R. which handles generally these toxicological aspects that this could be done for wood preservatives as well, because if you compare the documents which you have to send, be it to P.S.P.S. or be it to other organisations in other countries, there is a relationship of over 80 per cent between each document. So the studies you have to send are very similar.

It is our feeling that it should be possible, if we have a pressure group, to come to a global European homologation for active ingredients, and not only for active ingredients as such, but also for the preservatives in which the active ingredients are incorporated. It is not only affecting us and costing us a lot of money, but it is also affecting your industry because if you have a product containing a compound and another compound, if you go to country A you have to register it, you have to have a file, and if you go to country B you have to supply the same file, but sometimes there are some additional facts and it costs you more money. So I think there should be perhaps within your organisation somewhat more room for this aspect. I wanted to point this out to this audience.

DR. G. VAN STEERTEGEM: I completely agree with you and I think you are right, within the philosophy of the EEC. They would really like such a thing to happen. The major problem we are confronted with is who's going to make a proposal for that. I think my lecture clearly suggested that, if someone is going to make proposals, it would better be us. We should not wait for others to impose their views on us.

DR. RICHARD MURPHY (Imperial College): I should like to make a comment on your reference to the research programmes of the Commission, DG.12. I think in one way the Commission has made it quite clear that it would like research proposals to be linked as closely as possible with industrial needs. My opinion is that one of the best ways that we can maintain wood preservation and maintain it as a responsible sector in the eyes of the Commission is for us to support those research programmes both as an industry and from the research side, and thereby to make the right sorts of applications to DG.12 when programmes are announced.

DR. G. VAN STEERTEGEM: I think that is correct! As representative of the industry, we are certainly looking forward to a good collaboration with research institutes.

However, there has to be a two-side collaboration. On the one hand, it is up to the industry to help research institutes to get acceptance for their proposals. But, on the other hand, it is up to the research institutes to inform industry of the results of their research.

Maybe industry failed and didn't give enough support to the proposals of the research institutes on the E.E.C.-level, but maybe the research centres were not very successful neither in getting the results of their research better known by industry.

Anyhow, the mutual collaboration would lead to a perfect situation. The results of it would at least be better than the actual situation, where there is a committee of "super-experts" who decide about financing in dividing the money according to the "one third for forestry, one third for woodworking, one third for paper" principle and then, let us say 15 per cent for U.K., 15 per cent for France, and so on, so that every country gets back what it has been giving to the E.E.C. to perform research. If that is what we want, then we do not need to worry, because these things will happen automatically. If we really want interesting subjects to be financed, we need to work together.

I think an organisation such as B.W.P.A. or such as W.E.I., where there are ordinary members being the impregnators and associated members being research institutes, can really do a lot in this respect.

MR. J. DAVID (Catomance): Just a general observation. Do you see a future after 1992 for independent national organisations such as the British Standards Institution?

DR. G. VAN STEERTEGEM: There is most certainly a lot of work to be done by these institutions before 1992, as they have to be present at C.E.N. meetings, working on C.E.N. standards! But I think there is also a future after 1992. The new approach implies that priority is given to make Eurostandards for products in sectors where there are really problems, that is where there are barriers to trade. This does however not mean that there can be no standards in other sectors. As long as they do not create barriers to trade, the national standards can therefore remain. I believe there is a future for B.S.I., for instance in solving national problems relating to some products, without creating barriers to trade.

One could even go further. If a country for instance wants to make a standard or a technical specification for a product, but doesn't demand that products imported from other E.E.C.-states comply with this standard, I think there is a chance that the E.E.C. will not intervene. In order to illustrate this, we recently had a discussion with the E.E.C. on some taxes, called "Fonds Forestier National", which were imposed by the French government on the French woodworking industry. We went to the E.E.C. as European confederation of woodworking industries and explained that these measures would result in a discrimination. The E.E.C. replied "Maybe it is a discrimination, but anyhow it is negative for the French producers and doesn't hinder the trade, so we do not think we need to act against this regulation".

The same could eventually happen on the level of standards. If there is a national agreement on a certain action and no barrier to trade would result of it, you can proceed with the national action. In order to check this, every new standard or technical specification has to be notified to the E.E.C. If this shows there is no barrier, they will let it go. On the other hand, if barriers are created, the E.E.C. would probably issue a Directive or try to adapt the national regulation in such a way that the barrier is eliminated.

So, I do not think every office of the national standard institutions will be closed on the 31st of December 1992, certainly not.

THE CHAIRMAN: We have been talking about 1992, but you will have heard in Guy's presentation that the European standards which are being written by the working groups have to be presented by C.E.N. T.C.38 to C.E.N. by the 30th June next year which is really quite a horrifying prospect. It does mean that it is going to be a very busy year for a lot of people I can see around this room. It seems to me, Mr. President, that it will be of benefit to the B.W.P.A. to have as close a co-operation with the W.E.I. as it can. With that I have nothing more to say than to ask you to thank Guy for coming along and giving us such a very clear representation of the background and the work which still has to be done. *(Applause)*.

B.W.P.A. ANNUAL CONFERENCE 1988

THE PROBLEMS IN GERMANY WITH THE LOSS OF TRADITIONAL CHEMICALS TO THE WOOD-PRESERVING INDUSTRY

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ABSTRACT

In the Federal Republic of Germany prevails strong intention to restrict the use of arsenic and chromium as well as of various organic biocides broadly used in wood preservation. For P.C.P. total prohibition is scheduled. Creosote shall be applied only in plants and not by spraying or brushing in the field. All these restrictions are induced by health and safety problems and a reaction to diminish environmental pollution. To understand the situation it is necessary to recall the tradition of wood preservation in Germany in using the various types of wood preservatives as well as specific treating processes and fields of applications. These are quite different from the situation in the U.K. The status of ecology is very high in Germany and an intense "bio-movement" exists whereas the acceptance of wood preservation in the broad population goes down. The industry is intensively engaged to develop preservatives without chromium as well as to contribute to the safer use of wood preservatives in general.

1. INTRODUCTION

Within the last two decades health and safety aspects reached increasing importance all over the world. For the Federal Republic of Germany in recent times various chemicals were banned which have been used in wood preservation since long time. This is not only due to official regulations but also to the general feeling of the public which is mobilised against biocides. The intention of this paper is both to show the existing situation of the loss of traditional chemicals as well as restrictions and to demonstrate the facts, necessary to understand this situation. As things are very complicated it is necessary to simplify the relations to some extent. Furthermore, it must be considered that the situation is fluent and will depend also on the political development.

2. PRINCIPLE

2.1 General

Before going into details it is necessary to define the term "losses" as well as to give a brief overall-view on wood preservation in the Federal Republic of Germany.

2.2 Definition of "losses"

"Losses" are understood in this paper not only as a complete disappearance of chemicals but also as limitations in the use of certain biocides due to various restrictions as well as to an increasing refusal by the public.

These losses don't occur all of a sudden but are the result of a continual development.

2.3 Approval system

The official approval in Germany concerns only wood preservatives for load bearing constructional timber (PAV, given by the Institut für Bautechnik, Berlin) but not the treated wood in general (Anonym 1983). The approval for these preservatives is obligatory.

In contrast to load bearing timber wood preservatives for any kind of non-load bearing timber including joinery can't get an official approval. For these in 1985 a special quality label (RAL-Gütezeichen by the RAL-Gütegemeinschaft "Holzschutzmittel", Frankfurt) has been introduced on a volunteer basis (Anonym 1987). This quality control also includes the do-it-yourself market.

For both approval systems the efficacy and technical properties are evaluated by relevant committees. In addition the health and safety aspects are evaluated by the Federal Health Organisation (Bundesgesundheitsamt, Berlin).

Beside these approved product groups still a large number of preservatives is sold without any quality or health control. Since the P.C.P.-campaign in Germany, these products often are advertised with terms like "free of P.C.P.", "free of lindane", "biological preservatives", "safe and sound" and so on, without giving details about active ingredients (Willeitner 1988).

2.4 Reasons for "losses"

2.4.1 *Official restrictions*

The official restrictions concern all types of wood preservatives.

Laws mainly influence indirectly the use of chemicals by restrictions, injunctions, directions etc. The basic federal law is the "Chemikaliengesetz" (Law for Chemicals, 1980).

Statutory instruments (ordinances) have similar function but not the official status of laws. The actual basis is the Gefahrstoffverordnung (ordinance for dangerous substances, 1986), which classifies quite a number of chemicals with respect to the hazard of their use.

Some special laws or ordinances refer to specific chemicals for example in the pending restriction for P.C.P.

To be mentioned are also the so-called MAK-Werte (Maximale Arbeitsplatzkonzentration which are equivalent to T.L.V.).

2.4.2 *Further restrictions*

In addition to the official restrictions by laws or statutory instruments for all wood preservatives with approval various chemicals are not accepted or for the application varies injunctions exist. These will influence indirectly the formulation of wood preservatives and as a matter of fact the loss of certain chemicals.

These regulations only concern preservatives with approval whereas all the other types are not considered officially.

2.4.3 *Refusal by the public*

In addition to the official restrictions since more than 10 years an intensive anti-propaganda against certain chemicals takes place in news media, by ecological groups and others, like the P.C.P.-campaign. As a result the public distrusts and won't accept many chemicals (Willeitner 1988). This influences the trade markedly and finally is responsible for the loss of certain chemicals.

3. THE ACTUAL SITUATION OF RESTRICTIONS

3.1 **General**

Restrictions develop step by step starting with a restricted use of the respective preservative up to a total ban. Mostly the industry takes the chance to restrict itself in due time and to look for new biocides to the extend possible.

The restrictions in the Federal Republic of Germany don't correspond to those in other European countries; mostly they go beyond.

3.2 **Inorganic biocides**

3.2.1 *Arsenic*

Since long arsenic-containing wood preservatives were not allowed to be used in closed rooms. As of 1981 these restrictions only referred to copper-fluoride arsenic preparations but not to the classical C.C.A.-preservatives (Holzschutzmittelverzeichnis 1949-1987). This mainly concerned imported wood for prefabricated houses. At present the Federal Health Organisation aspires a complete restriction of all arsenic-containing wood preservatives until end of 1989.

The handling of arsenic containing wood preservatives is confined only to pressure plants. However, within Germany C.C.A.-preservatives were applied scarcely and at present no plant uses them due to many precautions obligatory when handling arsenic. The import of C.C.A.-treated timber is still allowed, however, many customers strictly demand timber "free of arsenic" which influences the trade markedly.

For the German wood preservative manufacturers the loss of C.C.A. type preservatives is of no importance as they were never used widely and are replaced by C.C.B. and C.C.F.

3.2.2 *Chromium*

Since all chromium compounds are now officially declared to be cancerous (MAK-Werte 1987) the health authority tries to restrict also the use of chromium in wood preservatives as soon as possible. The timespan mentioned varies between three and five years to reach this aim. This would be a dramatic change for most of the manufacturers as no wider experience exists so far with chromium free salts in ground contact. At present just one salt got approval and this occured only in 1988!

3.3 **Organic biocides**

3.3.1 *P.C.P.*

In 1977 an intensive movement against P.C.P. started due to several serious diseases for which P.C.P. was regarded being responsible. As a result an increasing part of the public explicit demanded preservatives "free of P.C.P.". The Federal Health Organisation forced the manufacturers to replace P.C.P. and on a volunteer basis since 1985 industry renounced on the use of P.C.P. in all preservatives with an official approval.

During the last year (1987) the Federal Government drafted a statutory instrument (ordinance) to prohibit completely trade and handling of pentachlorophenol, sodium-pentachlorophenoxide and other derivates as well as wood preservatives containing more than 0.5 per cent of P.C.P. and of wood containing more than 5 p.p.m. of P.C.P. The ordinance is tending due to objections by E.C. in Brussels.

The total prohibition of P.C.P. will involve problems for prophylactic treated imported wood because so far no adequate substitutes seem to be available. For preventive treatment of wood in use, however, several alternative biocides are available and applied with good success since long time.

3.3.2 *Lindane*

For lindane up to now no official restrictions are discussed. Nevertheless it is almost impossible to sell preservatives containing lindane as the public is strictly against it. News media and environmental groups make an intense anti-propaganda which resulted in a general fear of the population and they demand preservatives "free of lindane". As a result almost in all formulations lindane is replaced mainly by pyrethroids.

3.3.3 *Other chlorinated hydro-carbons*

In Germany D.D.T. is strictly forbidden. It is even not allowed to store it. Preservatives containing chlordane or contact poisons of the cyclodiene group (e.g. Dieldrin) will get no clearance. As this is common practice since long time it will not influence the market. Endosulfan is still in use.

3.3.4 *Organic mercury compounds*

Organic mercury compound are not allowed to be used in wood preservatives.

In general the prohibition of certain substances does not refer to unavoidable technical impurities below 0.1%.

3.4 **Creosote and derivated products**

Restrictions for creosote and derivated products are based on the cancerous potential of polycyclic aromatic hydrocarbons, represented by benzo(a)pyrene. The tendency is to demand less than 50 p.p.m. benzo(a)pyrene, to be achieved by a special way of destillation with a less amount of high boiling substances. In addition the application of creosote shall be restricted to closed plants. This involves an exclusion of the traditional use of the so-called "Carbolineum" (a light type creosote) for brushing fences and other wood for outdoor use. In addition the use of creosote will be prohibited for wood in play grounds, in indoor use and for all wood with intense skin contact.

The restriction won't influence the use of creosote for sleepers, maximum b(a)p 500 p.p.m. Also in other fields of application like poles, fences, vineyard posts or palisades the restriction would still allow to use creosote, however, it slows down as unions object or many appliers don't like the smell or bleeding of treated timber. On the other hand it should be stated, that many customers are convinced on the performance of this traditional wood preservative and will keep it.

3.5 **Further restrictions**

The following restrictions don't really mean a "loss of traditional chemicals", however, they will influence their use and therefore they are mentioned briefly.

3.5.1 *Kind of application*

Most of the wood preservatives are not allowed to be used by spraying except in closed tunnels (spraying tunnel). This will promote treating plants with the benefit of an improved treatment.

3.5.2 *Use of treated wood*

Specific restrictions are given along with the approval according to the composition of the preservative. No restrictions exist at present for pure boron-containing preservatives.

Wood preservatives (except boron) are not allowed for wood in contact with human or animal food. For lindane the restriction is still stronger and comprises all wood which is used in any room for storage of human or animal food.

Chromium-containing preservatives are not allowed for timber in frequent contact with skin unless the surface of the timber has been carefully washed after fixation.

Preservatives containing creosote and chlorinated naphthalenes and C.C.A.-salts are not allowed for indoor use in buildings.

In addition for the indoor use in buildings the following restriction exists for almost all preservatives, except formulations having only boron, lindane, pyrethroids or parathion as active ingredients:

Not allowed for wood constructions of large surface (radio surface to volume equal or more than 0.2) in rooms for the permanent stay of human beings or animals or for the storage of human or animal food, unless the interior part of the wood construction is completely covered.

Generally the philosophy in Germany is to restrict treated wood as far as possible and to apply wood preservatives only if a hazard exists. This refers especially to the indoor use of treated wood. In the new version of the respective standard DIN 68 800 it is explicitly mentioned that in general no wood preservatives are necessary inside all rooms for the permanent stay of human beings.

3.5.3 *Disposal*

The disposal of wood preservative residues, empty emballages, and treated wood involves increasing problems. At present no really distinct regulations are given, where to get off treated wood (1988). For burning any kind of treated wood various restrictions exist. For disposal the regulations in the various states of the Republic are different with a tendency to become stronger and more complicated.

We must be aware that all preservatives used today will once come to disposal.

4. SOME FACTS TO UNDERSTAND THE SITUATION

4.1 **General**

Compared to the situation in the U.K. and many other countries wood preservation in the Federal Republic of Germany shows various specialities which have contributed to the actual situation. They are partly based on the tradition of wood preservation. Furthermore the status of ecology is a very high one which directly influences the acceptance of wood preservatives. All details given in this paper only refer to the topic of the loss of traditional chemicals and cannot cover the whole field of wood preservation.

4.2 **Tradition of wood preservation**

4.2.1 *General*

The significance of tradition for specific national developments will be understood quite well in the U.K. and it would be interesting, to discuss the benefits and merits of tradition in comparison to the obstuction involved. However, this would be a more philosophic question and cannot be handled in this paper, which only shall demonstrate the current situation, its reasons, and its development.

Tradition of wood preservation in Germany is marked by specialities regarding wood preservatives as well as treating processes and the fields of application of treated wood. They are closely interrelated with each other. Nevertheless in the following each field is handled separately to demonstrate the differences to the relations in the U.K. as clearly as possible.

4.2.2 *Water-borne wood preservatives*

At the beginning of this century fluorides were introduced to wood preservation by the Austrian Malenkowic. Dr. Wolman added chromium, which led to the well known Wolman-salts. Later on also arsenic was incorporated to improve the efficacy. According to its components these are C.F.- and C.F.A.-salts. For many years they were commonly used for poles and other wood in ground contact.

1961 the Dr. Wolman company firstly got official approval for a copper-chrome-boron salt. 1966 Bayer followed with the combination of chromium-copper-fluoride and step by step C.C.B. and C.C.F. replaced C.F.A. which had approval until 1979.

In contrast to C.C.B. and C.C.F. the classical C.C.A. salts never were important in Germany. All of the respective preparations still listed in the official register of preservatives with approval are of no economic interest and since 1983 only producers from abroad have an approval. No national production of C.C.A. type preservatives takes place since long time.

4.2.3 *Organic solvent-type wood preservatives*

Organic solvent type preservatives are used for more than 50 years mostly by spraying and dipping. For a long time most of the formulations contained P.C.P. and lindane as active ingredients and were used also by do-it-yourself.

In the late 50's pigmented organic type preservatives were developed to combine the function of a preservative and of an open-porous finish (the so-called lasures). These often were used in the first place as paints.

4.2.4 *Treating processes*

In the Federal Republic not before the last decade a specific wood preservation industry has been established with an increasing number of pressure plants (Bellmann 1982). Originally, mainly sleepers and poles were pressure-treated whereas constructional timber was treated by carpenters, small wood preservers or pest controllers using non-pressure methods, mainly spraying. Even manufacturers of pre-fabricated houses used non-pressure methods, mainly spraying tunnel or dipping respectively soaking and are still doing so. For constructional timber spraying now has been replaced by dipping and soaking, mainly due to reduce pollution and the high costs of human work. Gluelam often is treated by brushing. Windows mostly are treated by a very short dipping in combination with painting and finishing.

Only for constructional wood used in gardens, parks, play grounds, and the landscape pressure treatment is usual.

The non-pressure treating methods are particularly fixed in the various standards. Only for wood in ground contact, pressure treatment is demanded, except creosoted posts, which may also be treated by a hot and cold butt treatment. Special attention merits the fact, that no double-vacuum plant runs in Germany.

The preferance of non-pressure treating methods for constructional timber goes along with the use of silico- and hydrogene fluorides and organic solvent type preservatives, containing P.C.P. for a long time. Only in the last decade chromium-containing preservatives obtained increasing importance and for organic solvent type preservatives P.C.P. completely has been replaced by other biocides.

4.2.5 *Fields of application*

With regard to the topic of this paper it is essential to understand that after all the destruction during world-war II precautions to protect materials had high priority by the public. As a result for a long time the general tendency was to treat all wood as far as possible. Pigmented organic type preservatives often were used inside living rooms just for the colour effect without considering the biocides incorporated. These biocides mostly were P.C.P. and lindane and this was one basis for the anti-P.C.P. and anti-lindane campaign.

4.3 **Status of ecology**

In Germany ecology has a very high standard. This concerns not only the so-called greens as the specific ecological party, but also a very broad part of the population. The green party is represented in the Federal Parliament and also in most of the States, the City Parliaments and others. Consequently also the three traditional parties (C.D.U., F.D.P., S.P.D.) force ecological activities. To put it in another way, "a green-touched movement" can be observed generally. This of course will influence legislation.

Furthermore our knowledge on harmful substances increased enormously, due to intensive investigations as well as to extremely refined analytical methods.

4.4 **Acceptance of wood preservatives**

At present a great concern against chemicals in general and wood preservatives in particular gets more and more importance. Customers often demand explicit "wood free of wood preservatives" and often newspapers report on traces of P.C.P. to be found in wood, down to 0.1 p.p.m.! Many architects are in general against wood preservatives in houses. Many feel that by constructional methods only wood deterioration can be avoided totally!

For outdoor use wood preservatives commonly are accepted but even there is some tendency to prefer constructions without ground contact and to avoid chemicals.

4.5 **The "bio-movement"**

The "bio-movement" also in the field of wood preservation attracts many persons. Sometimes really obscure receptures are given for "biological", "natural" or "alternative" wood preservatives. From the well known formulations only borax belongs to this group which is often used by unexperienced persons and sometimes even by local authorities. Recommended are also soda, extracts from citrus skins and so on.

5. CONCLUSIONS

After an intensive and broad use of wood preservatives in recent times the acceptance of wood preservatives within the German population slowed down markedly along with a general distrust against chemicals. Many groups gave pressure to legislation, authorities, standard organisations etc. to form restrictions.

So far only a few total restrictions by law or ordinances exist or are planned. All of them refer to organic biocides. Most important will be the scheduled prohibition of P.C.P. including the import of P.C.P.-treated wood.

The majority of the restrictions concern the approval of wood preservatives, where various biocides are not accepted, like chlordane, or where the national health authority demands to retreat to a fixed date, like arsenic end of 1989, or with a strong intention to retreat within some years, like chromium.

For most of the wood preservatives with any approval restrictions thus concern the field of application, mainly indoor use, and the mode of application.

Of special interest are also the inofficial restrictions due to anti-propaganda against certain chemicals or even against wood preservatives in general by ecological groups and the news media, like the common demand "free of P.C.P. and lindane".

Some kind of "loss of traditional chemicals" is also involved by the tendency of using "biological", "natural", or "alternative", wood preservatives, which mostly have a very doubtful efficacy. Nevertheless they are broadly accepted by the public and even by some local authorities.

Wood preserving industry undertakes strong efforts to find and to use new biocides which are accepted. In addition it is necessary within the public by enlighten on health and safety aspects as well as on the benefits of a proper chemical treatment if necessary.

Simultaneously non-chemical means for wood protection, mainly constructional methods are of increasing importance.

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DISCUSSION ON PAPER 3

Chairman: Mr. E. M. Pearce

THE CHAIRMAN: Thank you for guiding us through the problems which exist in Germany. I hope the same problems do not occur in the U.K.

PROFFESOR WILLEITNER: I hope so too.

THE CHAIRMAN: Ladies and Gentlemen, I am sure Dr. Willeitner will be very pleased to answer any questions which you have.

MR. T. SCUTT (Fosroc Ltd): You referred several times to the resistance of the population to using these chemicals and so on. Is it, in truth, the population or is it, in fact, resistance by certain pressure groups?

PROFFESOR WILLEITNER: Naturally. You are quite right, it is certain pressure groups. These pressure groups are very active in the news media and on the television. Nearly every three months you have a special programme showing propaganda against wood preservatives. In most of the special newspapers, like "Stern" – I do not know if you know the "Stern" but it is the newspaper which ran the Hitler story – there are arguments against the dangers of wood preservatives. So you are right, there are pressure groups, but the population follows these pressure groups.

MR. SCUTT: I sometimes get the impression several things are said in the name of the people by pressure groups and really the people do not care a damn.

PROFFESOR WILLEITNER: Yes, but you see the man goes to the market and demands a preservative free of pentachlorophenal but he does not demand a preservative with official approval. He says, "If the health organisation says it is sound, I do not believe it, but if it is free of pentachlorophenal then I believe it". It is foolish. I am sorry to say it to you, but it is.

DR. DAVID BELFORD (Private Member): I should like to thank Professor Willeitner for a very interesting paper. I think he will agree that he raised far more problems than be provided answers. I think perhaps in the United Kingdom matters have not reached quite the same pitch as it has in Germany, but they are getting there fairly quickly. I think it does behove industry, and I include the timber trade in this, really to take the matter quite seriously. Right does not always prevail; sometimes it needs a little help. These emotional appeals that do have such influence really do need to be countered.

It came home to me not so long ago when I appeared on a television programme and there was a lady there who was seven months pregnant who was proclaiming to the world how she feared the effects of wood preservatives on the life of her unborn child. However, in the little social event after the programme, as she lit her sixth cigarette and downed her fourth gin and tonic, what she was saying was ringing a little hollow to me.

We do need to take stock of this situation, I think, and try and mount a counter-attack. But this can only be done, I think, by segmenting the risk. You cannot paint all wood preservatives with the same brush, if you will excuse the metaphor. There are differences between those preservatives which are used by do-it-yourself people in their homes and those used in industrial processes. There are differences in the use of neat wood preservatives as opposed to treated timber. I really do think that industry needs to take stock of the situation. It needs to start taking an objective view on how to counter the misleading claims that are put forward by environmentalist groups.

PROFESSOR WILLEITNER: May I emphasise the point made in the paper. The industry has to come together and I am very grateful that you took this up. It should not say, "My preservative is less harmful than the other one". (*Cries of "hear, hear"*) It still happens. It is always happening. I did not intend to give you any solutions, but just to show you how dangerous things are. You mention about cigarettes. The philosophy of these people in Germany is: "It is my personal decision to take a cigarette, but I cannot avoid the pentachlorophenal if you introduce it into my house". This is the big difference according to these people. But you are quite right, they say pentachlorophenal is harmful but alcohol and cigarettes they do not want to know about.

DR. RICHARD MURPHY (Imperial College): I think many people here must be very concerned that in Germany there is a movement to try and get rid of chromium containing wood preservatives. Can you tell us, Professor Willeitner, on what is this based. Is this based on problems at treatment plants with unfixed chromium or would it be to do with fully fixed preservative treated material being used in the environment?

PROFESSOR WILLEITNER: In the latest list of MAK we, in Germany, list all chromium compounds in 3A. This means that they are proved to be carcinogenous. This is the reason why the health organisation says that it is now a necessity to avoid chromium, because freshly treated timber is also harmful and perhaps old treated timber may be harmful and we need to take care.

DR. A. VALCKE (Janssen Pharmaceutica N.V.): Professor Willeitner I would like to have your opinion on the fact that nowadays when you enter a shop selling wood preservatives in Germany you frequently come across wood preserving companies selling a product under the Blue Angel label saying that the product is made without active ingredients. Do you not think our industry is helping the other side a little bit because you have a product with a Blue Angel label and next to it you have the same group of products containing active ingredients, which gives the population a sort of feeling that actually we are using dangerous products.

PROFESSOR WILLEITNER: This is a very important point. The advertisement which talked about "free of pentachlorophenal" was an advertisement for pentachlorophenal as a dangerous substance, because if it is not dangerous you do not need to advertise the fact that a product is without it. As to the Blue Angel, all substancess which have a Blue Angel on them are bad in some respects because it is impossible to have a biocide which is really harmless. All biocides must have some harm in them and in Germany now as far as the approval committee for the Blue Angel is concerned, it is strictly the tendency not to give the Blue Angel to any biocide. It is the old products which still have the Blue Angel, but it will disappear because it is a nonsense to give a Blue Angel for a wood preservative.

MR. J. DAVID (Catomance): We must always remember that the fears which are being aroused are deep in psyche of almost everybody. The *Maleus Maleficarum* "The Hammer of the Witches" published in 1485 contains the Bull of Pope Innocent VIII which says he had heard from Germany about the terrible things which were happening to people, how the trees had been blighted, how women were no longer able to receive their husbands and husbands no longer able to go to their wives, and all the fears which have been produced now against wood preservatives.

Nothing has changed except that nowadays we do not burn manufacturers of wood preservatives. Something like 250,000 people were, in fact, burned because of those deep fears in the hunting of the witches in Germany and Europe generally in 1485 to about 1590/1600. So this is nothing new.

There is a change of view when you cross the Atlantic, of course. I went to America last week and on the little packets of Sweet and Low which you find in every restaurant it says, "This material contains a chemical which has been shown to cause cancer in laboratory animals", and they are also advertising a drink which says, "This drink contains extra caffeine, more preservatives and more carcinogenic material" and people were actually buying it.

PROFESSOR WILLEITNER: I have nothing to add.

MR. G. D. BRAIDWOOD (Bitmac): I was very pleased to read Professor Willeitner's paper. Shortly after I received an English translation of the Environment Minister's proposals .

PROFESSOR WILLEITNER: Which proposals?

MR. G. D. BRAIDWOOD: To ban creosote. The rationale behind that appears to be set out in the motives for the proposals which read: "This Act will serve to improve protection against wood preserving agents containing tar oils. The dangers which the named wood preserving agents can present to human life or health cannot be adequately countered by classification, packaging and labelling". That must be so in Germany, but certainly in the U.K. and I am certain in many other countries in Europe wood preservatives are adequately classified, packaged and labelled.

That statement of the rationale behind the proposals was quite surprising until you read Professor Willeitner's dissertation where he points out that there is this official approval for load bearing timbers, the unofficial one for the do-it-yourself market and the whole range of other do-it-yourself products which are not covered by any approval scheme at all. This is a source of immense surprise to people who have to put up with the Health and Safety Executives and their activities in the preservation field. Can I just ask one question. Is the proposal by the Environment Minister aimed at creosotes in general or only the official?

PROFESSOR WILLEITNER: No, in general. In general creosote should not be sold on the market. By official regulation we can only have creosote for load bearing timber and creosote which is in accordance with the RAL label. If you produce creosote according to the RAL label so far you have to minimise the benzo(a)pyrene below 50 p.p.m., which makes the creosote costlier than if you sell it without any care for labelling or anything else. Therefore the price is lower for the bad creosote and the bad creosote will be bought on the whole by the customer and, on the other hand, without this audience which you just mentioned, this private market, it cannot be regulated and therefore that is one of the reasons for this c reosote statement by our Ministry which will come before the E.E.C., so as to get the whole creosote market controlled, not only the official one with the official labelling.

MR. BRAIDWOOD: I remember watching a television programme in which it was said that the Japanese revered wood, they worshipped trees and they liked a lot of timber in their properties. The way they achieved their ends of revering trees and having lots of wood was to buy up South American rain forests, to cut them down for their exotic timbers. In Germany the Ecology Party or the Green Party are trying to prevent the German nation from buying exotic timbers just for this same reason. It may be, in fact, that when we go into a restaurant we will be making our selection from the Black Desert Gateau and not from the Black Forest Gateau.

THE CHAIRMAN: I am afraid time has run out. The next paper is due to start any second, so I should like to thank Professor Willeitner for a well presented paper and invite the audience to show their appreciation in the normal way. *(Applause).*

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PERFORMANCE OF WOOD PRESERVING AND WOOD FINISHING SYSTEMS FOR EXTERNAL JOINERY EXPOSED TO NATURAL WEATHERING

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INTRODUCTION

Wood exposed out-of-doors will undergo a complex combination of chemical, physical, mechanical and biological influences, which finally will lead to the degradation of the wood substrate. The deterioration of the wood surface under this unfavourable environment is generally referred to as the weathering. Weathering is not to be confused with decay, which results from the presence of excessive moisture for an extended period of time.

The preservation, finishing and maintenance of external joinery and timber assume the extension of the classical preservation against biological deterioration towards a physico-chemical protection against atmospheric influences.

According to the Belgian technical specification S.T.S. 52 (1973) external joinery is defined as "wooden parts which are completely or partly exposed to the natural weather conditions". However, wood should also give the mechanical strength to these elements. In the S.T.S. 52 windows, doors and wooden fronts are described under external joinery. Feist (1982) defines exterior wood surfaces as e.g. siding, decking, millwork. The wooden elements referred to in this paper are specified in the B.W.P.A. Manual (1986) under commodity specifications:

- C5: Preservative treatment of non-load-bearing external softwood joinery and external fittings (excluding cladding) not in ground contact.
- C6: Preservative treatment of external timber cladding.

Wood exposed out-of-doors may be protected either in a non-chemical or a chemical way.

Non-chemical protection is often also called constructional protection. This includes all preventive measures of architectural, constructional and material-technical nature.

Chemical protection involves the pretreatment, finishing and recoating with "wood preserving and wood finishing products". In the literature, these products are given different names such as: exterior wood stains (Hilditch 1983), pigmented stains, penetrating stains (Feist 1978), surface finishes (B.W.P.A. Manual 1986), coloured organic solvent wood preservatives (Hilditch 1983), wood-preserving stain, transparent wood finish, stain, topcoat product, preventive preservative (Anon 1982).

In this paper these products will be called "exterior wood stains". They form the point of contact between two different industrial approaches: on the one hand, the wood preserving industry which lays the accent on a biological preservation against fungi and/or insect attack and, on the other hand, the paint manufacturers who put the main emphasis on the physico-chemical performance of the products.

In a small country like Belgium about 100 of such products are currently available on the market. For many years this diversity has provoked a confusion with the official organisations, the professional users and not at least with the do-it-yourself consumers.

Therefore it was decided to start in 1980 with a research project which should investigate the efficacy of exterior wood stains under weather conditions when applied to wood species which are normally used for external joinery in Belgium.

The S.T.S. 52 specifies the type of wood preservatives for external joinery and the methods by which timbers may be protected. The Belgian homologation system is based on a classification of products in relation to the type of structural elements, taking into consideration the conditions of exposure and the timber species used. Products for external joinery are classified in homologation class C and are defined in Table 1 (Stevens and Cockroft 1981). Recently (1988) this table has been modified. C3-products have been deleted from the list. C1-products should now always provide an insecticidal protection. One group of products, generally referred to as "TOP-products" could not and still cannot obtain a homologation under the existing Belgian homologation scheme, although these products have known an increasing popularity among the do-it-yourself public. A major objective of our study was to investigate the performance of this product group.

TABLE 1
Homologation classes for wood preserving products used on external joinery in Belgium

Homologation	*Function*	*Treatment*	*Remarks*
C1	protection against fungal decay, insect attack, blue staining and temporary penetration of water	dipping, brushing, double vacuum impregnation	treatment must be followed by a finishing system (paint, C2 product . . .)
C2	ditto C1 complete system of protection and pigmented finishing	3 coats brushing, dipping	must be compatible with paints and varnishes
C3*	ditto C1 external joinery made of Pinus sylvestris	ditto C1	ditto C1

C3* has recently been deleted from this list (1988)

It was also a general feeling at the start of this project that thinking in terms of products was no longer an appropriate approach to the treatment of external joinery. In Belgium it is common practice that external joinery receives different treatments which are dispersed in time. Therefore, combinations of products or different coats of single products were evaluated.

Each combination forms a so-called "external joinery preserving and finishing system". Our research aimed at finding out which "systems" would have the best life-expectancy.

A selection of the investigated parameters will be reviewed in this paper. Special attention will be paid to physico-chemical characteristics of the "systems" such as the thickness of the coats, the penetration depth, the influence of natural weathering, the blue stain-in-service resistance and the degradation patterns. Finally, some general conclusions on the performance of the investigated wood preserving and wood finishing systems will be discussed.

MATERIALS AND METHODS

In this section the general methodology of the exposure studies is described. Specific methods investigating the influence of individual parameters will be dealt with in relation to the discussion of the individual results.

Selection of wood species

In Belgium about 50 per cent of the wood for external joinery consists of meranti (*Shorea species*). For this study, meranti of a common commercial quality as well as D.R.M. (Dark Red Meranti) and L.R.M. (Light Red Meranti) were selected.

Another tropical hardwood species retained was merbau (*Intsia spp.*).

Softwoods were represented by both Scotch pine (*Pinus sylvestris*) and spruce (*Picea abies*). The former one is only allowed for external joinery when treated with a C3-product (nowadays replaced by a C1-product).

Spruce (*Picea abies*) is one of the main softwood species grown in the Southern part of Belgium. However, it does not figure in the S.T.S. 52 list of timber allowed for external joinery. Nevertheless, it seemed worthwhile to determine its potential use for external joinery.

Planed flat sawn test samples free of any visible defects, measuring 40 × 8 × 2 cm, were used. For meranti and merbau only heartwood was selected, for spruce and red pine in addition also sapwood boards were tested.

Product and system types

Forty-two (42) different products, 35 of which were commercially available, were studied and are listed in Table 2.

It appeared from the literature that the solid content is an appropriate criterion to divide exterior wood stains into groups (C.T.B. 1983, Hambling 1976, Hilditch and Crookes 1981, Janotta 1975, Klug 1976). Each group was further subdivided on the basis of active ingredients, i.e. fungicides against decay (D), blue stain-in-service (B) or insecticides (I).

In Table 2 the Belgian classification is compared with the classification proposed by Hilditch and Crookes (1981). The presence of 18 "Top-products" reflects their popularity on the Belgian market. However, six of these high-build stains did not

TABLE 2
Product types used for the external joinery treatment systems

Number of Products	*Belgian Classification*	*Solid Content %*	*Biological efficacy*					*Hilditch & Crookes Classification exterior wood stains*
			DBI	*DB*	*DI*	*B*	*None*	
10	C1/C3	10-20	4	5	–	–	1	penetrating stains (low-build stains)
12	C2	20-35	7	2	–	3	–	medium-build stains
18	TOP	35-60	3	–	–	9	6	high-build stains
2	A1	–	–	–	2	–	–	C.C.A.-C. type salts

D = product containing fungicide against decay fungi
B = product containing fungicide against blue stain-in-service
I = product containing insecticide

TABLE 3
Treating types for external joinery used in outdoor weathering

Treatment Type	*Product Combination*	*Number of Coats*	*Product Function*		
			Preservation	*Finishing*	*Maintenance*
I	3 × C2 2 × C2WB	3 2	C2 C2WB	C2 C2WB	C2 C2WB
II	C1/C3 + 2 × C2 An + 2 × C2 C1 + 3 × C2	3 3 4	C1 & C2 An & C2 C1 & C2	C2 C2 C2	C2 C2 C2
III	C1 + 2 × (TOP) C1 + 3 × (TOP)	3 4	C1 C1	(TOP) (TOP)	(TOP) (TOP)
IV	C2 + 2 × (TOP)	3	C2	C2 & (TOP)	(TOP)
V	(C1) + 2 × (TOP) 3 × (TOP) 2 × (TOP)	3 3 2	– – –	(C1) & (TOP) (TOP) (TOP)	(TOP) (TOP) (TOP)
VI	C1/C3 + 2 × TOP* An + 2 × TOP* 2 × C1 + 2 × TOP*	3 3 3	C1/C3 & TOP* An & TOP* C1 & TOP*	TOP* TOP* TOP*	TOP* TOP* TOP*
VII	C2 + 2 × TOP*	3	C2 & TOP*	C2 & TOP*	TOP*
VIII	3 × TOP*	3	TOP*	TOP*	TOP*
IX	C1 + 2 × TOP	3	C1 & TOP	TOP	TOP
X	2 × C2 + TOP	3	C2 & TOP	C2 & TOP	TOP

C2WB = waterbased C2-product
(TOP) = high-build stain without active ingredients
TOP* = high-build stain with only fungicide against blue stain-in-service
TOP = high-build stain with fungicide against decay and blue stain-in-service
(C1) = C1-type product without active ingredients

contain a biocide. This is the main reason why the Belgian Wood Preservation Association has not yet included this group in their classification.

The group of 42 products was combined to 77 systems. Each system consisted of products originating from the same manufacturer to avoid incompatibilities and premature failures. The 77 combinations may be grouped in 10 "Treatment Types", which are presented in Table 3.

Application methods

Each sample underwent a pretreatment on all sides during the first application. Application techniques prescribed by the various manufacturers were: brushing, short immersion and vacuum-pressure for the C.C.A. type products. The subsequent finishing coats were always applied by brushing.

Exposure conditions

All samples were placed on aluminium racks under a 45° angle facing the south-west on the roof of the faculty for agricultural sciences of the State University of Ghent.

RESULTS AND DISCUSSION

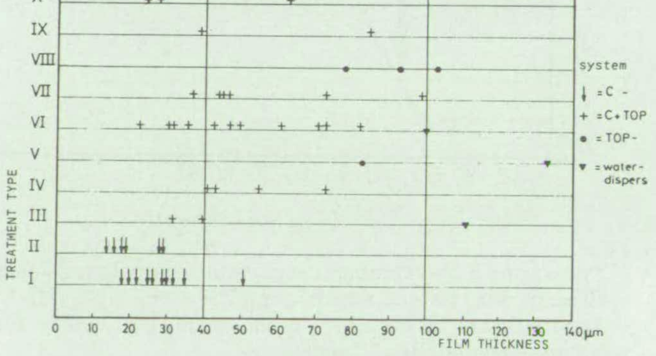
Film thickness and penetration

An efficient coating system should leave a surface film on the wood substrate to protect it from atmospheric influences, but at the same time a good penetration should be achieved to ensure a good biological protection.

For the determination of the thickness of the surface film, Scotch pine samples (10 × 4 × 1 cm) were treated with different systems at a coverage rate of 210 g/m^2. The thickness was measured on 25 μm slides by means of a digitiser.

Results are presented in Figure 1. It appears from this figure that the treatment types can be divided into two main groups, i.e. non-film-forming (C-systems of types I & II) and semi-film-forming (Top-systems of types III-X). Product systems with a waterborne acrylic or alkyd-acrylic resin formed a layer of 100-140 μm.

Fig. 1. Mean film thickness of different treatment types.



The various statistical analyses revealed that the primer coating and the final coating were the most important for the film thickness. Consequently, treatments with types I and II require at least three coats to assure a good weathering resistance.

For the protection against blue stain and decay fungi the fungicides should also penetrate in the wood substrate. It is generally accepted that at least 1.5 to 2 mm penetration is needed for blue stain-in-service control. For protection against decay a deeper penetration is required. Normally exterior wood stains are only applied by brushing, spraying or short immersions. The effect of superficial treatment techniques on their fungicidal effectiveness forms still today in many countries the topic of a wide debate. It is not the purpose of this paper to enter this debate.

The penetration depth was determined according to D.I.N. 52162 (1980). Penetration varied substantially within each treatment type. Certain systems showed no penetration front at all, due to the blockage of the Ceresblue dye by the binders at the surface. This was mostly the case with high-build stains with solid content of 40-60 per cent. Systems with a C1/C3-pretreatment showed penertrations of 2.3 to 4.5 mm, whereas C2-systems varied between 1.0 to 2.9 mm penetration. Top-systems showed only a limited penetration of 1.0 mm at the most. Statistical analysis on all penetration data revealed a very significant relation between the penetration depth of the first coat and the total system. This means that the first application should be carried out with great care, since it determines both the formation of the film and the penetration into the wood substrate. It was also noted that pigmented products showed a significantly lower penetration in comparison to the unpigmented types. This is illustrated in Table 4.

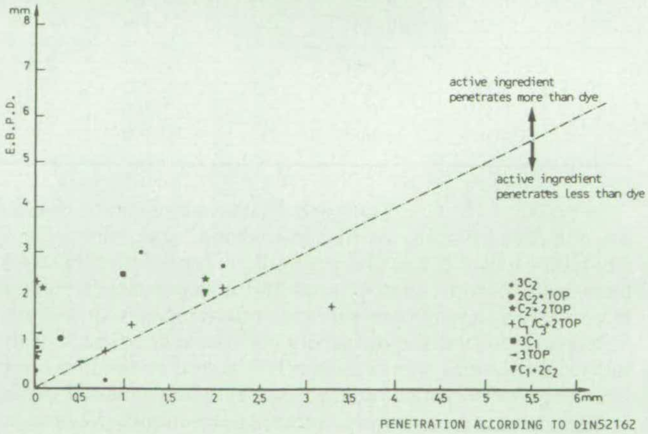
TABLE 4
Influence of pigmentation on penetration depth

System	*Pigmentation*	*Mean pigmentation depth (mm) (120 measurements)*
3 × C2	colourless	3.5
	Teak	1.9
C2 + 2 × TOP	colourless	2.5
	Teak	1.4
3 × TOP	colourless	0.0
	Teak	0.0

In addition, a biological assessment of the penetration was also carried out. Therefore samples were exposed to a mixed culture of *Aureobasidium pullulans (DeBary) Arnaud P268* and *Sclerophoma pityophila (Corda) v. Höhn S231*. After six weeks' exposure the blocks were cut transversely and the Biological Effective Penetration Depth (B.E.P.D.) was measured.

Data are given in Fig. 2 which compares the penetration values of some representative systems with the results obtained with the D.I.N. 52162 standard. Almost all systems showed a larger B.E.P.D. as could be expected from the D.I.N. 52162 test. This clearly emphasises the different penetration of the Ceresblue dye to that of the biocides. In particular, this phenomenon was observed for the medium and high-build stains.

Fig. 2. Penetration values obtained according to the D.I.N. 52162 standard compared with the Biological Effective Penetration Depth.



Physico-chemical performance

During the natural weathering, treated samples are exposed to atmospheric influences such as water, light and heat. The ability of the systems to resist these detrimental effects has been examined by the resistance of the systems to the penetration of water. This resistance is greatly defined by the diffusivity resistance coefficient and the water repellency of the systems. These characteristics will also define the fluctuations in overall moisture content of the underlaying wood substrate.

Action by water

Influence of natural weathering on the diffusivity resistance coefficient μs

The diffusivity resistance coefficient μs relates the water vapour permeability of the tested material to the water vapour permeability of an air layer of the same thickness under equal test conditions i.e. temperature, barometric pressure and vapour pressure difference.

$\mu s = \lambda L / \lambda s$

λL = water vapour permeability in air (kg/m.h.Pa)

λs = water vapour permeability through system (kg/m.h.Pa)

The diffusivity resistance coefficient μs for the various systems was determined according to the method developed at E.M.P.A.-Switzerland (Kühne and Sell 1971 a and b, Sell and Leukens 1971, Jühne *et al* 1972, Sell 1975 and 1976). From μs the specific diffusivity resistance factor Us can be calculated. It expresses the thickness of an undisturbed air layer with the same μs of the tested system.

$Us = \mu s \times s$ (expressed in metres)

s = thickness of film in μm

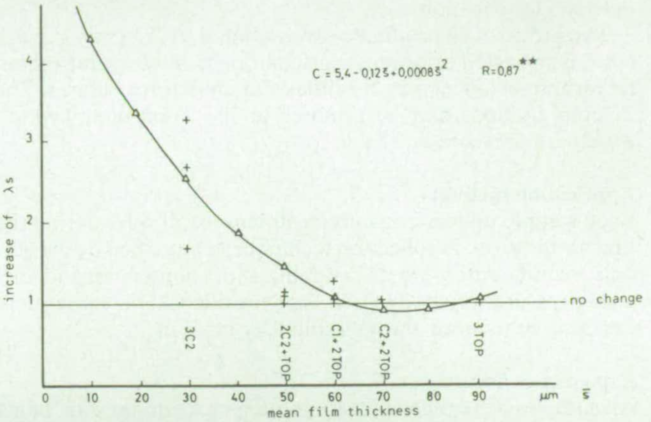
In Table 5 μs en Us for different product systems before and after natural weathering are recorded. The weathering was performed on treated meranti cylinders which were exposed under a 45° angle facing the south-west for six months.

TABLE 5
Influence of natural weathering on the diffusivity resistance coefficient

System	*Non-weathered*		*Weathered*	
	μs	*US (m)*	*μs*	*US (m)*
3 × C2	28,700	0.9	8,800	0.3
	20,300	0.6	12,000	0.4
2C2 + 2 × TOP	52,400	2.6	45,400	2.3
	51,800	2.6	52,800	2.6
C2 + 2 × TOP	77,600	5.4	72,300	5.1
	76,000	5.3	76,600	5.4
C1 + 2 × TOP	30,000	1.8	28,800	1.7
	30,500	1.8	23,800	1.4
3 ×TOP	29,000	2.6	28,700	2.6
	24,000	2.1	24,400	2.2
3 × C2	29,600	0.9	11,000	0.3
2 × C2 + TOP	83,800	4.2	76,700	3.8
C2 + 2 × TOP	72,900	5.1	71,600	5.0
3 × TOP	79,600	7.2	80,400	7.2

In practice, C-, C + TOP- and TOP-systems can be defined as non-film-forming, semi-film-forming and film-forming treatment types. It was also generally accepted that these systems were porous, semi-porous and non-porous. It appears from Table 5 that there was no such relationship. Our research demonstrated that the diffusivity resistance coefficient of the individual systems was significantly affected by the film thickness, the type of binder and the water-repellent characteristics.

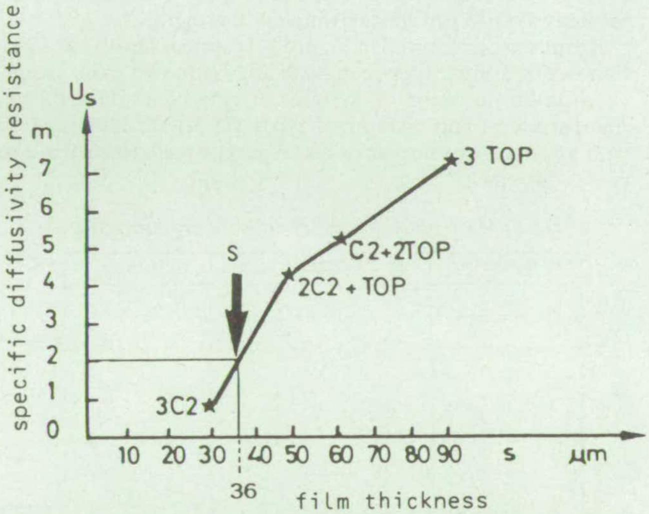
Fig. 3. Change of the water vapour permeability λs due to natural weathering.



The changes of the water vapour permeability λs of some systems due to natural weathering are pictured in Fig. 3. Systems with a mean film thickness higher than 50 μm showed no increase in vapour permeability after six months' exposure. These systems possess a Us greater than 1.5 metres. According to Bagda *et al* (1981) a system showing a Us greater than 2 m can be defined as water vapour resistant. Therefore it is possible to determine a critical film thickness S which guarantees a Us above the minimum value. The Us was measured for different combinations of a certain type of a C2- and a Top-product.

From Fig. 4 it can be seen that a product system with a mean thickness greater than 36 μm will protect the external joinery against an increase in water vapour permeability.

Fig. 4. Determination of the critical film thickness S.



Types I and II may exhibit a decrease in diffusivity resistance coefficient after natural weathering. The other types (III-X) showed no increase in water vapour permeability under the weathering conditions of this test.

Influence of natural weathering on the water repellency

All exposed samples were visually inspected at regular intervals. With nearly all systems a decrease in water repellency was noted within four months from the start of the weathering. Samples which received a maintenance coat showed the same decrease after about three-four months.

In Table 6 the change of the contact angle due to weathering is illustrated. For each system independent of the treated wood species, a contact angle greater than 90° was measured prior to the weathering. After three years' exposure the contact angle had dropped to values below 90°. The maintenance had no significant influence on the permanence of the water repellency.

Influence of weathering on the overall moisture content

The movement of moisture in treated wood through the

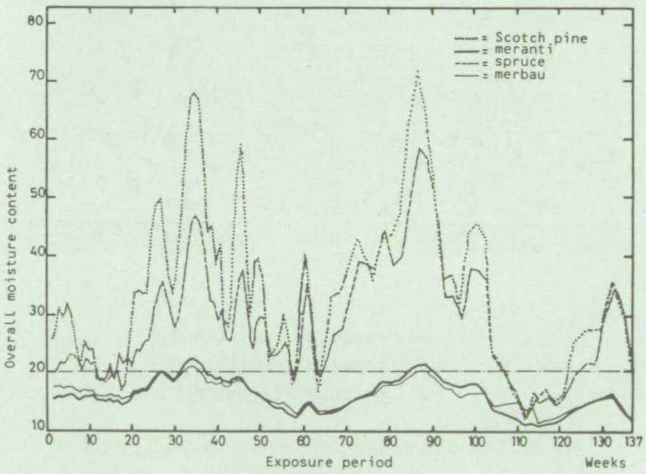
TABLE 6
Change of the contact angle due to the weathering

System	*Wood Species*	*Pigmentation*	*Contact Angle*		
			start	*3 year weathering no recoating*	*3 year weathering recoating*
2 × C2 + TOP	meranti	light dark	114 107	14 8	20 15
	merbau	light dark	113 107	25 8	23 17.5
C3 + 2 × TOP	red pine	light	95	10	34
C2 + 2 × TOP	spruce	light	95	10	16
3 × C2	meranti	light	95	8	12

exposed surface coating is most important. The ability of the systems to monitor the moisture movement can be followed by measuring the overall moisture content fluctuations of the wood substrate. The systems should avoid the building up of a water content at a level which permits fungal decay. This level is generally fixed at 20 per cent. As previously discussed the diffusivity resistance coefficient is the major controlling factor.

In Fig. 5 the moisture content fluctuations of the four untreated wood species during 137 weeks of natural weathering are given. The overall moisture content of the softwood species showed the greatest variations. They increased with a proceeding weathering time.

Fig. 5. Overall moisture content of untreated species during 137 weeks' exposure.



The changes in moisture content of meranti samples treated with four different systems are visualised in Fig. 6. All treatments were sufficient to keep the moisture content below the critical 20 per cent level. However, the difference between the treated and the untreated meranti decreased with time due to physical degradations, increased water vapour permeability etc. From Fig. 7 it is also obvious that after three years' weathering none of the tested systems was still able to keep down the moisture content in the wood.

On merbau (Fig. 8) the stabilising effect of the various treatments was better compared to meranti, probably because of the higher dimensional stability of this timber species and the high μs values (50,000 to 80,000).

The results on spruce (Fig. 9) were unexpectedly encouraging. Both tested systems significantly reduced the moisture content in comparison with the untreated samples. On the basis of these results spruce proves to be a suitable timber species for external joinery.

The overall moisture content of Scotch pine sapwood samples pretreated with a C3-product and finished with a medium- or high-build stain exhibited important fluctuations. During the wettest periods the moisture content even exceeded the fibre saturation point of 30-35 per cent (Fig. 10). This leads to the conclusion that Scotch pine sapwood is less suitable for external joinery.

Action by light

Besides the effect of water, radiation also causes a superficial

Fig. 6. Overall moisture content of meranti samples during 137 weeks' exposure.

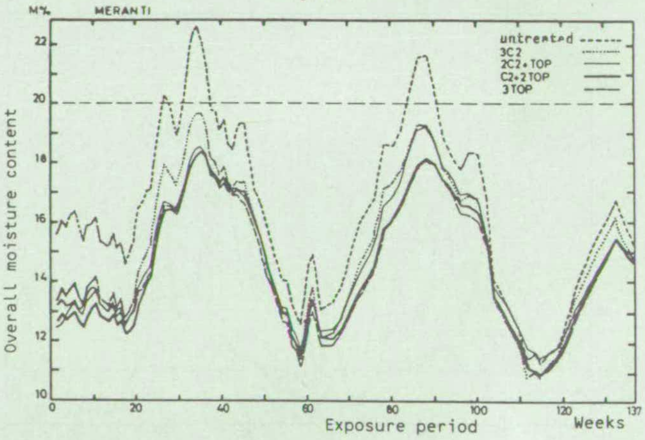
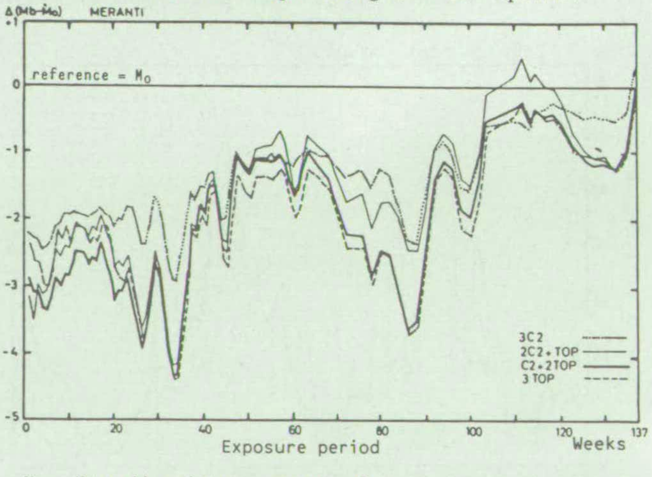


Fig. 7. Difference in overall moisture content between treated and untreated meranti samples during 137 weeks' exposure.



M_b = Overall moisture content of treated meranti samples
M_o = Overall moisture content of untreated meranti samples

deterioration of wood stains and exposed wood surfaces. The effect of a light degradation can be observed in a variety of phenomena e.g. the loss of gloss, the darkening of the coating etc. Some of these visually noticeable changes were quantitatively determined during this research programme.

The glossy appearance of exterior wood stains is a decorative aspect which should last as long as possible, preferentially up to the end of the period of maintenance. In Table 7 a summary of the gloss-values before and after six months of weathering is given. The gloss percentage was measured with a Multiangle Glossmeter under a light incidence angle of 60°. Only a minimal loss of 0 to 13% was noted after six months.

Fig. 8. Overall moisture content of merbau samples during 137 weeks' exposure.

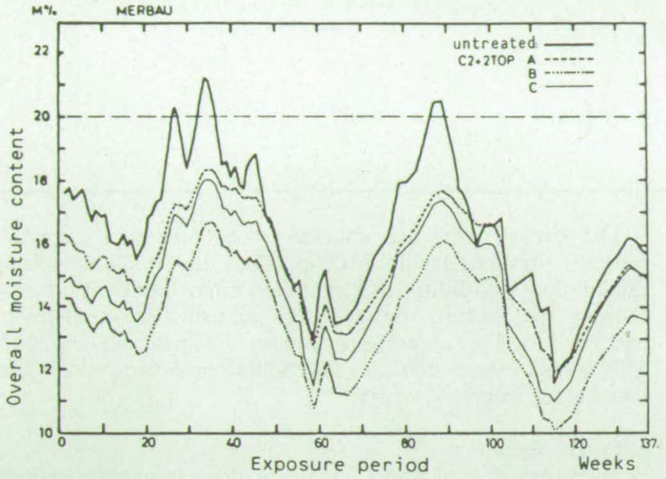


Fig. 9. Overall moisture content of spruce samples during 137 weeks' exposure.

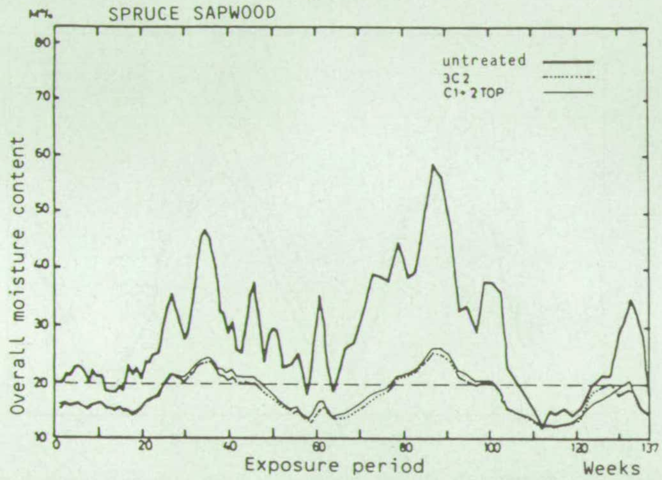
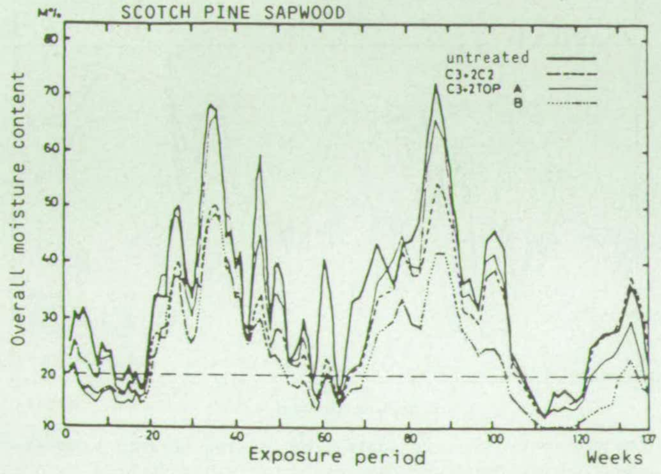


Fig. 10. Overall moisture content of Scotch pine samples during 137 weeks' exposure.



Spectral reflectance measurements were used to determine the visual changes on an objective basis. Fig. 11 shows the effect of light falling on a coating before and after weathering. A part of the incident light (lo) is reflected by Fresnel-reflection (Su). The non-reflected part penetrates the film and is refracted, scattered or absorbed. The remaining non-absorbed part of the light is again reflected by Fresnel-reflection at the underside of the film (Si) and leaves the film as diffuse

TABLE 7
Change of gloss-percentage after six months natural weathering

System	*Colour*	*Start weathering* %	*After 6 months weathering* %
3 × C2	teak	83	73
3 × C2	oregon	81	80
3 × C2	teak	65	59
3 × C2	teak	55	54
2 × C2 + TOP	light brown	34	34
C2 + 2 × TOP	teak	27	23
C2 + 2 × TOP	teak	61	60
C2 + 2 × TOP	light brown	38	25
C2 + 2 × TOP	dark brown	40	33
C2 + 2 × TOP	teak	86	84

Fig. 11. Spectral reflectance characteristics before and after weathering.

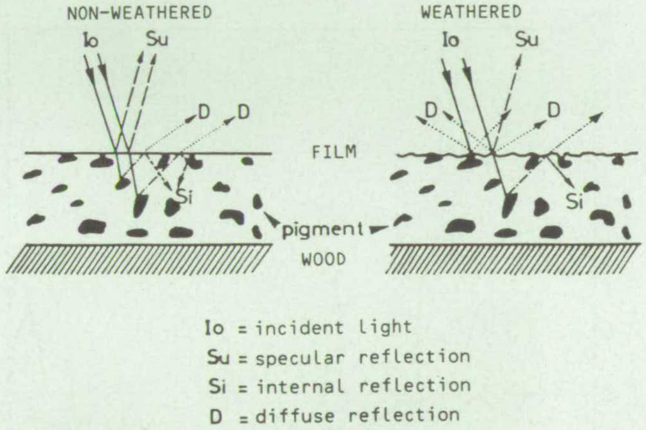
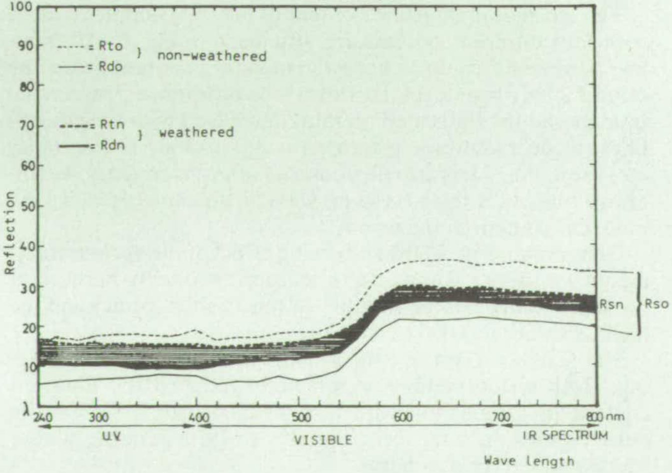


Fig. 12. Reflectance spectra of a dark pigmented C2-system.



reflected light (D). Through these selective absorptions and reflections the human eye can detect the colour of the film. If the surface is still "smooth", the Fresnel-reflection will be a "specular reflectance". If the film has degraded by, say, natural weathering the "diffuse reflectance" will increase.

In our research ten systems were applied to an aluminium surface in three coats. Before and after six months' weathering, the spectral reflectance over the wavelength range of 240-800 μm was measured. Berner and Rembold (1982) demonstrated that about 4 per cent of the light falling on a smooth surface (n=1.5) is directly reflected (Rs1). The remaining 96 per cent penetrates the film and is absorbed or undergoes multiple internal reflections. The remaining part is reflected by the aluminium support and is detected by the spectrophotometer as the specular reflectance (Rs2). The residual part of the light is measured as diffuse reflectance (Rd). For each system the reflectance parameters were measured as Rt = Rs1 + Rs2 + Rd, in which Rs1 = 4% × G (gloss value).

The changes in light reflectance of two specific systems due to natural weathering are given here as examples. The dark pigmented C2-type system (Fig. 12) showed about 10 per cent more reflection in the UV-light range compared to the semi-transparent C2+Top-system (Fig. 13). The total reflection, on the contrary, was lower in the visible light range with the C2-system. The difference could be visually detected as a difference in gloss. Due to weathering the specular reflection over the 240-800 mm range decreased in both systems. The diffuse reflection on the contrary increased, which indicates the start of a surface erosion. From both figures (12 and 13) it also appears that iron oxide pigments which were used to colour the tested stains are very effective UV light absorbers.

Fig. 13. Reflectance spectra of a semi-transparent C2 + TOP-system.

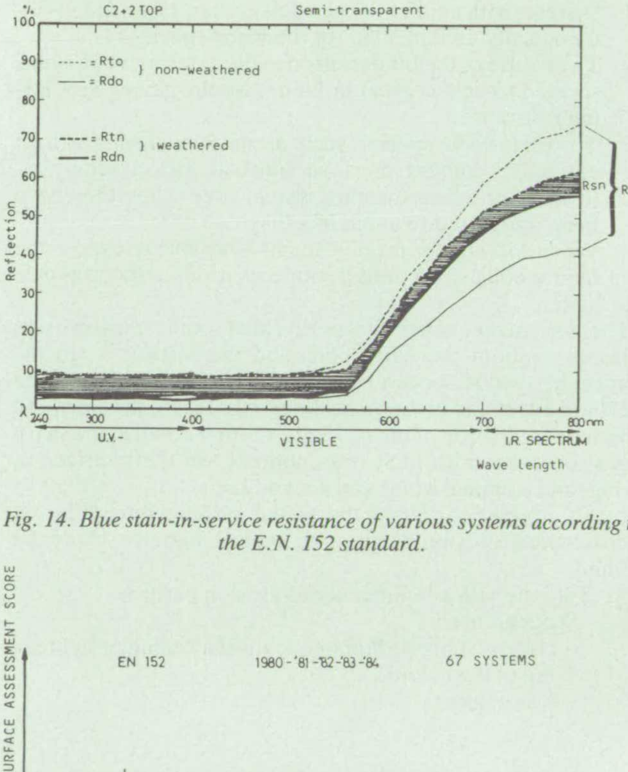
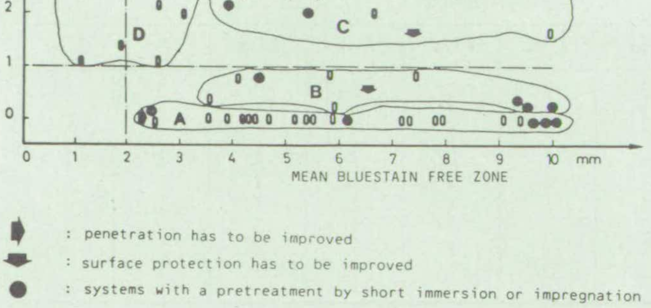


Fig. 14. Blue stain-in-service resistance of various systems according to the E.N. 152 standard.



Our research indicated that spectral reflectance measurements proved to be an appropriate technique to quantify light degradation effects.

Blue stain-in-service resistance

Exterior wood stains will last longer when they resist the growth of blue stain fungi. The C.E.N. has developed the E.N. 152 standard to assess the performance of wood preservative treatments including exterior wood stains against blue stain-in-service. According to this procedure, both the proportion of surface stain and the depth of wood free from stain are determined.

In this project the E.N. 152 was used for testing whole system performances instead of single product performances. A six months' natural weathering was applied as ageing procedure. The results of the tests carried out between 1980 and 1985 are presented in Fig. 14. Out of 67 systems only four showed an internal protected zone less than 2 mm whilst 54 had a blue stain-free zone larger than 3.5 mm. All systems could be divided into four groups:

A. Systems with a good to excellent blue staining resistance.
B. Systems with a medium blue stain protective action. In this case, some superficial staining occurred during the subsequent laboratory test owing to the erosion during weathering.
C. In this group only a failing superficial protection was noted.
D. These systems both fail at the surface and underneath the coating system.

Obviously, a pretreatment applied by immersion or vacuum-pressure resulted in the largest blue stain-free zones.

In order to find out which treatment types provide an adequate protection, a blue staining index was calculated:

Ib = Surface staining + 1/mean protected depth

For the untreated samples Io was determined in the same way. Each year Ib and Io were compared and an Efficacy Value (%) was calculated:

E (%) = 100 – [(Ib/Io × 100)]

By using E (%) the natural resistance of the untreated wood samples and the seasonal variations were taken into account. Effective protection can be guaranteed by a E-value of 65 per cent minimum.

From Table 8 it appears that 37 systems proved to be effective. The number of systems with a E ⩾65 per cent for each treatment type are also indicated in the score column. These

TABLE 8

Efficacy values for the different treatment types

Treatment type	*Total Number*	*Not-effective E<65%*	*Effective E>65%*	*Score*
I	15	7	8	0.53
II	10	9	1	0.10
III	2	–	2	1.00
IV	4	3	1	0.25
V	3	3	–	0.00
VI	18	3	15	0.83
VII	6	1	5	0.83
VIII	3	1	2	0.67
IX	3	–	3	1.00
X	3	3	–	0.00

scores vary between 0 (no system with E ⩾65 per cent) and 1 (all systems with E ⩾65 per cent). Both the absence of an effective fungicide and the failing weathering resistance are the main reasons for an inadequate overall protection. It was also noted that protective systems with a medium- or high-build stain topcoat performed better than low-build finishes.

All systems which passed the E.N. 152 tests were further examined microscopically. Different blue staining patterns were observed. It again appeared that the biological resistance of the systems against superficial staining largely depended upon the weathering resistance, proving that an ageing procedure should be used before biological assessment. Since film thickness and weathering resistance are rather related to each other, it seemed logical to investigate the influence of the number of coats on the blue staining resistance. System combinations of a C2- and a Top-product both containing 0.6 per cent dichlofluanide were studied in this respect. Table 9 reveals that a minimum of three coats is needed to achieve a good performance independent of the combination. This leads to the conclusion that external joinery constructed of blue staining susceptible timbers should receive different treatments.

TABLE 9
Influence of the number of coats on the blue staining resistance

Treatment		*Surface score*	*Blue stain-free zone (mm)*
C2	1 coat	2.4	0.8
	2 coats	0.4	1.3
	3 coats	0.0	2.7
TOP	1 coat	3.0	0.5
	2 coats	2.4	2.7
	3 coats	0.0	2.4
C2 + TOP	1 + 1	2.2	3.0
	1 + 2	0.2	2.9

From the previous discussions, it also can be concluded that each product applied to externally exposed timbers should contain an anti-blue stain fungicide. Under these conditions the treatment types used here can be regrouped i.e. III, IX, X = VI and IV, V = VII. A further conclusion regards treatment type II (C1 + C2 combination) which seems unsuitable for exterior exposures, reducing the 10 treatment types to four final systems.

Weathering performance

Apart from defining the physico-chemical and biological influences responsible for the degradation of the exposed systems also the general weathering performance was investigated.

During the 36 months' exposure period all samples underwent a visual and a microscopic inspection at regular intervals. All samples treated with the same system received a mean score from 4 to 1.

Score	Visual assessment
4	– No change compared to unweathered conditions.
3	– Small changes i.e. loss of gloss, a homogeneous darkening or lightening of the colour. No asthetic or technical loss.
2	– Significant changes i.e. peeling, slight blue staining, microchecks etc. A maintenance coat can still restore these defects.
1	– Advanced erosion i.e. checking, significant blue staining etc. A maintenance coat can no more restore these failures.

Table 10 shows that all untreated samples had completely degraded at the surface after only 12 months of exposure. The most significant changes observed during the weathering process are marked in Table 11. A superficial greying due to light degradation was seen in all tested species. This was accompanied by a dirt accumulation on the softwood species. After three years' exposure an incipient decay (brown rot) was observed on the sapwood of both spruce and pine. Typical degradations linked to the type of wood such as bleeding, resin exudation etc. were noted as well.

From the visual evaluation of the treated wood samples some general conclusions could be drawn:

1. Systems with a film thickness lower than 25 μm failed systematically, independent of the wood species.
2. The nature of the binders used in the exterior wood stains seemed to have a great influence on the global weathering resistance.
3. Tropical wood species such as merbau having a high extractive content must be finished with a semi-film-forming or a film-forming system even when they have been pretreated to avoid bleeding.
4. When softwood is used, it seems advisable to expose the heartwood face to the exterior conditions as much as possible.

The microscopic observations revealed some typical erosion patterns for both the hardwoods and the softwoods. In the tropical hardwood species the erosion occurred the fastest on the sharp edges and in the vessel lines, whereas in the softwood samples degradation of the coatings was first noted at the sharp edges, on areas with high resin content, on the interface of spring- and summer-wood and around knots.

In an attempt to divide the tested systems into different microscopical erosion types, two typical patterns could be defined:

A. Systems with a homogeneous erosion pattern

Appearance:

- colour changes: homogeneous darkening or lightening of the colour;
- loss of gloss;

TABLE 10
Visual assessment of untreted samples at regular intervals during weathering

Wood species	*Exposure period*									
	0 m	*3 m*	*6 m*	*9 m*	*12 m*	*15 m*	*18 m*	*21 m*	*24 m*	*36 m*
Meranti	4	3	3	3	2	2	2	2	2	1
LRM	4	3	3	2	2	2	2	2	2	–
DRM	4	3	3	3	2	2	2	2	2	–
Merbau	4	3	3	3	2	2	2	2	2	2
Spruce sapwood	4	2	2	1	1	1	1	1	1	1
Spruce heartwood	4	2	2	1	1	1	1	1	1	1
Pine heartwood	4	2	2	2	2	2	1	1	1	1
Pine flatsawn	4	2	2	2	1	1	1	1	1	–
Pine quartersawn	4	2	2	2	2	1	1	1	1	–

TABLE 11
Degradation phenomena observed during weathering after three years' exposure

Degradation pattern	*Wood species*					
	Meranti	*Merbau*	*Scotch pine*		*Spruce*	
			Sapwood	*Heartwood*	*Sapwood*	*Heartwood*
Greying	x	x	x	x	x	x
Blue-staining	(x)	(x)	x	x	x	x
Dirt accumulating	x	x	x	x	x	x
Vesselline erosion	x	x	–	–	–	–
Bleeding	–	x	–	–	–	–
Resin Exudation	–	–	–	x	–	–
Checking	(x)	–	x	(x)	x	(x)
Fibrous surface	–	–	x	(x)	x	(x)
Algae growth	–	–	x	–	–	–
Decay	–	–	(x)	–	(x)	–

– = not observed
x = pronounced
(x) = starting

- powderlike degradation ("farinage");
- microscopical checks in the coating.

Erosion pattern: "crocodile skin pattern"

V-shaped microchecks can be seen all over the surface. Dirt accumulation and in some instances blue staining first occurred in these microchecks. Systems with this erosion type can be recoated without an intensive maintenance procedure.

B. Systems with a heterogeneous erosion pattern

Appearance:

- colour changes: spotwise or patchwise darkening or lightening;
- peeling of the layer;
- pronounced blue staining;
- formation of microchecks in the wood substrate.

Erosion pattern: "birdsfeet pattern"

The surface is irregularly eroded. The maintenance is very intensive and it is mostly difficult to restore the original appearance.

By coupling the visual inspection with the microscopic observations it became once again clear that the biological performance and the physico-chemical performance are closely related. A regrouping such as performed after the biological tests was not possible here. The main reasons were:

- the use of stable and durable wood substrates;
- the use of film-forming products showing a slower degradation compared to the non-film-forming ones. Perhaps accelerated weathering can indicate much faster the differences between the film-forming systems;
- the quality of the individual products in a system has a substantial effect on the overall efficacy of the system.

GENERAL CONCLUSIONS

The various experiments carried out gave evidence that only three different types of exterior wood stains should be defined for further homologation i.e. low-build stains (C1), medium-builds (C2) and high-builds (Top). The main characteristics these products should possess are given in Table 12.

The above-mentioned product types can be combined to six different treatment types, which proved to be acceptable for the preservative-finishing treatment of external joinery (Table 13). It is recommended to apply the different coats with the shortest delay in order to avoid premature erosion during the first exposure period of the joinery elements.

Table 14 summarizes the suitability of the various treatment types for their application to external joinery timbers under different exposure conditions. From this table the most appropriate combination i.e. with the best life-expectancy can be derived.

TABLE 12
Optimal characteristics for exterior joinery wood preservatives and exterior wood stains

Optimal Characteristics	*Product Type*		
	Low-build C1	*Medium-build C2*	*High-build TOP*
Solid content (%)	10-15	30-35	~50
Pigmentation	none	semi-transparent	semi-transparent
Film thickness (1 coat)	~5 μm	15-20 μm	25-30 μm
Water repellent	no	yes	yes
Penetration (Scotch pine sapwood)	min. 2 mm	min. 2 mm	min. 2 mm
Decay fungicide	yes	yes	no
Blue stain fungicide	yes	yes	yes
Insecticide	yes	no	no
Treatment process	Double-vac. impr. Short immersion Spraying Brushing	Spraying Brushing	Brushing
Coverage rate g/m^2 (1 coat)	~100	~70	~70
Wood Moisture Content	max. 25%	max. 20%	max. 18%

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TABLE 13
Treatment types for external joinery

Product Type	*Treatment Type*	*Combination*	*Function*		
			Protection	*Finishing*	*Maintenance*
C	I	C1 + 2C2	C1 & C2	C2	C2
	II	3C2	C2	C2	C2
T	I	C1 + 2 TOP	C1 & TOP	TOP	TOP
	II	C2 + 2 TOP	C2 & TOP	C2 & TOP	TOP
	III	2C2 + TOP	C2 & TOP	C2 & TOP	TOP
	IV	3 TOP	TOP	TOP	TOP

TABLE 14
Suitability of various treatment types for external joinery under different exposure conditions

Exposure Type	*Treatment type*	*Joinery Type*								*Pigmentation*
		Constructional				*Non-constructional*				
		A	*B*	*C*	*D*	*A*	*B*	*C*	*D*	
Indirect weathering No direct exposure to rain nor irradiation	CI	x	x	x	x	x	x	x	x	All colours admitted
	CII	x	x	x	x	x	x	x	x	
	TI	x	x	x	x	x	x	x	x	
	TII	x	x	x	x	x	x	x	x	
	TIII	x	x	x	x	x	x	x	x	
	TIV	x	x	x	x	x	x	x	x	
Direct weathering *Type a:* normal buildings with max, 3 stages	CI	x	–	x	–	x	–	x	–	3 not on B and D
	CII	x	–	x	–	x	x	x	x	
	TI	x	x	x	x	x	x	x	x	
	TII	x	x	x	x	x	x	x	x	
	TIII	x	x	x	x	x	x	x	x	
	TIV	–	–	x	x	–	–	x	x	
Type b: enforced buildings with more than 3 stages	CI	–	–	–	–	–	–	–	–	1 not on A, B, C and D 3 not on B and D
	CII	–	–	–	–	x	–	x	–	
	TI	x	x	x	x	x	x	x	x	
	TII	x	x	x	x	x	x	x	x	
	TIII	x	–	x	–	x	–	x	–	
	TIV	–	–	–	–	–	–	x	x	

x = compatible
– = not compatible

Pigmentation:
1. Light: colourless to light brown
2. Medium: light brown to medium red
3. Dark: dark brown to black

Timber species:
A. Softwoods with low resin content, e.g. spruce, redwood, red cedar
B. Softwoods with high resin content, e.g. Scotch pine, oregon, larch, pitch pine
C. Hardwoods with low extractives content, e.g. afzelia, merranti, mahogany, padouk
D. Hardwoods with high extractives content, e.g. merbau, niangon, kerowing, mengkuland

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DISCUSSION ON PAPER 4

Chairman: Mr. P. G. Shaw

The Chairman: Thank you, Dr. Valcke, for putting us on board with this really very comprehensive research project. The work is extremely complex and detailed. I am sure there is a tremendous amount of original thought in the work that has gone into it. The paper, I am sure, has stimulated a lot of thought and interest and I am sure you will have questions to ask.

Dr. A. F. Bravery (Princes Risborough Laboratory): I should like to associate myself with the Chairman's comments, Alex. It is a most impressive paper. The mind boggles at the number of variables that you have managed to study in the work. There is just one point which occurred to me. You mentioned, when discussing the incidence of blue stain in relation to different levels of the same active ingredient, that you attributed it to an influence of weathering. I presume that it could equally well be, and might in fact be more, related to the formulation because clearly the availability of the biocide would be governed as much by the formulation as by anything else. Is that correct?

Dr. Valcke: I can agree there. When we talk of the weathering resistance of the system this is, of course, 100 per cent related to the type of formulation which has been used. It is true to say that many fungicides behaved very well internally but they lost their activity completely after weathering at the surface. It was difficult for us to investigate that at the time. It could either be the degradation of the fungicide itself, which is a possibility of course, or it could be a loss due to evaporation or it could be both. Many times we saw that it was very much related to the degree of weathering of the formulation in that when the product was still sound after weathering there was a good chance of it coming through the blue stain tests. So I think you are correct in saying that the activity of the blue stain fungicide is very much related to the formulation.

Mr. E. M. Pearce (Fosroc Ltd.): I notice that in your presentation you made a comment on the fact that double vacuum impregnation is now being introduced into the treatment of joinery timbers in Belgium. Have you had the opportunity to investigate the difference that you would get by applying preservatives by double vacuum impregnation in comparison with timber treated by an immersion process and then followed up by a different system. Have you followed that up at all?

Dr. Valcke: Actually this plant has only very recently been opened, so I did not have a chance at the time to do that. What we have been comparing is LOSP treated products applied by short immersions, and, for instance, C.C.A. treated timber, mainly spruce, applied by a rueping process, which was at that time indicated to us by the manufacturer, and on top of this an exterior wood stain. Of course, you cannot compare both systems but by pointing out this impregnation procedure I know that with C.C.A. treated timber, mainly spruce, and on top of it exterior wood stain you have got a very good product. I think it is nothing new because Dr. Feist has pointed out also that chromium has something to do with a very good surface protection.

So there is another point which should perhaps be indicated, because chromium is going to disappear. It is very important to emphasise that we also noticed that when we applied on top of C.C.A. treated spruce pigmented products the weathering of the C.C.A. treated timber was slowed down.

Dr. C. R. Coggins (Rentokil Ltd.): What struck me most in the paper, which is an excellent one, and I can add my congratulations as well, was the loss of water repellency very early on in the life of the film on exposure. It seems to me that we have any number of coating systems which have excellent film lives, excellent film properties, but all of them rapidly lose their water repellency. So better water repellent systems allied to the excellent film lives achievable today is really what we have got to be looking towards to improve overall performance.

That is a comment. As a question, Dr. Valcke, I wonder if you can comment on this apparent inability to restore contact angle when you re-coated the systems after three years.

Dr. Valcke: As far as we could see the measurement of water repellency and thus the measurement of the contact angle was quite difficult. We finally went through the photographic method you have seen on the slides because we wanted to be sure that we were always measuring at the same spot, applying the same amount of water and waiting for the same time-period. But I think water repellency is very much related to the surface erosion and to the smoothness of the surface, and even when you try to restore it, on a microscopic scale you never have a smooth surface. That is probably the reason why you are not able to restore it. Actually it went down quite fast. After three months we lost all water repellency. I should also have pointed out that we could never restore the water repellency even after applying the new maintenance coats, we never got the same contact angle as we had at the very start. Probably because we were never able to restore the surface to the same smoothness again.

Mr. E. M. Pearce (Fosroc Ltd.): Can I follow up this point though inasmuch as is it important to have a high contact angle with a film forming material. Surely it is the integrity of the film in preventing moisture entry into the substrate that is important, not necessarily the contact angle.

Dr. Valcke: I agree with you. In our opinion it is much more important to have high water vapour diffusivity resistance rather than having water repellency, but at the time we started the project, water repellency was pointed out by most of the manufacturers as a very important characteristic. Actually the importance of a high vapour diffusivity resistance is not new because paint manufacturers have known for a long time that water repellency is not as important as the vapour going in.

Dr. A. F. Bravery (Princes Risborough Laboratory): Can I come back to a point you mentioned. You alluded to the incorporation of different specific biocides in your low build Cl system, and in particular the incorporation of insecticide. We have heard a lot already today about the need for greater caution in what pesticides are used and where, and this is a potentially contentious issue. I wonder if you could elaborate on your logic a bit there?

Dr. Valcke: As pointed out previously, we tried to find out where each product is used, and then tried to define on which species and what hazards this species is exposed to. In our opinion, external joinery – even when there is some debate going on if "Yes" or "No" there is a possibility for insecticidal attack – should be treated with an insecticide. As we are using more and more susceptible species – due to the fact that tropical species are becoming more and more rare – we finally decided that it was necessary to establish a hazard class for external joinery which makes an insecticidal treatment necessary.

I think when you look at the ratio of potential exposure coming from external joinery compared with, let us say, when you treat a ceiling, it is very minimal. Secondly, we also pointed out that you have to apply a system with a high water vapour resistance on the inside. So you prevent the kind of danger you are talking about that is the potential emission of vapour which, without doubt has also provoked a lot of discussions in our country. The water vapour resistance is very much related to the type of resin which is used. Since polyurethane type resins are very good sealants, we advised many people that the problems with lindane they were faced with, could be overcome when they treat the wood with polyurethane resin which will avoid it coming through.

So I do not see any danger in using insecticides. I think we should be aware as a wood preserving industry that we are treating a biologically susceptible material which is exposed to certain hazards and it should be treated with decent fungicides and insecticides in an acceptable way. If we do not do that, then I do not see how we are going to put external joinery made out of wood in a position to compete with, say, P.V.C. or aluminium. If you can deliver to the client a product which complies with all kinds of criteria, going from the biological to the chemical to good treatment practices, then you have a good product, a new building product actually which can compete with P.V.C. and aluminium. If we go away from that due to the pressure of what we call the Green Party, then I think we are going to lose finally the competition with other materials.

MR. J. H. M. WORRINGHAM (Cuprinol Ltd.): You suggest that a minimum film thickness of 36 microns is recommended to control vapour permeability. Did you observe this for one particular model system or would you expect this to behave similarly across formulation types?

DR. VALCKE: No. I pointed out the fact that we were checking one specific combination but actually that is also one of the standards now which we were thinking of. Each combination should be checked because this critical film thickness will be different for each type of course. What was clear was that when you got a film thickness of less than 25 microns then you got systematic failures. So it should be certainly higher than that.

THE CHAIRMAN: May I ask for your views on the susceptibility of spruce. I see you say in the paper that spruce is not an accepted species for joinery in Belgium. Clearly you have some sympathy, I would detect, for its use.

DR. VALCKE: Yes, I think so. When we make an abstraction of the treatability of this species of course, which is not that obvious, I think spruce is a much better species than pine sapwood. Pine sapwood is used and, as you have seen, we had a lot of problems in our tests with pine sapwood; nearly every system failed. I think we should replace pine sapwood with spruce. That is my personal feeling, or at least we should put it on the list of approved wood species for external joinery. There is no reason to suppose that spruce cannot behave in a suitable way because we know that our neighbours in the north – Holland – use a lot of spruce for external joinery with good results. We do not see why the Belgian authorities should not put spruce on the list. It is good for Belgium economically as well.

DR. C. R. COGGINS (Rentokil Ltd.): Chairman, would you allow me to come back on the contact angle issue. I take the point about movement of water through films in the sense that Eddie Pearce was referring to, but is it not so nevertheless that if it maintains a high contact angle you are actually going to prevent liquid water passing through the film and getting into the wood. I think your results, particularly with pine sapwood, over the three year exposure period indicate that none of the films is keeping water out of the wood. There is a recent classic example from the west coast of Norway, for instance, where products with excellent film lives failed to keep water out of wood exposed out of doors and that resulted in premature decaying. If the excellent film life had been combined with excellent life of water repellency, then they would have done a much better job, based on contact angle.

DR. VALCKE: Perhaps it was also due to the fact that at that time we were using mainly paraffinic type of products, i.e. the products we tested contained only these types, whereas now there are certainly new water repellents which would have a higher natural resistance.

DR. COGGINS: Did you test any of those?

DR. VALCKE: No.

THE CHAIRMAN: Mr. President, Ladies and Gentlemen, we have clearly overrun our time by about 10 minutes. I think that, in itself, is an indication of the keen interest that has been shown in the paper. If I could finish by asking you all in the normal way to show your appreciation. *(Applause).*

B.W.P.A. ANNUAL CONFERENCE 1988

NEW ASPECTS OF WOOD CREOSOTING WITH RESPECT TO PROCESS AND ENVIRONMENTAL ASPECTS

by ING. D. de JONG

Part I General Aspects Related to Creosote as well as Salt Treated Timber.

1. INTRODUCTION

The application of preservative treated timber may cause contamination of the environment. In the case of creosote treated wood the oil-film on the water surface makes this contamination to become visible, or otherwise in a more serious situation, dead fishes indicate that there is something really wrong. Salt treated timber may give contamination too, however without being visible as in the case of creosote treated timber. Of course, not only a serious contamination with poisoned fish is unacceptable, any pollution should be, if not avoided, minimised. Although it may be impossible to avoid pollution completely, a great deal of contamination can indeed be avoided. Stimulated by the authorities, responsible for environmental hygiene, activities have been initiated to investigate the actual level of contamination and the possibilities to reduce the loss of preservative from the treated wood. The research activities learned that improvements are possible and not only that, it proved possible to reduce the amount of preservative loss substantially. Furthermore it proved possible to improve the process of creosoting. It resulted in a completely redesigned creosoting plant.

The first part of this paper discusses potential causes of environmental contamination, their relative importance and what might be done to reduce problems.

The second part gives details of the new design for the creosoting plant.

2. THE ENVIRONMENTAL PROBLEM

As indicated in the Introduction there is or may be a problem at the site of the application of the treated wood. It is, however, not the area with a high pollution risk. The real problems are to be expected on the yard of the treatment plant. This is, of course, understandable. Year after year the wood is, after being treated in the treatment-cylinder, left on the draining area until dripping has stopped. Sooner or later it is then transferred to the storage area where it is kept until it can be sold. During this period rain may cause a repeated loss of preservative from the surface of the treated wood thus causing a continuing contamination of the soil.

The application of creosote oil leads to another environmental problem, its smell. Not everybody appreciates the characteristic smell of a freshly creosoted batch of timber. These vapours from the treated wood, in particular immediately after treatment, may have to be sucked off and in one way or the other be eliminated. In the case of the new plant, as it is described in the second part of this paper, these vapours are burned.

3. THE LOSS OF PRESERVATIVE FROM THE WOOD

The loss of preservative from the wood is of major importance to the wood preservation industry. Any reduction of the preservative level in the wood means an attack on the efficacy, means a reduction in potential service life. To investigate the "loss characteristics" of any preservative the artificial aging tests, EN73: artificial aging by evaporation and EN84: artificial aging by leaching, were designed years ago.

The loss of preservative from the wood is more than just a possible reduction in service life, it means that the evaporated or leached components are introduced into the environment. It is this second effect that is getting more and more attention because it is felt that these preservative-components may present a hazard to the environment.

It has become usance to use the word "leaching" for every situation where there is a loss of preservative due the interaction with water. This however is wrong. In particular in relation to this environmental hazard it is not leaching that may cause serious problems, the greater part of any loss of preservative (components) is no leaching at all.

In order to prevent misunderstandings the word "leaching" is used in this paper in a very strict sense. This makes it necessary to define this property together with the other relevant properties that in the end all result in a loss of preservative with or without the interaction of water.

Definitions

Leaching

Leaching is the transfer of the wood preservative (components) out of the wood structure to the surrounding water.

Note: Leaching applies to the active ingredients causing the N.A.D., the *natural durability* as well as to the H.I.D., the *"human incorporated durability"* (incorporated in the wood during the preservative treatment).

Dripping

Dripping is the loss of the excess of preservative solution that runs off the wood immediately after the treatment.

Note: The two factors involved are the wood (in particular its surface characteristics) and the preservative solution. (viscosity, surface tension etc)

Washing

Washing is the removal of preservative from the wood surface by a (suitable) liquid (in general water).

The loss of preservative without interaction with water.

Evaporation

Evaporation is the loss of (volatile components of) the wood preservative direct into the air.

Defining potential problems may be useful for the discussion, they do not offer a solution. Before it is possible to think of technical solutions and to take any measure the causes of the pollution have to be analysed and characterised first; in other words, we need to know what actually happens during and after the treatment process and whether a modification in any part of the treatment process may result in a reduced pollution and if so, to what extent.

4. THE POTENTIAL CAUSES OF ENVIRONMENTAL POLLUTION

A differentiation can be made between five categories of potential pollution:

Category of pollution	(Main) location
1. design and/or operation of the equipment	the treatment plant
2. dripping	treatment plant
3. washing	treatment plant and elsewhere
4. leaching	elsewhere
5. evaporation	treatment plant (with creosote f.i.)

4.1 The design and/or the operation of the equipment as a cause of pollution

All preservative solution should be removed from the cylinder before the door is opened or even can be opened. Otherwise, the remaining fluid will flow away as the door is opened.

4.2 Pollution by dripping

The shorter the time is between two runs the greater the out-put of the plant can be. Depending upon the number of charges that can be treated per shift or per day it may be more or less interesting to keep the bogies inside the cylinder for a certain period of dripping-time. If this time is kept short substantial quantities of preservative solution may drip off the bogies and the timber outside the cylinder.

4.3 **Pollution by washing**

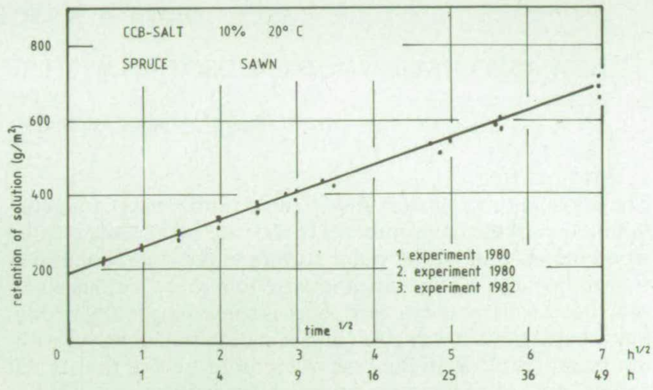
Another and very serious cause of contamination is the loss of preservative due to washing. The most likely cause of washing is, of course, rain. The most threatened place for any loss by washing is the yard of the treatment plant, because of two reasons:

a. The treatment plant has to deal with the freshly treated timber with highest levels of surfacial preservative-residues. Physical processes as after-penetration or fixation still have to begin.
b. It is the treatment plant where the process goes on day after day, year after year and, most likely, always at the same places; the storage area for the treated timber.

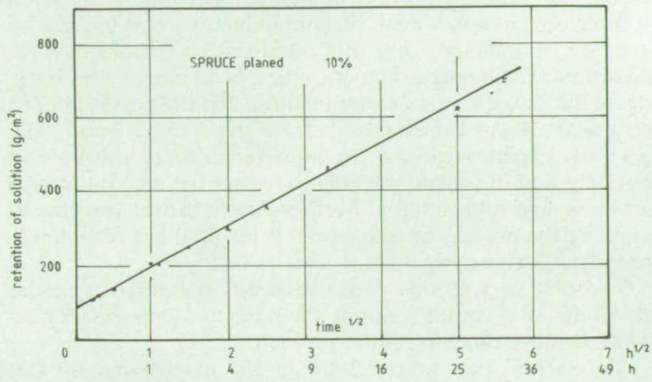
4.3.1 *Primarily washing*

The treatment plant is the first and most important "point-source" for the loss of preservative (components) from the treated wood by washing. The preservative to be washed is mainly what remained on the surface of the wood after the treatment, what has been called the "spontaneous retention". The amount of this spontaneous retention depends largely on surface characteristics and material. For timber this may be about 100-200 ml/m². This is illustrated in Fig. 1.

This first cause of losses may be called "primarily washing" and is restricted to the treatment plant, unless the treated wood is to be transported to the customer immediately after the treatment. Although it is the major hazard for pollution, there are other places and causes for washing.



RETENTION OF SOLUTION IN RELATION TO DIPPING TIME



RETENTION OF SOLUTION IN RELATION TO DIPPING TIME

(from: Tauch- und Trogtränkung mit CKB- Salzen Göttsche, Reimer, 16. Holzschutztagung 1982)

Fig. 1.

from:
The leaching of copper, chrome, and arsenic from CCA-impregnated poles stored for ten years in running water.
IRG/WP/3122. 10-8-1978

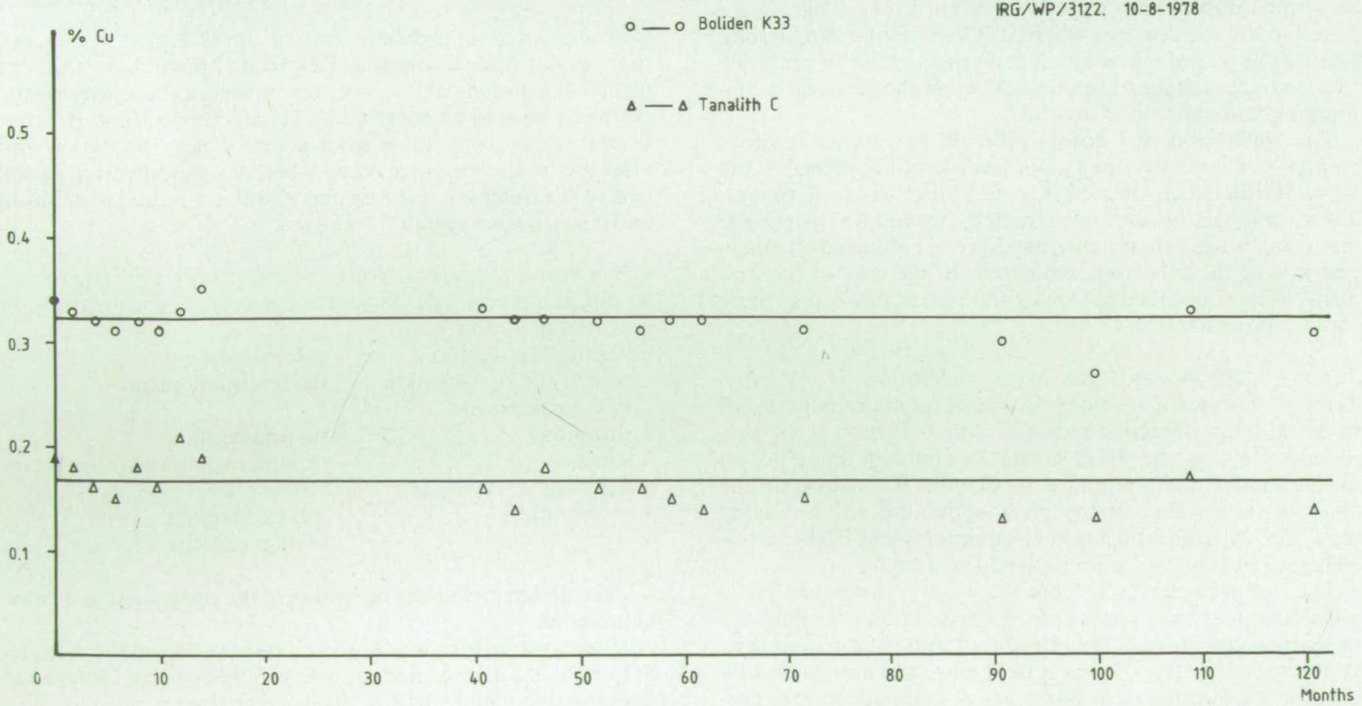
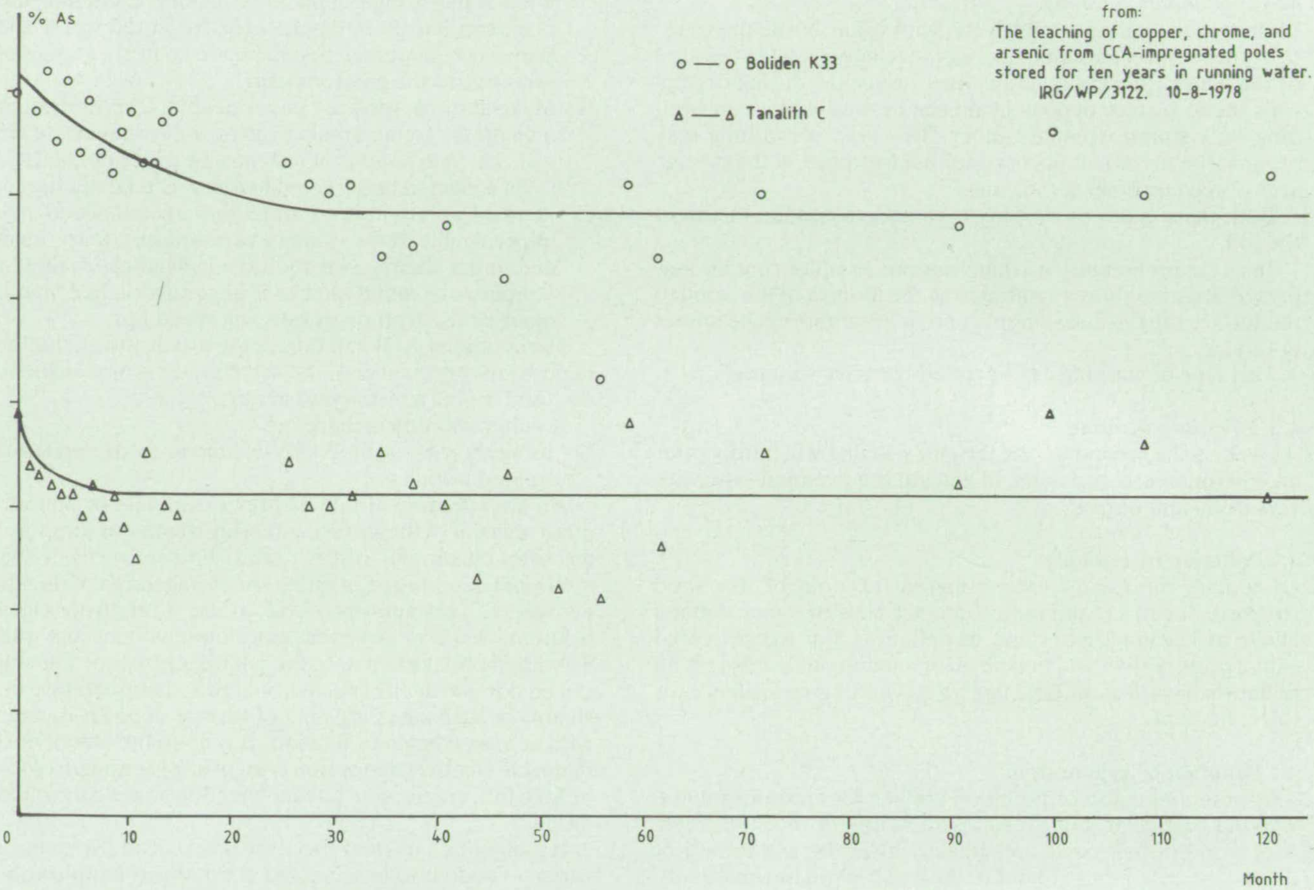
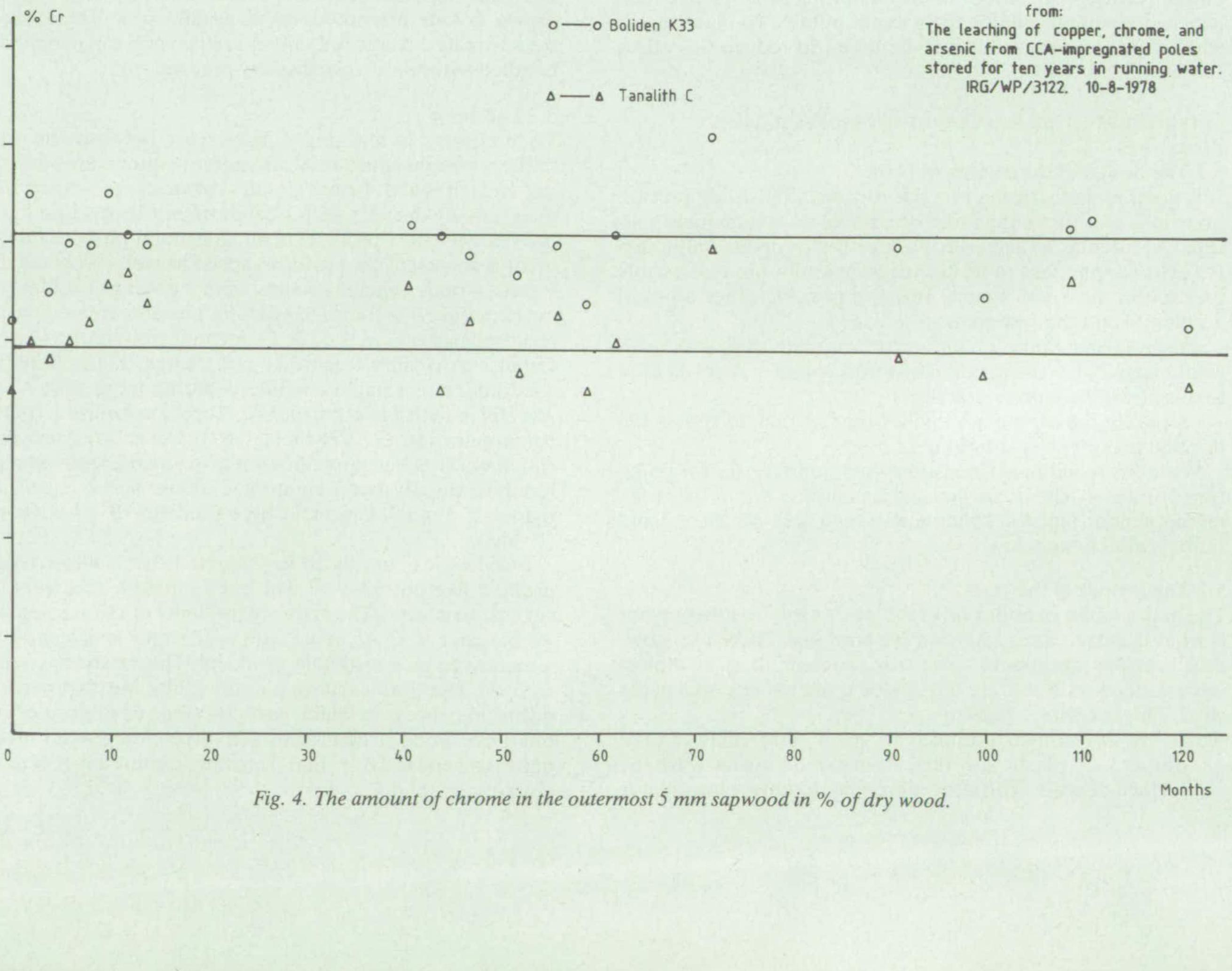


Fig. 2. The amount of copper in the outermost 5 mm sapwood in % of dry wood.



from:
The leaching of copper, chrome, and arsenic from CCA-impregnated poles stored for ten years in running water.
IRG/WP/3122. 10-8-1978

Fig. 3. The amount of arsenic in the outermost 5 mm sapwood in % of dry wood.



from:
The leaching of copper, chrome, and arsenic from CCA-impregnated poles stored for ten years in running water.
IRG/WP/3122. 10-8-1978

Fig. 4. The amount of chrome in the outermost 5 mm sapwood in % of dry wood.

4.3.2 *Secondary washing*

In particular, but not exclusively, with water borne preservatives the surface amount of preservative may increase because of the water, preservative included, transport during drying. This (new) surface deposit again can be washed by rain, running over stored, treated timber. This type of washing may occur at the treatment plant as well as elsewhere, at the storage area of the customer for instance.

Both these types of washing may cause a contamination of the soil.

In as far preliminary washing was not complete and/or new preservative residues migrated from the interior of the wood to the surface the final washing may occur after putting the timber in service.

This type of washing can be called "tertiary washing".

4.3.3 *Tertiary washing*

As well as the secondary the tertiary washing will hardly offer an environmental problem. In general the eventual losses are very small and diffuse.

4.4 **Pollution by leaching**

Of course, the loss of (active ingredients) out of the wood structure due to a (continuous) interaction with water, defined above as leaching, is a cause of pollution. For wood treated with a preservative as creosote oil or a fixing salt leaching is no pollution hazard at all. The figures 2, 3 and 4 give evidence for this statement.

4.5 **Pollution by evaporation**

This potential cause of pollution applies for creosote treated wood in particular, not for salt treated timber. For the creosoted wood in particular immediately after the withdrawal of the charge out of the cylinder as the wood is still hot and smoking, which means that the more volatile components disappear.

It is not the question whether or not this is a detached environmental problem or merely a matter of subjective feelings of individuals and/or the general public. The question is what measures can or have to be taken to reduce this effect substantially.

5. THE POSSIBILITIES FOR COUNTERMEASURES AGAINST POLLUTION

5.1 **The design of the treatment plant.**

It is good manufacturing practice to have all possible precautions taken to prevent as well accidental as systematical spillage. Accidental spillage is f.i. a door that is opened although the cylinder happens to be not yet completely empty. Possible precaution measures against this and possible other types of accidental and the systematical spillage is

– an emergency tank: a liquid-proof concrete tank with sufficient capacity for the maximum stored volume. A precaution that is already common practice

– a separate tank to be built under the railtrack to collect the dripped preservative solution.

With this (combined) measure two potential risks for pollution of the soil, the *accidental loss* of solution out of the treatment cylinder and the *solution that may drip* off the treated timber, are eliminated.

5.2 **The lay-out of the yard**

The major cause of pollution of the yard of the treatment plant is what has been defined above the washing. There are, however, various options to solve this problem. It is of utmost importance to concentrate the treated timber at one area of the yard. This simplifies measures.

A. A low investment option is to cover the freshly treated timber with plastic sheeting. Rain can no longer wash the surface deposit. This procedure may require a low investment it has a high demand on labour, including supervision, can hardly be applied for creosoted wood and still there is no guarantee that there are no further losses of preservative to the environment.

B. Make the storage area impermeable. The rainwater running off the treated timber can no longer penetrate into the soil. The rainwater is or may now be contaminated so it has to be collected and treated before it can be discharged.

C. A third solution is to store the treated wood over an impermeable floor (mainly as a precautionary measure) and under shelter. An additional advantage is that, as the temperature under-shelter is generally higher than in the open air the fixation of salts will speed up.

The solutions A, B and C have the disadvantage that surface deposits may remain onto the wood until it is applied in its end-use (and causes a tertiary washing).

A better solution is therefore

D. to apply a *controlled after-treatment* to the preservative-treated wood.

An after-treatment that assures a complete or almost complete removal of the surface-adhering treatment solution. Such an after-treatment offers clean timber surfaces with a minimum of pollution of either the storage-area of the plant or elsewhere. This approach is of course a relatively expensive solution. It offers however, more options than just washing. This applies in particular to the salt treated wood. The washing can be done with either water of elevated temperature or with steam. In both cases washing of surface deposits is combined with at least a begin of fixation. It is up to the individual plant to decide whether this option is used only for a begin of fixation or for a full, accelerated (steam-)fixation under controlled conditions.

It is obvious why this procedure is best of all. No or hardly no surface-residu is to be expected at the site of temporarily storage (before the final application of the treated wood) or immediately after the installation of the treated wood.

The creosoted and steam-treated wood gets a completely different appearance. The surface has no longer the dark brown colour creosoted wood usually has. The surface of steam-treated creosoted timber is clean and can eventually be handled without the usual safety precautions.

5.3 **Leaching**

Theoretically is leaching a risk-factor because the treated timber contains substantial amounts of either creosote or, with salt treated wood, heavy metals. However, the experience of many, many decades with treated timber learns that leaching does not give any problem at all. A general proof of this statement is the excellent performance of as well creosoted as salt treated wood. Leaching simply *cannot* give any problem at all. An actual service-live of 65 years for creosote treated posts was reported last year at the I.R.G. meeting in Canada (Visscher). Other experiences learn that salt treated diking timber also used under real harsh conditions during more than 40 years was still in such a good shape that it could be re-used. (personal communication H. Visscher, 1987). Other evidence for the statement that leaching does not give an environmental problem has already been mentioned above and is given in the figures 2, 3 and 4. Originally presented in a 1978 I.R.G.-paper (Evans).

Besides, it is hardly to be expected that a water repelling product like creosote-oil will leach out of a relatively dense (wood) structure. The active ingredients of salt treated wood, for instance C.C.A., react with each other and/or with wood structure to give insoluble products. This fixation, combined with the fact that leaching is nothing else but that part of the diffusion process in which particles (ions or molecules) move out of the wood structure into the surrounding water, makes it quite understandable that leaching cannot be a hazard of environmental pollution.

5.4 Evaporation

Freshly creosoted timber produces quite some odour. Its smell, one of the characteristics of a nearby creosoting plant, is not appreciated by everybody. There are two peak-sources of vapours to enter the atmosphere. The first one is the period following on the opening of the door of the treatment vessel and when the bogies are pulled out. The second cause of evaporation is formed by the stacks of creosoted timber stored on the yard.

The basic solution for the first part of the problem is simple. Place an air-sucking system, beginning at the door of the treatment cylinder plus the railway track that covers the bogies as they are to be pulled out of the cylinder. All vapours can be sucked off; an additional treatment of the contaminated air is the second, however necessary, step to prevent the vapours to enter the outer atmosphere. There are various ways to treat the contaminated air.

1. It can be washed with water.
   This does not (yet) solve the problem, one can better say that it only "dissolves" it. The air may now be clean or clean enough to be discharged, the polluting components are transfered in the water-phase, which now needs to be treated (biologically or by other means) to remove the dissolved, volatile creosote components.
2. The contaminated air as such can be blown through a charcoal and/or a biological filter in which the volatile components are extracted from the air and, if a suitable bio-filter is applied, broken down by micro-organisms.
3. A third possibility is to use the contaminated air as the combustion air. This is probably the most promising possibility.

The problem of the "smoking" stacks on the storage area of the yard can probably only be solved without an after-treatment of the creosoted timber. With an after treatment however the level of (disliked) smells is reduced dramatically.

EXPERIMENTAL WORK

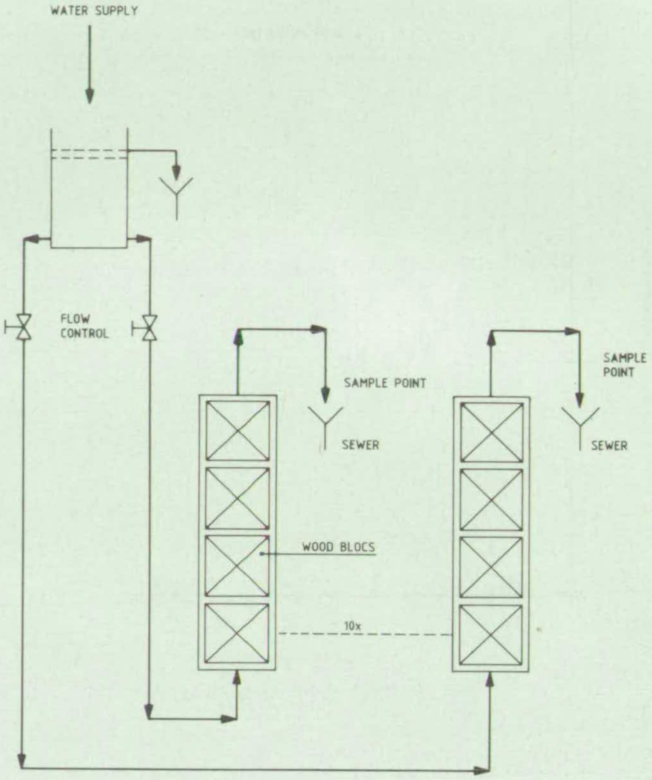
To get an idea about the level of contamination due to surface deposits without and with an after treatment the European leaching test EN 84 cannot be used. The two main reasons are

1. The aim of the EN 84 test is to leach within a few weeks an amount of preservative out of the wood structure which is expected to be equivalent to an overall leaching during a service life of many, many years.
2. The EN 84 test specimen are small and have an extremely high surface to volume ratio as compared to commercially treated timber as is shown in Fig. 5. It is for sure that a high surface to volume ratio is beneficial to leaching. It makes it, however, more complicated, if not impossible, to translate test data to loss rates under use-conditions.

surface to volume ratio of some dimensions

dimensions	ratio	
Test specimen EN 84 + EN 113 5,0 x 2,5 x 1,5 cm	2,51	cm^{-1}
Diking Timber		
4 x 13 cm	0,65	"
5 x 15 cm	0,53	"
Poles		
diam. 6 cm	0,67	"
10 cm	0,40	"
12 cm	0,33	"

Fig. 5.



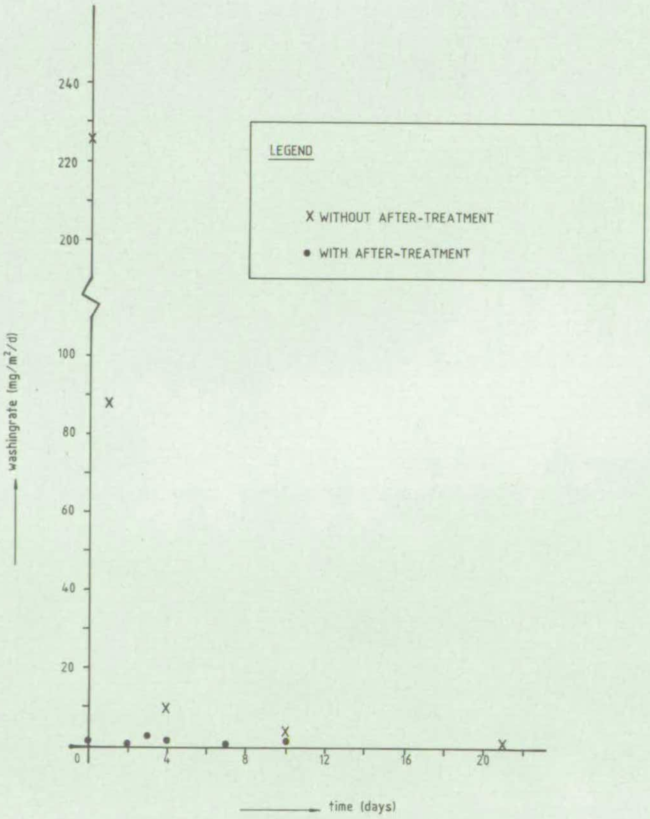


Fig. 7a. Washing of fluorantene.

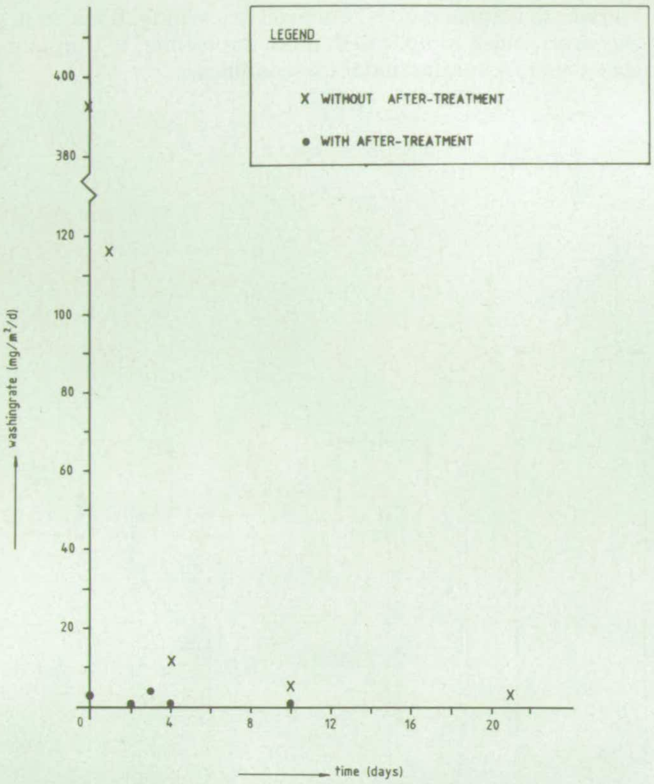


Fig. 7b. Washing of phenantrene.

A test model was designed that fits as close as possible the end-use situation.

TEST MODEL FOR WASH-OFF EXPERIMENTS

Sections of poles (diam. 12 cm, length 20 cm, both ends sealed) were placed in

- glass (for creosote treated pole sections) or
- P.V.C. (for C.C.A.-type B treated pole sections) cylinders.

The cylinders were filled up with water of standard drinking water quality. The water was refreshed periodically (thus simulating "stagnant water") or continously (simulting "running water" conditions). All test specimen were treated with the same "water-conditions". The last step was the analysis of the outcoming wash-water.

A diagram of the laboratory wash test model is given in Fig. 6.

Fig. 7 gives the result of a wash test of creosote treated poles without and with a steam after-treatment. The difference is remarkable. The fact that there is hardly any further loss of relatively soluble components proofs the interesting possibilities of an after-treatment.

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B.W.P.A. ANNUAL CONFERENCE 1988

NEW ASPECTS OF WOOD CREOSOTING WITH RESPECT TO PROCESS AND ENVIRONMENTAL ASPECTS

by Dr. Ir. L. J. Kuijvenhoven

Part II New Design for the Creosoting Plant.

1. Introduction

The use of creosote as a wood preservative is of a long standing. However, it was the start of the railroad in the last century which established the industrial importance of creosote, leading to its systematic, scientific and technical development. The use of creosote was promoted by a scarce supply of wood and an abundant availability of coaltar from the rapidly emerging coal and steel industry.

In the last decennia however, the environmental and health problems became apparent and it became clear that action should be taken to solve these problems. Before effective measures could be taken, one should identify the major problems. From an inventory carried out by Tebodin by order of the Dutch authorities (1), it appeared that the main environmental problems were related to water, air and soil pollution. Knowing this, it also became clear that only an integrated solution in which all these aspects were considered could lead to an acceptable situation.

In the first part of the paper Mr. D. de Jong discussed the potential causes of environmental contamination, their relative importance and what might be done to reduce these problems.

The second part of this paper deals with the development of a new process for creosoting and the reduction of environmental problems by using the new process, as well as an improvement of the economics of this process.

For this development a grant was given by the ministry of Economic Affairs and by the ministry of Environmental Affairs.

2. Design of a Full-scale Installation

Before describing the new process, it is necessary to give a brief description of the present method of wood creosoting.

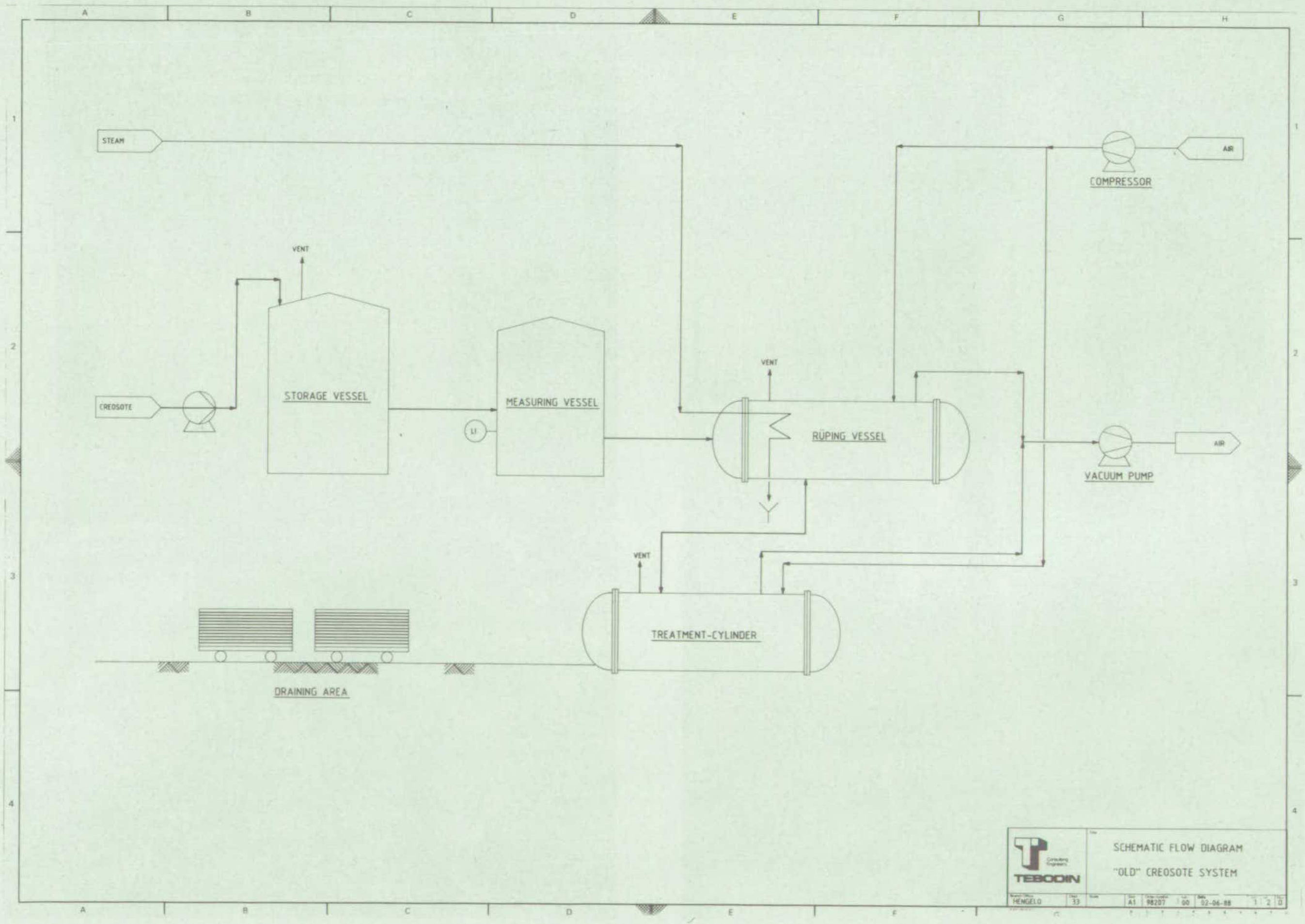
2.1 Present techniques for creosoting of wood

Present techniques are known under the following names:

- full cell process;
- empty cell process;
  - single Rüping process;
  - double Rüping process.

In practice also some variants of these processes exist.

A simplified description of the single Rüping process is as follows (see Fig. 1). The wood is brought into the treatment cylinder and set under a pressure of 200-400 kPa. Then the creosote with a temperature of about 120°C is pressed from the Rüping vessel, which is under the same pressure, into the treatment cylinder. When this cylinder is filled, the pressure is increased to about 800 kPa and this will last a certain time. In consequence, creosote is pressed into the wood. When the retention, or the pressure time, has reached the prescribed



Flowscheme 1. Schematic flow diagram "old" creosote system.

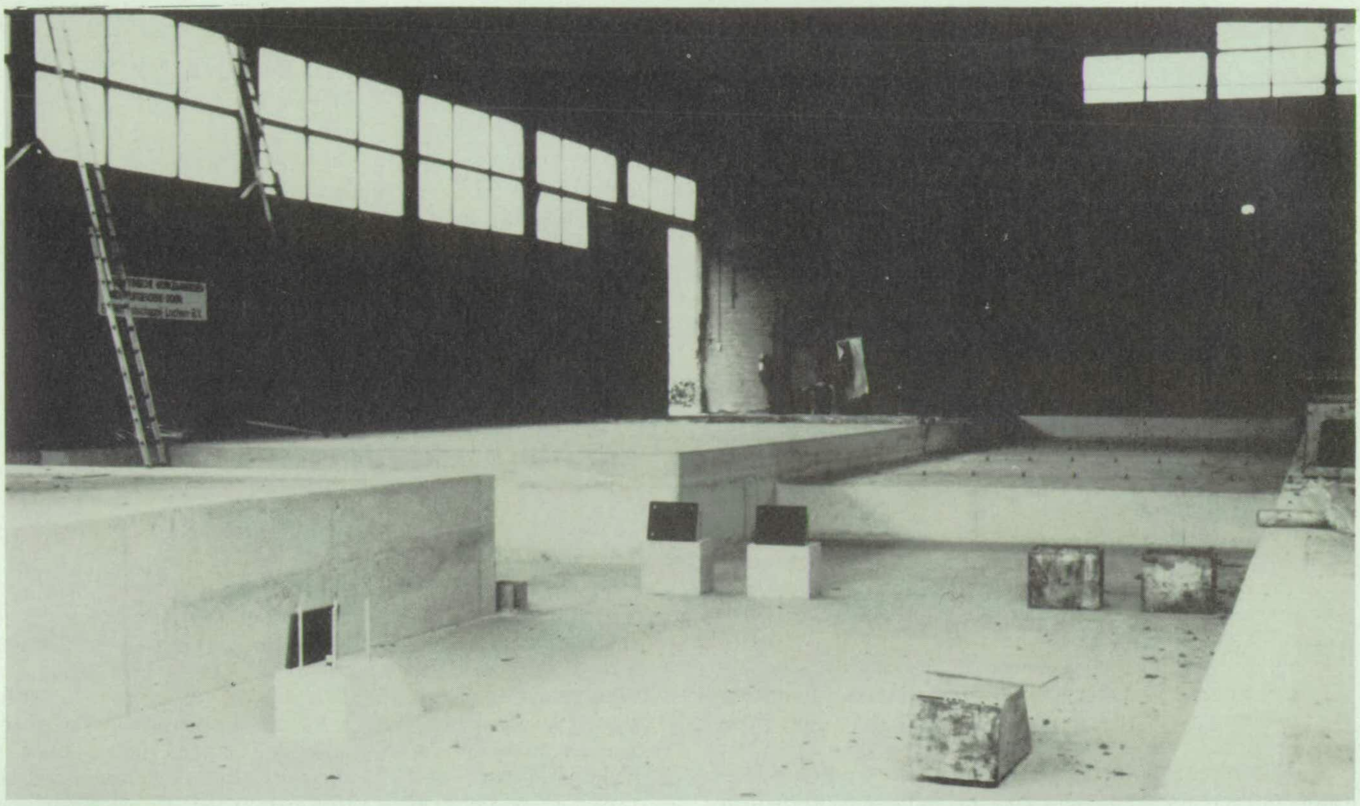


Fig. 1. Watertight ground protection.

Fig. 2. Storage tanks.

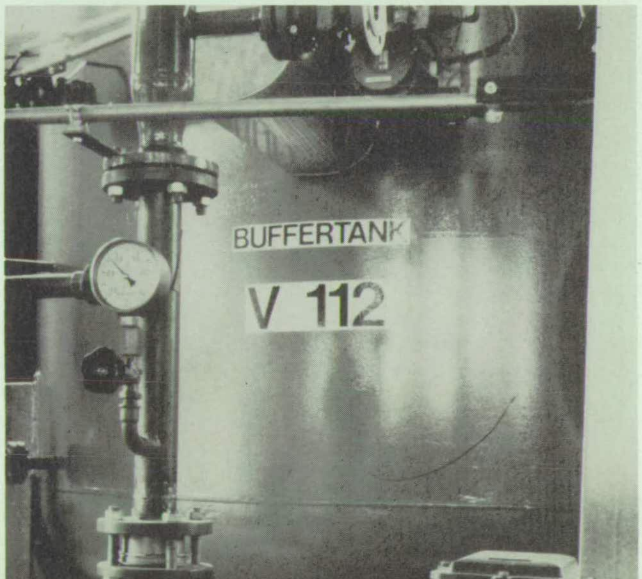


Fig. 3. Detail of the vacuum pump.

value, the pressure is reduced. Now the vessel is set under a vacuum of about 20 kPa to remove most of the creosote surplus.

When the wood is removed from the treatment cylinder it has a temperature of about 70-80°C and creosote vapours will get off the wood. In the meantime also drops of creosote will run off the bogies and off the wood as has been described in the first part. After a certain time the newly creosoted wood is transported to the storage yard where further creosote losses can be expected.

During the creosoting process, water will emerge from the wood and will mix with the creosote. This water/creosote mixture is pumped back to the Rüping vessel after the creosoting process.

The water and volatile creosote components will evaporate from the creosote in the Rüping vessel, when this vessel is pressureless.

The main problems with the present day techniques are as follows:

– the retention of creosote in the wood can only be measured afterwards;

– the process of wood creosoting is a very "operator-sensitive" process;

– environmental contamination during the creosoting process and during the storage and the use of the wood.

In the new process, the fore-mentioned environmental problems are solved, while also the creosoting process can become more economical.

2.2 **New approach**

Process

From the inventory (1) it becomes clear that most of the environmental problems, occurring during the creosoting process, could be solved easily by some adjustments of the creosoting vessel, and by making a watertight ground protection around the vessel and under the railroad tracks. These measures, however, did not adequately minimise the problems during the storage in the yard or during the use of the creosoted wood. So research was focused on these problems.

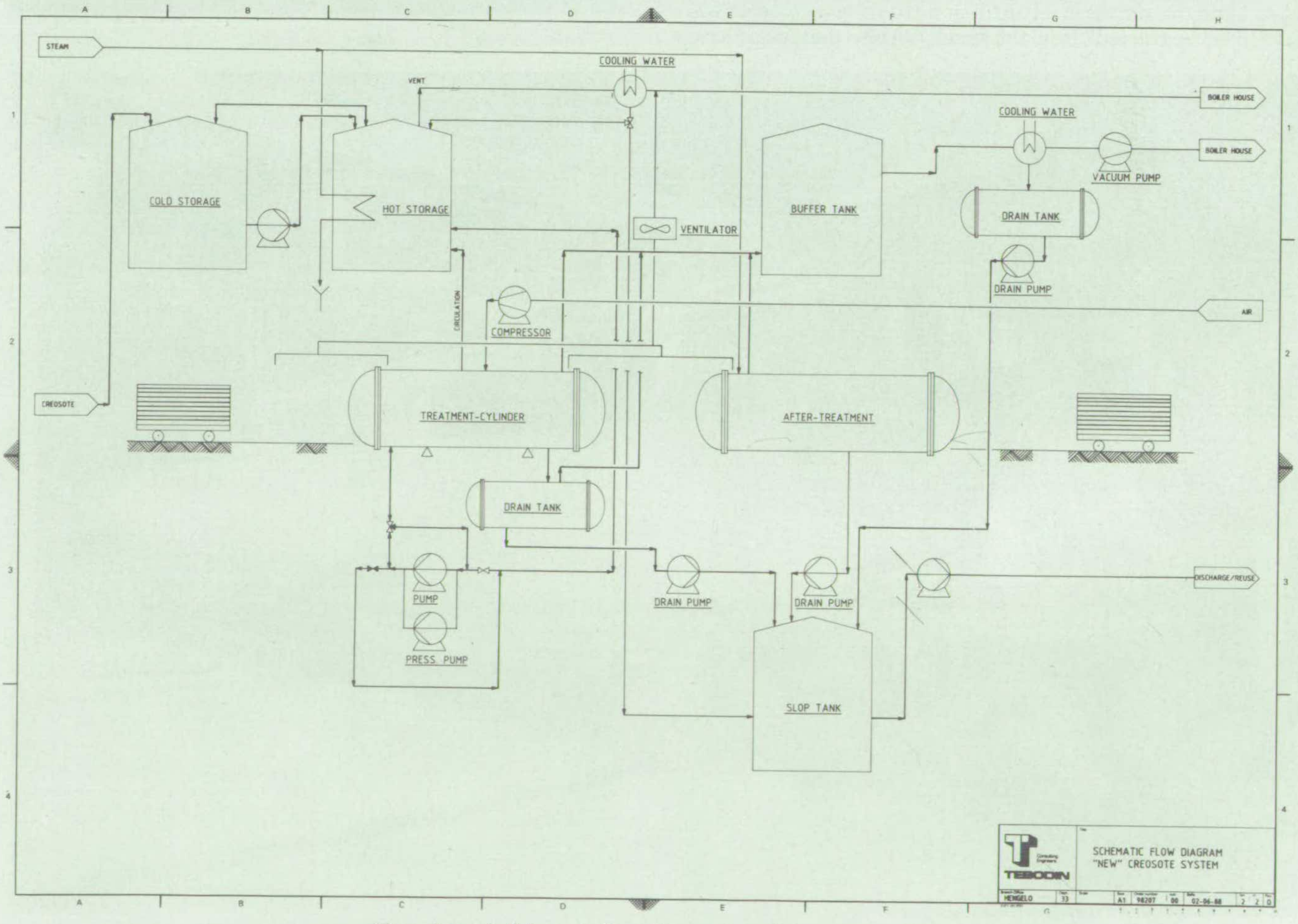
From laboratory test work (see Part I) it appeared that the environmental problems during the storage and use of creosoted wood could be solved by treating the newly creosoted wood with steam; this is called the "after-treatment". It will be clear that with such an after-treatment, creosote can be washed off (= creosote loss and extra water pollution). So it is essential that the newly creosoted wood contains no more creosote than prescribed. This means that it is necessary to measure the retention of creosote not *after* the treatment as is the present day technique but in fact *during* the treatment. This idea, together with some potential environmental improvements, was further developed by a task force from Markerink's Houtbedrijf, Cindu Chemicals and Tebodin Consulting Engineers. It resulted into a new approach for wood creosoting, in such a way that most of the fore-mentioned problems could be solved together, while at the same time the resulting process would become a more economical process, as the amount of creosote could be optimised.

This new process is divided into two separate parts:

1. Adjustment of the creosoting vessel;
2. System for after-treatment.

These parts, in principle, can work apart from each other. In Fig. 2 a simplified flow scheme is given.

In the new system the wood can be treated similarly as in the



Flowscheme 2. Schematic flow diagram "new" creosote system.

old system (full cell process, empty cell process, etc.) and only the differences in the way of operating are discussed below.

These are:

- P.L.C. control;
- weighing;
- hot storage tank;
- treatment of vapours;
- after-treatment;
- various.

2.2.1 *P.L.C.-control*

The P.L.C. (programmable logic computer) is the heart of the new system, it controls all the necessary steps and will replace the "operator-sensitive" actions by well programmed actions. All the various ways of creosoting, as prescribed in the Dutch NEN 2913, are programmed and can be activated. The process chosen, including all the process parameters, such as treatment time, temperature, pressure, vacuum, weight of the wood before and after the treatment, will be printed on a protocol. With this protocol it will be clear for the customer in which way his wood was treated and that he got what he ordered.

2.2.2 *Weighing*

In the new process the treatment vessel is put on "load-cells". In this way it is possible to measure the weight of the contents of the treatment vessel at any time with an accuracy of 1 percent. This means that, once the weight of the wood is known, one can measure the amount of creosote pressed into that wood at any time. It is now possible to stop the process just in time, when the prescribed amount of creosote has been pressed into the wood. This means that an overdosis of creosote, as is common practice nowadays, is not necessary anymore. And this means in its turn that not only less creosote will have to be "extracted" from the wood, but also that the process

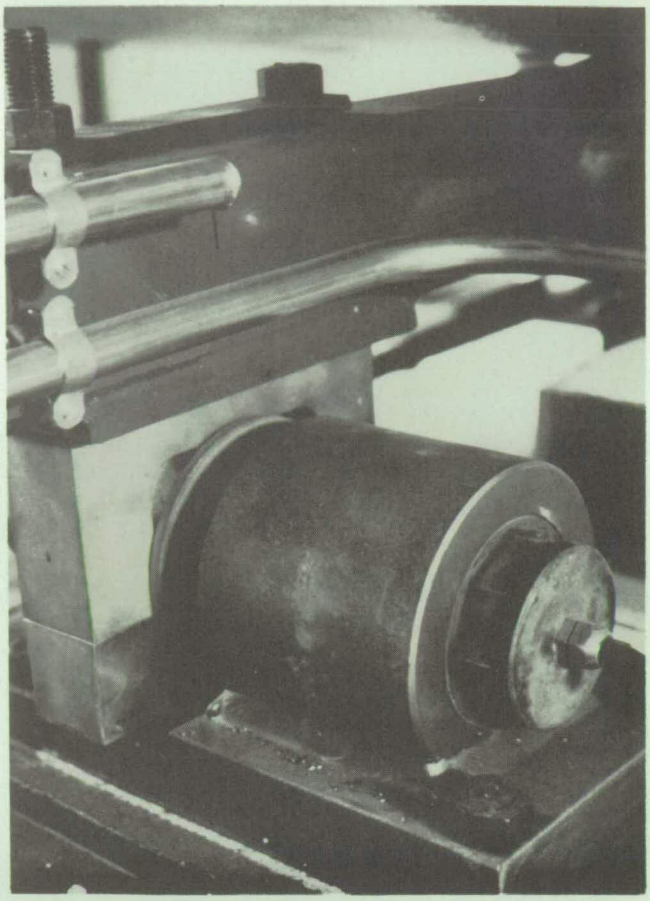


Fig. 4. Load cell.

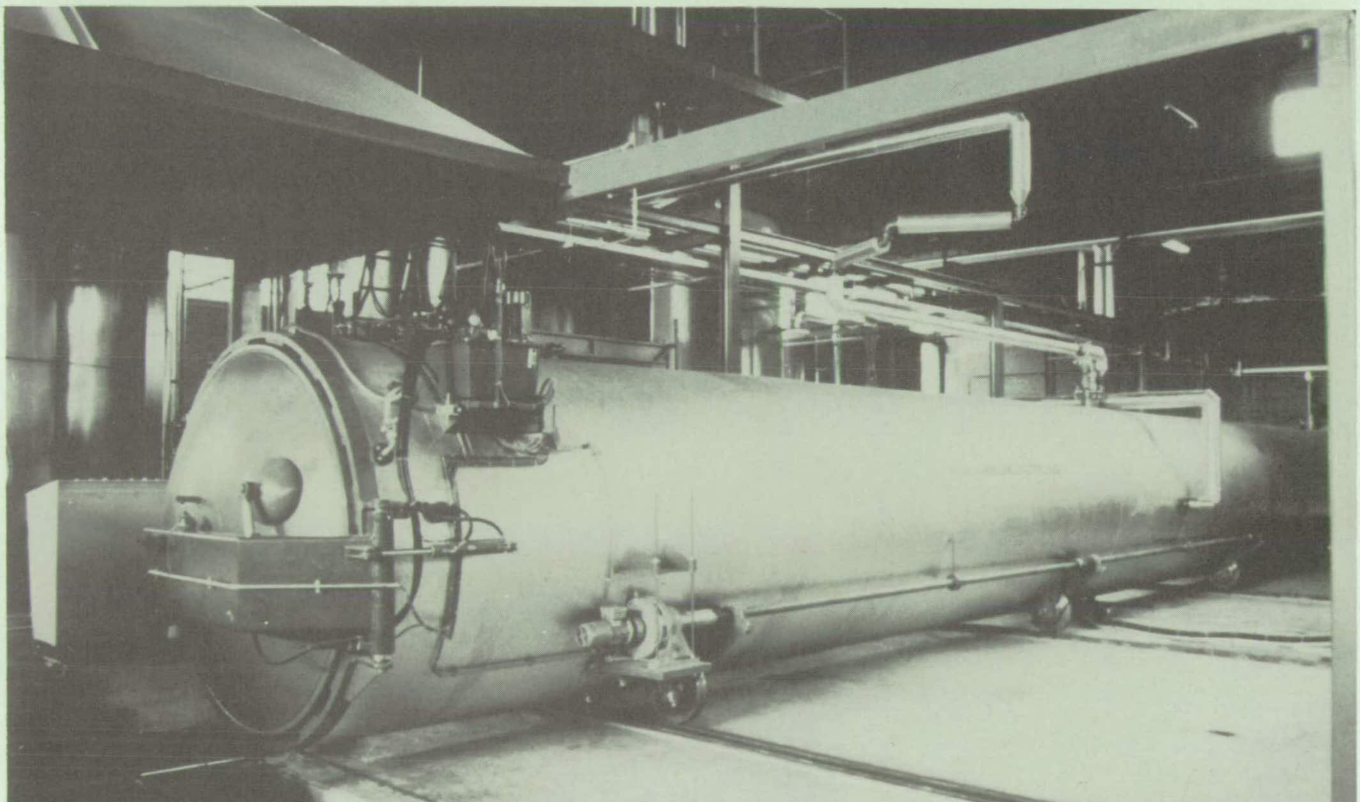


Fig. 5. After treatment vessel.

will be more economical as less creosote is necessary in the new system compared to the old system.

This reduction of creosote may amount up to 10-20 percent, depending on the type of wood and the "normal" overdosis used in the present way of creosoting wood.

2.2.3 *Hot-storage-tank*

In the new system a "hot-storage-tank" is foreseen instead of the "Rüping" vessel in the old system.

This hot-storage-tank is kept at ambient pressure at a temperature of 120°C. At this temperature, the water, as well as volatile creosote components, will evaporate from the liquid. These vapours are condensed in a condensor and are discharged to a sloptank. The non-condensable components are sent to the boiler house and are burnt.

Periodically the hot-storage-tank is brought on level by pumping fresh creosote from the cold-storage-tank into the hot-storage-tank.

2.2.4 *Treatment of vapours*

At several places vapours of creosote components are released from the system. This will take place, not only at the hot-storage-vessel, as was described before, but also at the treatment cylinder when the pressure is reduced and/or when the cylinder is opened and at the after-treatment vessel. These vapours are transported to a buffer vessel. This buffer vessel is used to prevent very strong pressure fluctuations in the vapour system. From this vessel the vapours are released, via a condensor, to the boiler house were they are burnt. When the treatment cylinder has to be set under vacuum, a vacuum pump is incorporated in this system. Vapours that are released by opening of the treatment cylinder are sucked off and will also be burnt in the boiler house.

2.2.5 *After-treatment*

Newly treated wood is brought into the after-treatment vessel. In this vessel the wood is treated with steam in order to remove the surfacial preservative residues. In such a way they can no longer cause health and/or environmental problems. The condensed steam, which is contaminated with creosote components, is pumped into the sloptank.

2.2.6 *Various*

One of the main technical problems that had to be solved was the translation of the Dutch N.E.N.-rules, the experiences of the operators, and the future demands of Markerink's Houtbedrijf with respect to a quality assurance of the creosoted wood, into a simple to operate P.L.C. system. We have developed a system that can fulfil the requirements set.

Another aspect that needs attention is the purification of the contaminated condensate and water. Before this water can be discharged into the sewer system, it has to be treated in a waste water treatment system.

3. ACKNOWLEDGEMENT

The authors of both Part I and Part II acknowledge the assistance and information provided by Mr. E. Schollema (Markerink's Houtbedrijf), Mr. H. van den Bosch (Cindu Chemicals) and Mr. A. G. Gerritsen and Mr. J. E. Rijsdijk (experts on wood technology).

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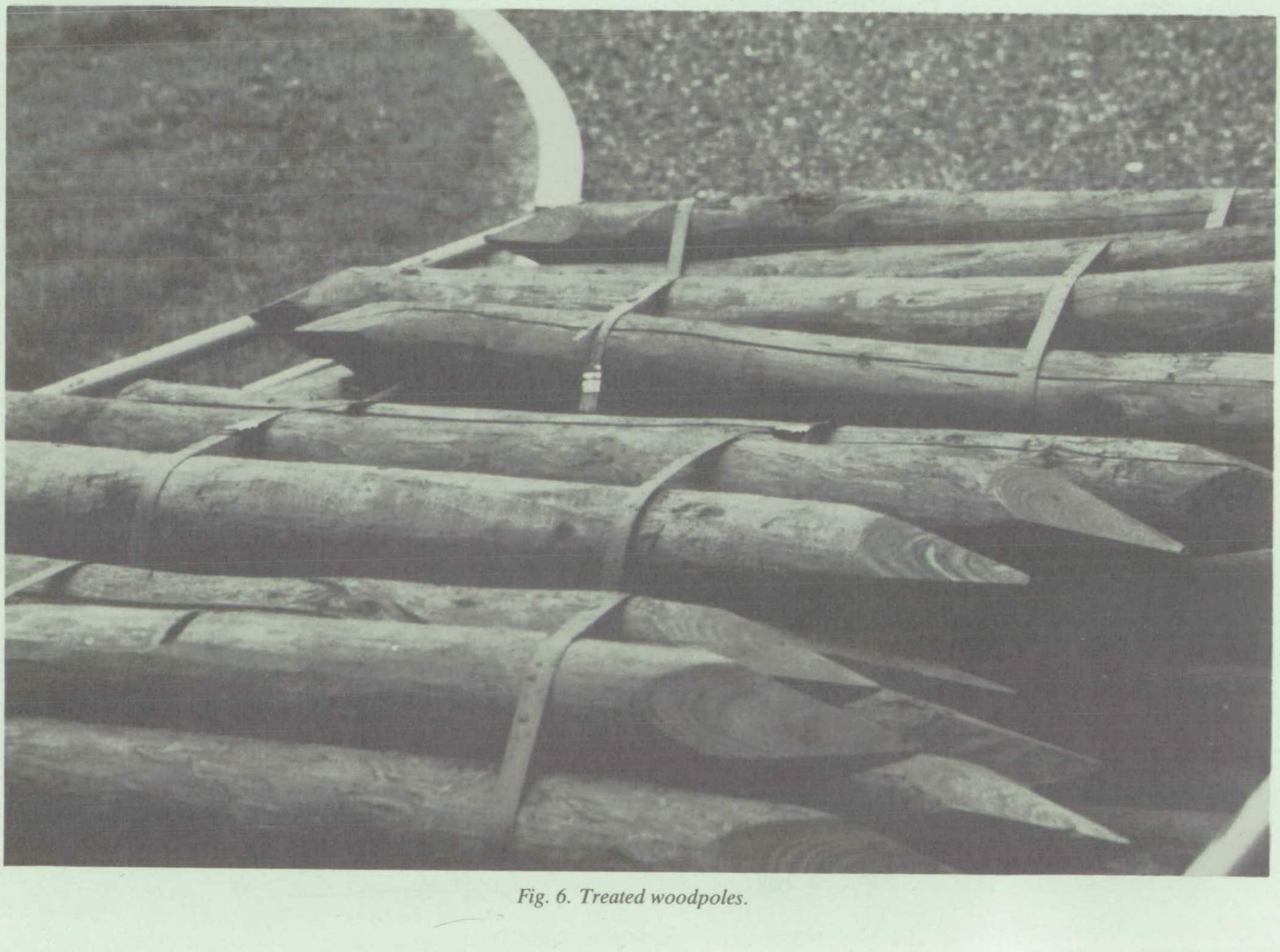

Fig. 6. Treated woodpoles.

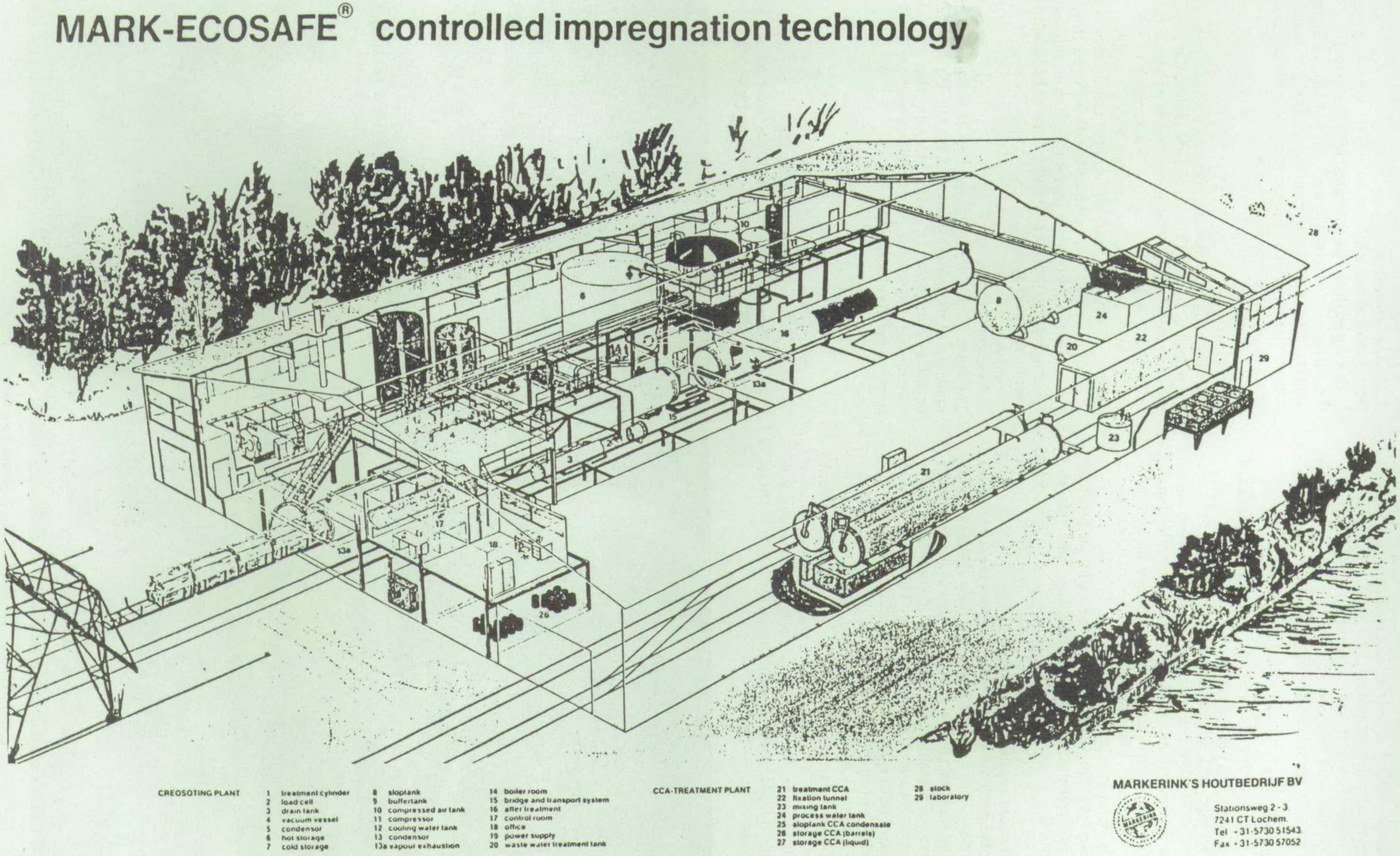

Fig. 7. Birds eye view.

DISCUSSION ON PAPER 5

Chairman: Mr. R. P. Marshall

THE CHAIRMAN: I think that was a most stimulating presentation, demonstrating the use of modern course techniques and processes to the application of what is the most traditional of preservatives, creosote. I am sure that the co-authors will be delighted to answer any questions. We have a few moments before coffee and, as I say, I think they will be only too happy to take any questions on the process which anyone wishes to put. Can I now throw the meeting open for questions and discussion.

To start the ball rolling, one thing which occurred to me is if the actual process is subject to any patent protection or is it in the process of being patented or what is the position?

DR. L. J. KUIJVENHOVEN: There are no patents on this project. It is incorporated in plants at Markerink's Houtbedrijf.

THE CHAIRMAN: So if somebody else wanted to build a plant . . .

DR. KUIJVENHOVEN: They would come to us and we will tell them which way it can be done.

THE CHAIRMAN: So if anybody is thinking of building a plant that is how to do it?

DR. KUIJVENHOVEN: Yes.

MR. G. O. HUTCHISON (Calders and Grandidge): I am very interested in your technique for measuring the retention of creosote but we have found that trying to measure the retention as you go runs the risk of not getting full sapwood penetration. In the U.K., particularly when treating telegraph poles, full sapwood penetration is a primary requirement. We all known that there is a vast variability in the amount of sapwood in any charge. Connected with that, your one per cent variation in the accuracy of your working does, I think, pose a problem because the retention I estimate you are looking for on an average charge, because your weighing the cylinder, the timber and the creosote in the process, probably represents, I would say, between five and ten per cent of the total mass. So your accuracy for measuring your retention, I suspect, cannot be very good. Can you comment on that.

DR. KUIJVENHOVEN: I should like to give you the following answer. We measured the treatment cylinder and said that is zero and then we only measured the difference between the wood brought into the cylinder, the creosote which was brought into the cylinder, and then we started the weighing of the contents. That will be done and supervised by one person and I guess that the fact the retention, as you call them, might be when you are also measuring the complete frequency in there as well.

THE CHAIRMAN: Are you happy with that answer. Would you like to make any further comment?

MR. HUTCHISON: No.

DR. H. A. PEARCE (Bitmac): I should like to congratulate Dr. Kuijvenhoven and Mr. de Jong on their papers. I think it is particularly appropriate in this year which is the one hundred and fiftieth anniversary of the patenting of the Bethell process of pressure impregnation of timber that they should present a paper here today. I think it is important for us to realise that creosote is very much a success story in terms of wood preservation, and it goes back a long way. It is difficult, I think, at times to say things new or novel about the creosote process. I think we have heard today something new and something novel. It is interesting to see in your slides that you appear to be painting the plant blue. We heard yesterday from Germany about the Blue Angel there. I think here we have perhaps the Blue Angel of creosote impregnation plants.

The question I have is on the reaction from your customers to the creosoted timbers which they have been receiving by this process. They are obviously very different. They look different; it looks a better timber to handle. What sort of reaction are you getting from the users of the product.

DR. KUIJVENHOVEN: At this moment the plant is still under construction so we have not had very much response at this moment. We have, of course, talked to our clients and mentioned this new system but they do not want to pay more for anything than they did before. Concerning the Blue Angel we heard about yesterday, we have not chosen a blue tank in relation with the Blue Angel. We have not painted any angel on it for your information.

MR. A. KENYON (Fosroc Ltd): Thank you very much for your papers this morning. I have two questions. Have you any indication of the cost of this installation, the total installation, and what size of vessels were you showing on the slides.

DR. KUIJVENHOVEN: Well, the total cost of the installation which is now under construction with all the parts which are attached to it for storage purposes and other adjustments including developments cots is about two and a half to three million Dutch guilders. With regard to the vessel sizes, the treatment cylinder is about forty cubic metres, if that is your question, and the hot storage tank is about seventy-five to eighty cubic metres.

DR. JOHN MORGAN (Princes Risborough Laboratory): I am afraid I am not an engineer and I cannot comment on the plant which you demonstrated or showed to us but I know a good thing when I see one. It certainly seems a very significant advance on any creosoting system which I have seen in this country. However, my question does not centre round that. My question really centres around the long term performance of this cleaner timber which is coming out of the plant. You showed a slide right at the beginning which showed the rainbow effect on the surface of water, which did not appear when you put your clean poles into the water. However, over a long period of time we know that creosote tends to move around the pole, to drain down, and also in certain types of pole you get bleeding. Can you say whether over a longer period of time the pole remains clean and whether you have overcome the bleeding problem.

MR. de JONG: I do not think that we can say at the present moment what will be the effect on long life. On the other hand, what we are removing is just the surface layer, just that residue which remains on the surface of the timber. It does not make any difference to what is inside the wood. Where you have bleeding with present processes, well, you may have the same problem but I think it is more a problem of the creosote specification than of the timber as such or of the treatment process as such.

THE CHAIRMAN: Can I take one final question which will bring us neatly to half past ten. Would anybody like to round off the discussion?

MR. G. SAWYER (Buckinghamshire College): I notice the condensers that you have installed before the vacuum pump and I should like to know how you overcome the problem of solids condensing in the condensers, particularly naphtha.

DR. KUIJVENHOVEN: Yes, we know the problem. We solve the problem by heating the condensers, say, once a week, for instance, so as to evaporate the naphtha.

THE CHAIRMAN: Well, Ladies and Gentlemen, I think that neatly brings us to the witching hour of half past ten when we can retire and have our coffee, but not before we acknowledge, I think, a very stimulating and progressive talk which has been presented to us this morning. I believe the plant you have seen demonstrated is due for commissioning in August. Is that correct?

DR. KUIJVENHOVEN: Yes, in August it will be in operation.

THE CHAIRMAN: So probably in a year or so's time we might have a further paper here in Cambridge which tells us how successful they have been in translating what is, I think, a very modern concept into a commercial plant, and how that plant is operating. So that is possibly something for the future. Just one final point. The poster, the full blow up of the slide, is in the room on the right as you go out of the door. It is displayed there if you want to have a closer look at the plant. No pirating is allowed, of course. Can we show our approval to our co-authors this morning in the usual way. *(Applause).*

B.W.P.A. ANNUAL CONFERENCE 1988

THE ROLE OF COPPER IN FIXED WATERBORNE PRESERVATIVES

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1. Introduction

The performance of permeable softwoods treated with copper chrome arsenic (C.C.A.) preservatives has proved to be an outstanding success story in wood preservation, although satisfactory treatment of impermeable softwoods such as spruce still presents problems (Saunders, 1982). The treatment of many hardwood species, including those which are relatively permeable to fluids, has been less effective in comparison with the permeable softwoods and premature failure due to soft rot organisms has been noted on several occasions (e.g. Dickinson, 1974). The premature failure of treated hardwoods to soft rot attack known as the 'soft rot problem' has been reviewed and explored by a number of authors (e.g. Drysdale, 1979; Gray, 1983) and will not be discussed here. However, the interim results of the International Research Group on Wood Preservation (I.R.G.) Collaborative Field Experiment (Dickinson and Gray, 1986) illustrate clearly that timber species can be classified on the basis of their performance when treated with C.C.A. The performance classes 1 to 5 are defined after seven years' exposure as follows:

Class 1	decay confirmed in untreated samples only
Class 2	decay confirmed in untreated and 0.75 per cent C.C.A. treated samples
Class 3	decay confirmed in untreated and 0.75 per cent and 1.5 per cent C.C.A. treated samples
Class 4	decay confirmed in untreated and 0.75 per cent, 1.5 per cent and 3 per cent C.C.A. treated samples
Class 5	decay confirmed in all samples (including 6.0 per cent C.C.A. treated).

Examples of timber species from each class are:

1. *Pinus sylvestris* (Scots pine)
2. *Homalium foetidum*
3. *Alstonia scholaris*
4. *Fagus sylvatica* (beech)
5. *Betula pendula* (birch)

The objective of the work described here was not to solve the soft rot problem but to raise the performance of some treated hardwoods to a higher class by optimising the copper in the C.C.A. preservative.

In some countries and in some situations the use of copper chrome boron (C.C.B.) preservative is widespread. However field trials of wood treated with C.C.B. have provided variable results. In a review of non-arsenical waterborne preservatives Tillott and Coggins (1981) showed that the performance of C.C.B. treated beech was better than that of C.C.A. treated beech in both India and in the U.K. On the other hand, in a field trial of treated *Pinus radiata* and *Eucalyptus regnans* in Papua New Guinea, Tamblyn and Levy (1981) found that C.C.A. was more effective than C.C.B. They observed that to some extent the performance of C.C.B. was affected by the occurrence of brown rot caused by copper tolerant organisms.

The laboratory work undertaken to investigate these conflicting observations formed a series of experiments which are dealt with in sequence. Several of the experimental procedures were common to many of them so the materials and methods are described at the beginning to avoid repetition.

2. Materials and Methods

Wood samples

Scots pine sapwood *(Pinus sylvestris)* and birch sapwood *(Betula pendula)* blocks measuring 30 × 10 × 5 mm and stakes measuring 150 × 10 × 5 mm were selected according to the European Standard (E.N. 113, 1982).

Preservatives

Copper chrome arsenic (C.C.A.) formulation was made up according to the British Standard (B.S. 4072 type II, 1974) (Tanalith C) from analytical grade reagents in distilled water.

Composition:

- 35 per cent cupric sulphate pentahydrate
- 45 per cent sodium dichromate
- 20 per cent arsenic pentoxide dihydrate (or equivalent arsenic acid).

Copper chrome boron (C.C.B.) formulation was made up as above but with boric acid substituted directly for the arsenic compound giving:

- 35 per cent cupric sulphate pentahydrate
- 45 per cent sodium dichromate
- 20 per cent boric acid

A range of w/v concentrations was used.

Preservative terminology

The other preservatives used were modifications of the basic C.C.A. formulation. Their compositions were expressed in terms of C.C.A. equivalents (C.C.A. eq.) and the compounds used were always the same as those used to make up C.C.A. and C.C.B. For example an arsenic solution with a composition of 2 per cent C.C.A. eq. contained the same quantity of arsenic pentoxide as was used to make up a 2 per cent C.C.A. solution. Similarly, a 2 per cent C.C.A. eq. C.C.A.B. solution contained the same amounts of copper, chromium and arsenic as a 2 per cent C.C.A. solution and the same quantity of boron as a 2 per cent C.C.B. solution.

Treatment and ageing

Samples were vacuum pressure impregnated. Conditioning and drying was carried out as described in the European Standard (E.N. 113, 1982). The samples were then cold water leached according to the European Standard (E.N. 84, 1980). Boron is readily removed by water nevertheless all samples were leached prior to exposure except where stated.

Basidiomycete tests

A miniaturised test was used (Bravery, 1979). Six replicate blocks were exposed in groups of three in Petri dishes on plastic mesh over fungal cultures growing on 4 per cent malt extract agar. Incubation was at 22°C. for six weeks. Decay was assessed by weight loss. The white rot fungus used was *Coriolus versicolor* (F.P.R.L. 28A) and the copper tolerant brown rot fungus used was *Coniophora puteana* (F.P.R.L. 11E).

Soft rot monoculture tests

A soft rot monoculture test method was developed for use in this work (Gray, 1983). Six replicate wood blocks were exposed in pairs directly on fungal cultures growing on modified Gersonde and Kerner-Gang medium incorporated into agar in Petri dishes. Inoculation of the agar was by spore suspension. Two soft rot fungi were used. Incubation was at 30°C for six weeks for *Chaetomium globosum* (F.P.R.L. S70K) and 12 weeks for *Phialophora fastigiata* (F.P.R.L. S6A). Decay was assessed by weight loss.

Soil burial test

Soft rot tests involving the use of unsterile soil as the source of inoculum rather than monocultures are regarded as being more appropriate indicators of soft rot performance in the field. However, such tests present a variety of problems in practice. A reliable unsterile soil burial test has been developed specifically for the present study in order to distinguish differences in the soft rot performance of the various formulations. Preliminary trials were carried out to enable selection of a suitable soil substrate and soil moisture content which would provide the necessary conditions for decay of both treated and untreated wood (Gray, 1986a). The resulting test method described below has been the subject of an international collaborative test within the International Research Group on Wood Preservation (Dickinson and Gray, 1987).

Six replicate blocks were buried with their long axes vertical in John Innes No. 2 potting compost maintained at 30-35 per cent moisture content. Soil jars were incubated at 28°C. and 85 per cent R.H. for 12 weeks. Decay was assessed by weight loss.

Soil bed test

In recent years the value of long term soil bed testing has been recognised by several authors (e.g. Hedley, 1980). Soil bed facilities were developed in this work together with a static bending strength testing apparatus which enabled non destructive rather than destructive assessment of decay in the miniature stakes (Gray, 1986b). Ten replicate stakes were buried to a depth of 140 mm in either Princes Risborough Laboratory field site soil or John Innes No. 2 potting compost in deep bins in a room maintained at 28°C. and 85 per cent R.H. Decay was assessed repeatedly at intervals during extended exposure periods by comparison of static bending strength.

3. EXPERIMENTAL

Comparison of C.C.A. and C.C.B.

In order to define the spectrum of activity of C.C.A. and C.C.B. it was necessary to split the fungal decay hazard into its three major components: white rot, soft rot and copper tolerant brown rot.

Scots pine and birch blocks treated with C.C.A. and C.C.B. were tested against monocultures of *Coriolus versicolor* (white rot), *Coniophora puteana* (copper tolerant brown rot) and *Phialophora fastigiata* (soft rot).

The results given in Table 1 and Figs 1-5 can be summarised as follows:

(i) C.C.A. and C.C.B. protect pine and birch against white rot (Figs. 3 and 4).

(ii) C.C.A. protects pine and birch against copper tolerant brown rot (Figs. 1 and 2).

TABLE 1

Performance of Scots pine against *Phialophora fastigiata*

Treatment	*Concentration (% W/V C.C.A. Eq.)*	*Weight Loss (%)*
Untreated	–	0.46
C.C.A.	0.4	0.43
	0.6	0.09
	0.8	0.10
	1.2	0.08
	1.8	−0.12
	2.6	−0.32
	3.7	0.01
C.C.B.	0.4	0.58
	0.6	0.14
	0.8	0.16
	1.2	0.23
	1.8	−0.23
	2.6	−0.39
	3.7	−0.49
C.C.A.B.	0.4	0.21
	0.6	0.05
	0.8	0.03
	1.2	0.18
	1.8	−0.04
	2.6	−0.13
	3.7	−0.31

PERFORMANCE OF TREATED WOOD AGAINST CONIOPHORA PUTEANA

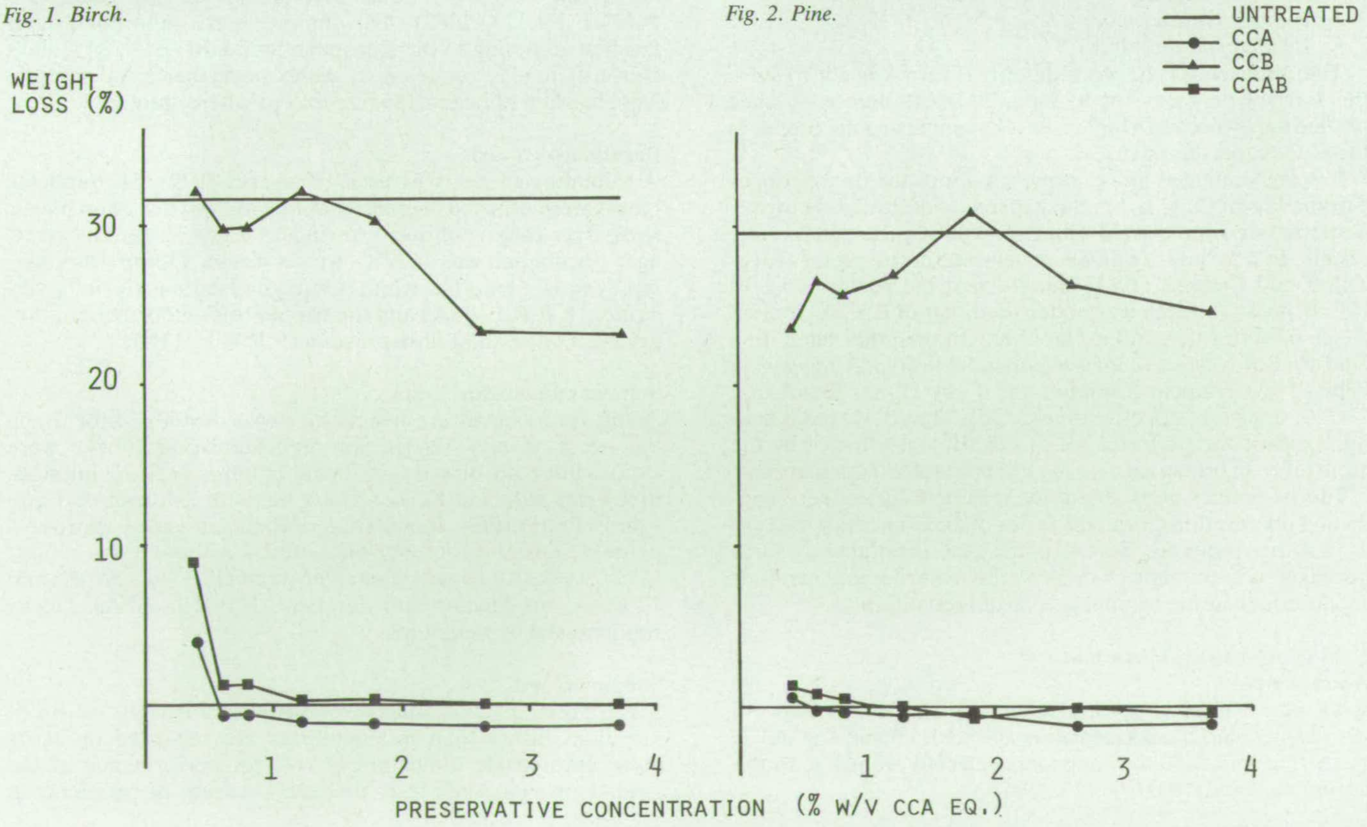


Fig. 1. Birch.

Fig. 2. Pine.

PERFORMANCE OF TREATED WOOD AGAINST CORIOLUS VERSICOLOR

Fig. 3. Birch.

Fig. 4. Pine.

(iii) C.C.B. does not protect pine and birch against copper tolerant brown rot (Figs. 1 and 2).

(iv) C.C.B. affords better protection to birch against soft rot than does C.C.A. (Fig. 5).

These results explain the apparently contradictory field trial results referred to above – where the decay hazard was mainly soft rot C.C.B. treated wood performed better than C.C.A. treated wood but where the hazard was copper tolerant brown rot organisms C.C.B. treated wood failed.

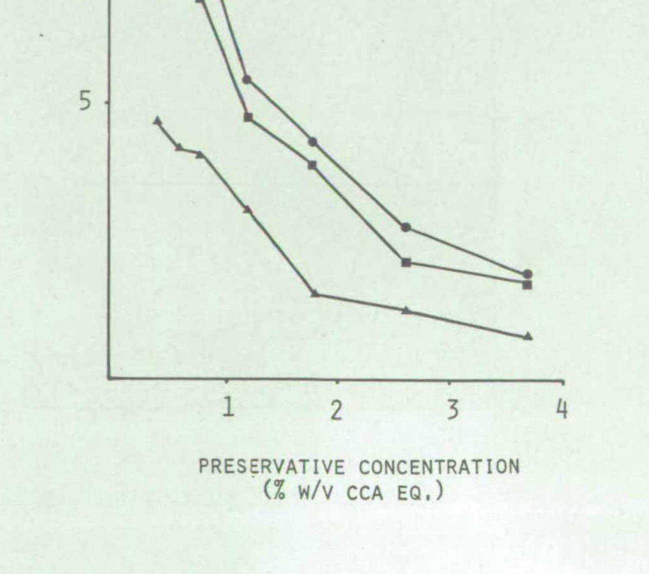
Assessment of a copper, chrome, arsenic and boron mixture

In an attempt to combine the good protection against soft rot provided by C.C.B. and the all round performance of C.C.A. a copper, chrome, arsenic, boron (C.C.A.B.) preservative was prepared by adding 20 per cent by weight of boric acid to C.C.A. C.C.A., C.C.B. and C.C.A.B. treated birch and pine samples were tested against the white rot, copper tolerant brown rot and soft rot organisms. The results given in Table 1 and Figs 1-5 show that the C.C.A.B. mixture protected both timber species against the white rot and brown rot (Figs. 1-4) but its performance against the soft rot organism was intermediate between that of C.C.A. and C.C.B. (Fig. 5). Obviously the simple addition of boron to the formulation was insufficient to mirror the soft rot performance provided by C.C.B. in the wood indicating that more complex interactions were involved.

Performance of the individual preservative elements

In order to confirm the exact roles of the various preservative components in protecting the wood against decay birch blocks were treated with various combinations of the copper, chro-

Fig. 5. Performance of birch against Phialophora fastigiata.



PERFORMANCE OF BIRCH AGAINST CONIOPHORA PUTEANA

Fig. 6. Unleached.

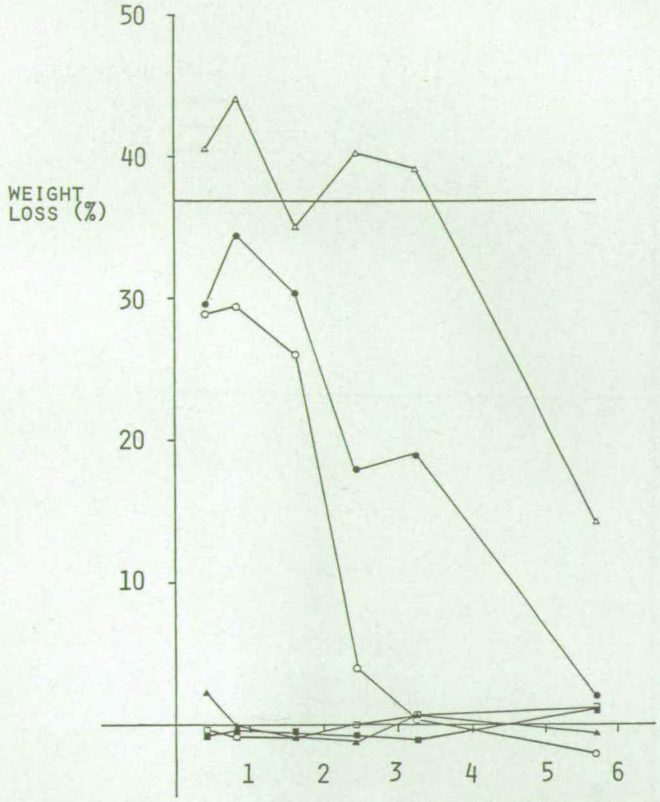
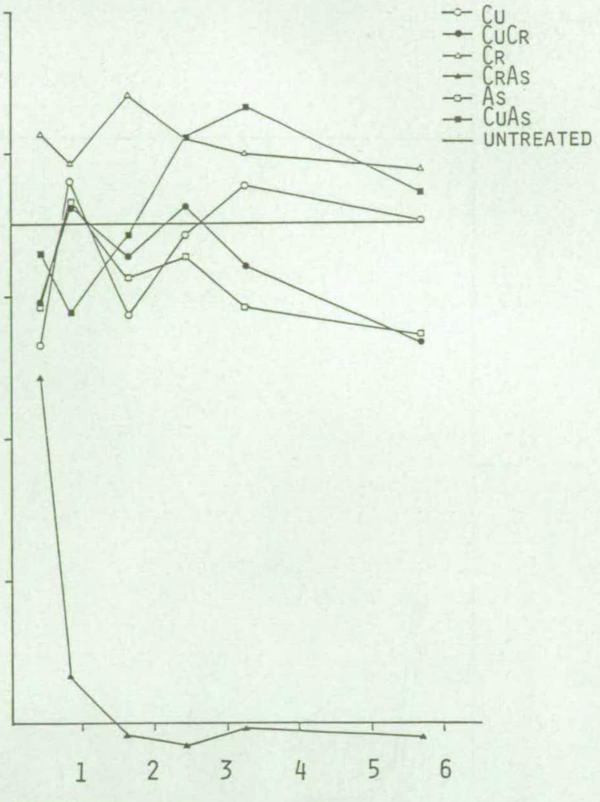


Fig. 7. Leached.



PRESERVATIVE CONCENTRATION (% W/V CCA EQ.)

mium and arsenic compounds used in C.C.A. Boron, a component of C.C.B. was excluded because it had been shown to be leached from both boron treated and C.C.B. treated wood samples. The treatments were:

copper	Cu
chromium	Cr
arsenic	As
copper chrome	CuCr
copper arsenic	CuAs
chrome arsenic	CrAs

Both leached and unleached blocks were decay tested against *Coniophora puteana* (copper tolerant brown rot),

PERFORMANCE OF BIRCH AGAINST CHAETOMIUM GLOBOSUM

Fig. 8. Unleached.

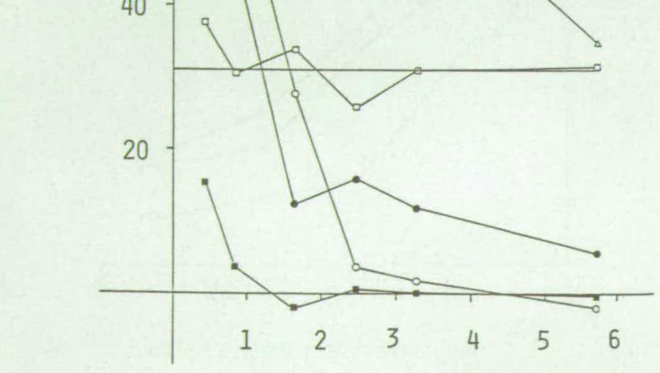
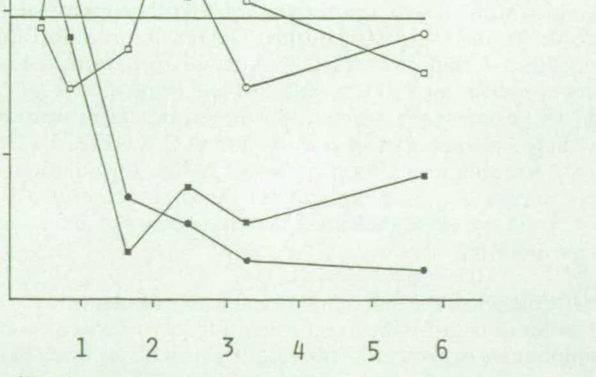


Fig. 9. Leached.



PRESERVATIVE CONCENTRATION (% W/V CCA EQ.)

Chaetomium globosum (soft rot) and unsterile soil. The results are given in Figs. 6-11.

The findings can be summarised as follows:

(i) In unleached birch any treatment containing arsenic was effective against the copper tolerant brown rot and any treatment containing copper was effective against the soft rot in monoculture and in the soil.

(ii) In leached birch only fixed arsenic (CrAs) was effective against the copper tolerant brown rot and only fixed copper (CuCr) was effective against the soft rot in monoculture and in the soil.

Therefore fixed arsenic was necessary to control attack by the copper tolerant brown rot organism and fixed copper was necessary to control attack by the soft rot fungus. The only exception to this was the relatively good result with copper arsenic in the soft rot monoculture. This was probably more a feature of the test method than the preservative – *Chaetomium globosum* may be particularly sensitive to copper arsenic which might be detoxified in the soil by other colonists. The soil results would appear to support this since *Chaetomium* is readily isolated from the soil system (Troya, Gray and Dickinson, 1988).

Performance of double treatments

Since fixed copper and fixed arsenic were required for the full spectrum of activity of the preservative and the best aspects of C.C.A. and C.C.B. could not be combined by the simple addition of boron to C.C.A., the following experiment was set up to combine the merits of the two preservatives by applying the preservative components as double treatments. The first two double treatment formulations were: C.C.B. + A and B + C.C.A. The double treatments involved treatment of the wood samples with one preservative then, after the required periods of conditioning and drying, treatment with the second preservative. For example, in the case of a 2 per cent C.C.A. eq. C.C.B. + A, the wood sample was first treated with a 2 per cent C.C.A. eq. C.C.B. solution, conditioned, dried and then treated with a 2 per cent C.C.A. eq. arsenic solution. In this way equal amounts of copper, chromium, arsenic and/or boron were used in all of the formulations. This enabled direct comparison of the treated wood to be made.

The two double treatments B + C.C.A. and C.C.B. + A were tested in birch against the soft rot, *Chaetomium globosum*. The results given in Fig. 12 show that the performance of the C.C.B. + A treated wood was significantly better than that of the B + C.C.A. treated wood despite the fact that

PERFORMANCE OF BIRCH IN UNSTERILE SOIL

Fig. 10. Unleached.

Fig. 11. Leached.

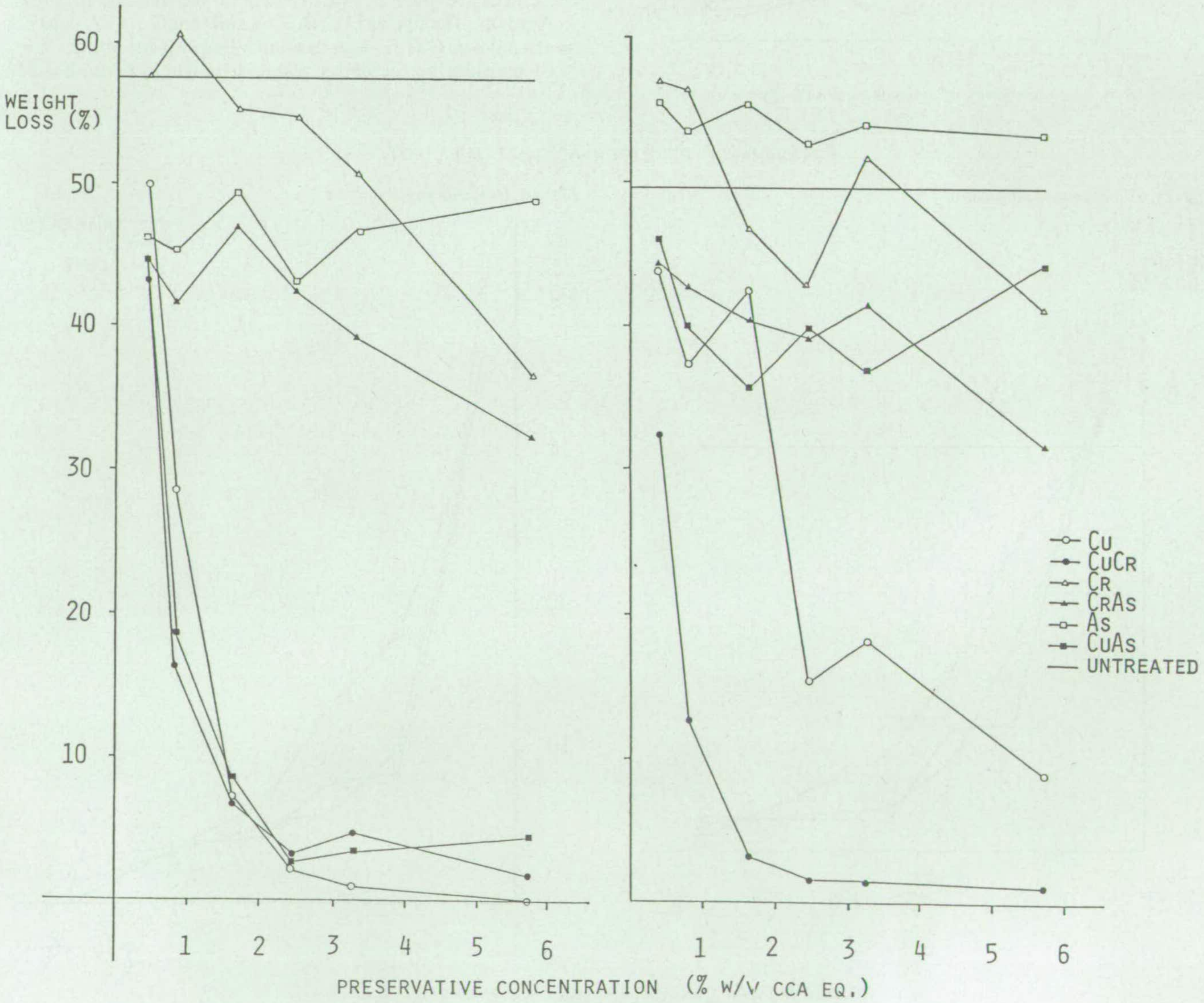
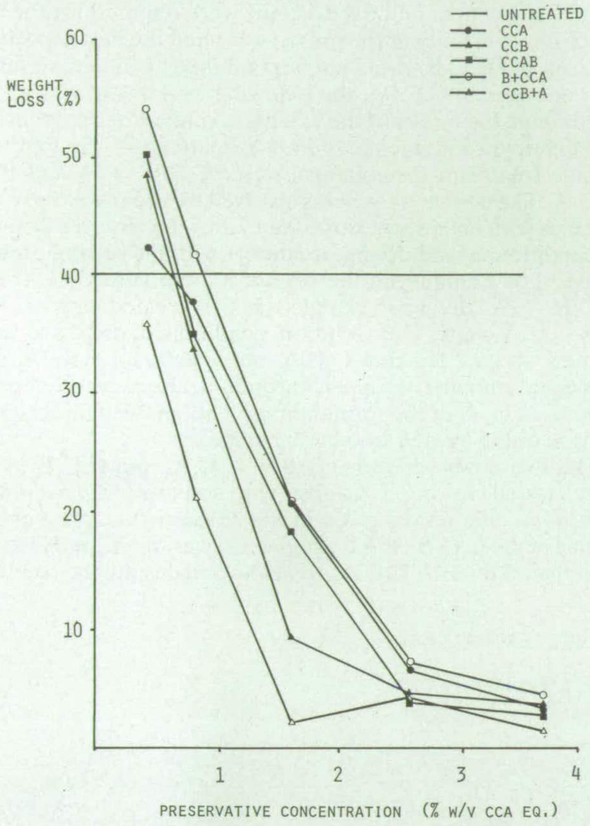


Fig. 12. Performance of birch against Chaetomium globosum.



both formulations contained equal quantities of the same components. When the results are compared with those for C.C.A., C.C.B. and C.C.A.B. it can be shown that over a range of concentrations the performance of the B + C.C.A. treated wood was inferior to that of the C.C.A. alone and that the performance of the C.C.B. + A treated wood was better than that of C.C.B. alone. In addition C.C.B. + A was effective against the copper tolerant brown rot.

In a further longer term test of C.C.A., C.C.B and C.C.B. + A treated birch in the soil bed, the C.C.B. + A treated stakes performed better than the C.C.A. treated stakes, the C.C.B. treatment being intermediate (Gray and Dickinson, 1983). The residual strength data collected over a period of 400 days were extrapolated to a rate of loss in strength of 0.01 per cent per day (i.e. a stake life of approximately 27 years in the soil bed). To achieve this negligible rate of decay the retention of copper (kg m-3) required would be 5.84 for C.C.A., 4.68 for C.C.B. and 3.27 for C.C.B. + A. In other words 1.8 times as much copper would be needed to give a similar performance if the treatment were C.C.A. rather than C.C.B. + A.

Since virtually all of the boron was lost from the treated wood during leaching, and treatments where the copper and arsenic were applied separately appear to have provided better performance against soft rot, two additional double treatments were formulated. C.C. + A (copper chrome + arsenic) and C + C.A. (copper plus chrome arsenic) were tested in birch against a soft rot monoculture and in soil burial. The results of these tests are given in Figs. 13 and 14 and indicate that C.C. + A was as effective as C.C.B. + A and that C + C.A. was not as effective as C.C.B. + A in controlling soft rot attack.

By considering the decay results as a whole it can be seen

PERFORMANCE OF BIRCH AGAINST SOFT ROT

Fig. 13. Chaetomium globosum.

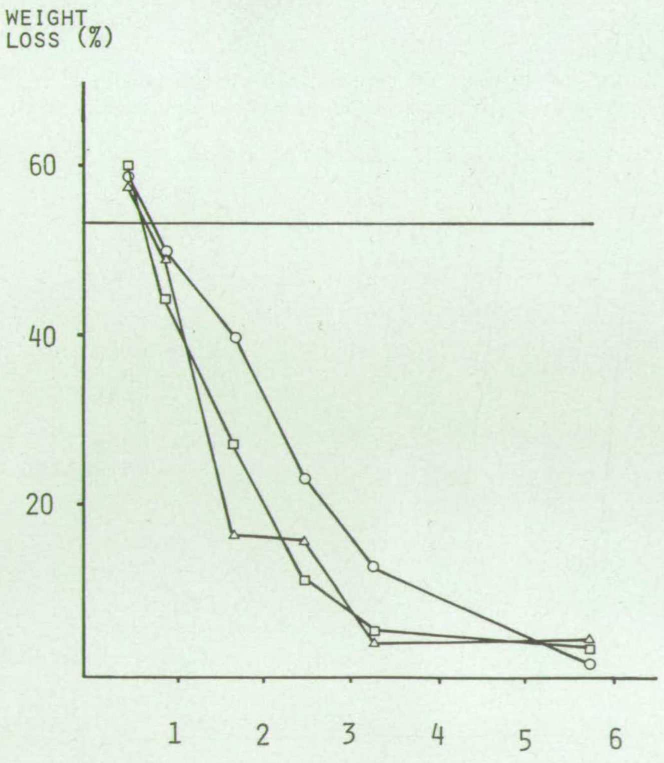
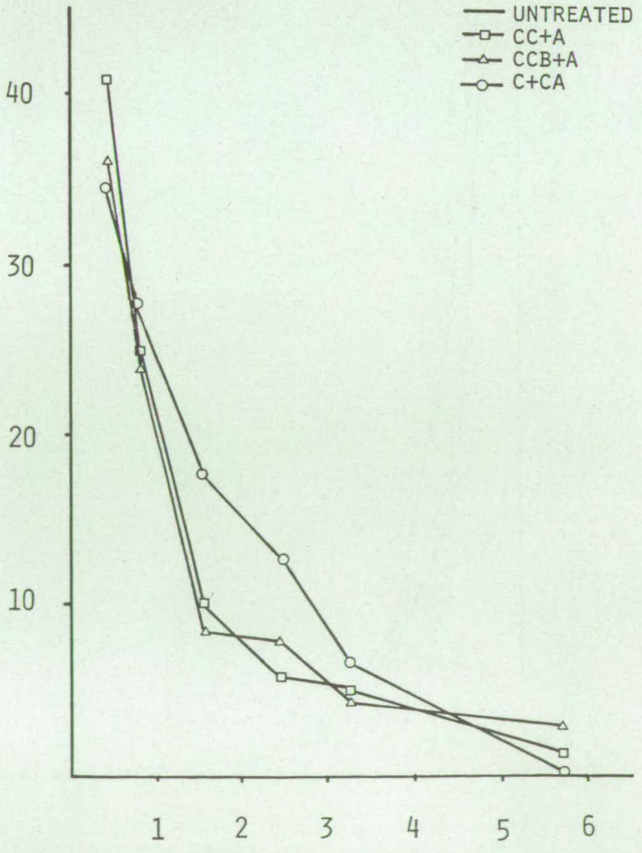


Fig. 14. Unsterile soil.



PRESERVATIVE CONCENTRATION (% W/V CCA EQ.)

that formulations which provided birch with good protection against soft rot attack had two features in common:

(i) the copper was applied as copper chrome (e.g. C.C.B.)
(ii) the arsenic (if used) was applied separately.

Percentage of preservative component which remained unleachable in treated sawdust after various time periods

TABLE 2
Copper

Time (Hours)	Treatment C.C.A. %	C.C.B. %	C.C.A.B. %	Copper Sulphate %
1	19.10	27.80	18.57	32.23
2	18.85	27.30	18.10	30.80
8	26.33	35.27	25.60	30.43
24	37.20	41.80	34.10	26.37
43	44.43	46.40	44.47	28.07
96	94.70	90.33	90.83	37.03
192	93.77	94.20	95.63	31.67
384	98.60	99.37	97.60	41.75

TABLE 3
Chromium

1	16.03	10.47	16.73	
2	15.30	9.37	15.87	
8	24.57	20.87	25.23	
24	32.77	25.83	31.63	
48	39.00	32.33	39.00	
96	89.80	82.57	84.43	
192	89.07	87.10	93.07	
384	99.60	99.43	99.27	

TABLE 4
Arsenic

1	19.50		18.97	
2	19.90		20.47	
8	38.80		38.60	
24	57.40		54.93	
48	71.23		70.47	
96	99.90		99.70	
192	99.90		99.90	
384	100.00		99.90	

The biological tests used highlighted differences in the soft rot performance of birch samples treated with the various formulations. These differences were apparent even though the wood samples had been treated with equal quantities of the same preservative components although in different configurations. Two approaches were taken to explain these results. The first was chemical analysis of replicate treated and leached wood samples to establish whether or not more preservative was present in the samples which gave a better performance. The second approach was a study of the progress of fixation of the preservatives with time.

Chemical analysis

Birch samples treated with C.C.A., C.C.B., C.C.A.B., B + C.C.A. and C.C.B. + A were selected for chemical analysis. Three replicate blocks of each concentration were milled to make wood flour which was extracted using the method described in the British Standard (B.S. 5666, Part 3, 1979). The extracts were analysed for copper, chromium and arsenic using an argon plasma emission spectrometer. The mean retention for blocks of each treatment concentration was calculated. The results are given in Figs. 15-17. At most of the concentrations the retention of each of the elements was lower in the C.C.B. + A treated blocks than in the C.C.A., C.C.B., C.C.A.B. and B + C.C.A. treated blocks (no arsenic in C.C.B.). The superior performance of the C.C.B. + A treated birch against soft rot was therefore not due to increased retentions of copper, chromium, arsenic or boron.

Fixation studies

Samples of birch sawdust were mixed with a 2 per cent C.C.A. eq. solution of copper sulphate, C.C.A., C.C.B. and C.C.A.B. After time periods of 1, 2, 8, 24, 48, 96, 192, and 384 hours the sawdust samples were leached thoroughly with distilled water. The resulting leachates were analysed by argon plasma emission spectrometry for copper, chromium and arsenic and the percentage of the total quantity used of each element that remained unleached in the sawdust was calculated. The standard solutions used for the analysis were made up in similar leachates of untreated birch. The results are given in Tables 2-4.

From the results the principal difference between the C.C.A. and the C.C.B. was the amount of copper which was 'fixed' within the first hour. Approximately 50 per cent more copper was unleachable after one hour as a result of the C.C.B. treatment than both the C.C.A. and C.C.A.B. treatments. In addition the amount of fixed copper resulting from the copper

PRESERVATIVE RETENTIONS OF BIRCH SAMPLES DETERMINED BY ANALYSIS

Fig. 15. Copper.

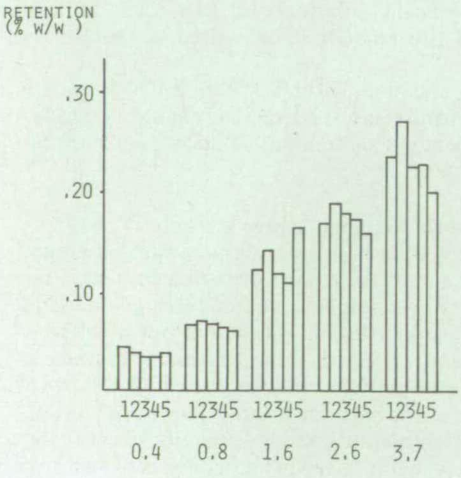


Fig. 16. Arsenic.

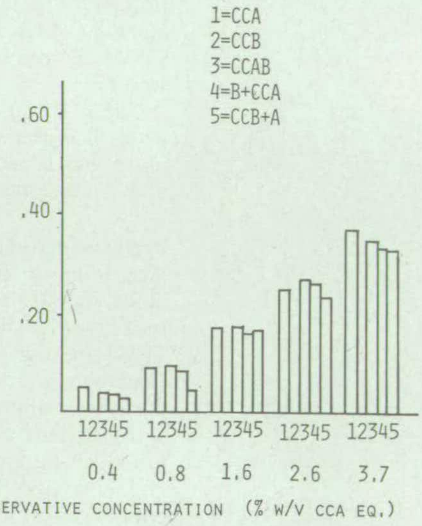
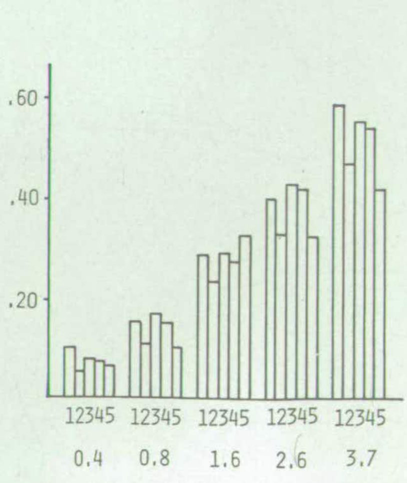


Fig. 17. Chromium.



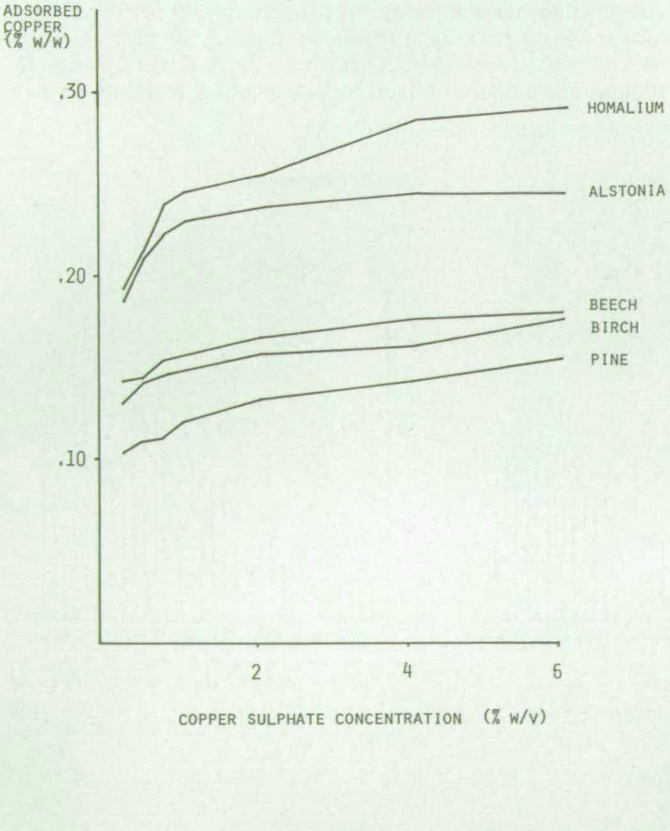
sulphate treatment was similar to that of the C.C.B. treatment. The fixation of copper from the copper sulphate solution is the result of copper adsorption to the wood substance and is said to be instantaneous. This type of reaction has been observed in the early stages of the fixation of copper in C.C.A. (Eadie and Wallace, 1962; Levi, 1969; Wilson, 1971; Dahlgren, 1972; Pizzi, 1982) and in C.C.B. (Pizzi and Kubel, 1982). In their studies Kubel and Pizzi (1982) suggested that 5-20 per cent of the copper was adsorbed as copper sulphate in C.C.A. whereas up to 30 per cent was adsorbed in C.C.B. Their figures are remarkably similar to those presented here. It seems that the quantity of copper adsorbed was reduced in the presence of arsenic (as in C.C.A. but not in C.C.B.).

From these results it appears that adsorbed copper (as opposed to copper fixed through the action of chromium) may play an important role in the prevention of soft rot attack in birch. Consideration of these findings and the thoughts of other workers in the field (e.g. Drysdale, *et al.*, 1980; Butcher and Nilsson, 1982; Kubel and Pizzi, 1982; Nilsson, 1982) has led to the following hypothesis:

1. Adsorbed copper is responsible for preventing the initiation of soft rot attack in the S_2 layer of the fibre cell wall. Soft rot cavity formation is initiated by T-branching of the soft rot hypha (Corbett, 1963). Nilsson (1982) hypothesised that T-branching (i.e. soft rot cavity initiation) occurred at specific sites in the cell wall which he termed T.I. (T-branch induction) sites. Adsorbed copper acts by blocking these sites.
2. Arsenic interferes with copper adsorption, therefore C.C.A. treatment (i.e. copper in the presence of arsenic) of timber results in only a proportion of these T.I. sites being blocked by copper, whereas a treatment of copper in the absence of arsenic (e.g. C.C.B.) leaves more of these sites obscured by copper.
3. Treatment of some hardwoods and softwoods with fixed copper followed by arsenic would increase their resistance to soft rot decay whilst also affording protection against other fungi and insects.

This hypothesis has been discussed in detail elsewhere (Gray, 1983; Gray and Dickinson, 1983). Since adsorbed copper appeared to be important in preventing soft rot attack in birch further work was undertaken to clarify its role.

Fig. 18. Effect of timber species on copper adsorption from copper sulphate solution.



The role of adsorbed copper

Rennie, Gray and Dickinson (1987) have proposed an acid form ion exchange mechanism for the adsorption of copper by wood. Acid form ion exchange involves the displacement of H^+ from an acidic site by another cation, in this case Cu^{2+}.

Factors affecting copper adsorption

A detailed study of the factors affecting copper adsorption has been carried out (Rennie, *et al.*, 1987) using the following technique. Air dried sapwood sawdust of particle size 500-125 um was mixed with preservative solution and left to stand for an appropriate time period before being filtered and leached with distilled water. After leaching the sawdust sample was oven dried, digested and analysed for copper using atomic absorption spectrophotometry. The effect of the following parameters was examined using this method.

(a) *timber species*

Five timber species, one from each of the five classes of the I.R.G. Collaborative Field Experiment referred to above, were selected and treated with several concentrations of copper sulphate solution. The amount of adsorbed copper was determined after one hour. The results are given in Fig. 18.

Within the hardwood species there was a correlation between the level of adsorbed copper and the performance against soft rot when treated with C.C.A. (Dickinson and Gray, 1986), the more adsorbed copper the greater the resistance of the treated wood to soft rot attack. There was also a correlation between the level of adsorbed copper and the lignin content of the wood (Butcher and Nilsson, 1982). This was not true in the case of the softwood where the lignin is of a different type.

(b) *pH*

The amount of adsorbed copper resulting from treatment by copper sulphate and C.C.A. solutions of different pH was determined. The results given in Figs. 19-22 show that the amount of copper adsorbed increased with increasing pH.

(c) *treating solution*

The levels of copper adsorption resulting from treatment with 2 per cent C.C.A. eq. solutions of copper chrome (C.C.), C.C.A. and C.C.B. were determined. The results are given in Figs. 23 and 24. The C.C. and C.C.B. treatments resulted in much higher levels of adsorbed copper than did treatment with C.C.A. This was a direct result of the pH of the treating solution and is likely to be the explanation of why the addition of arsenic (which lowers the solution pH) to C.C.B. to form C.C.A.B. reduced the amount of adsorbed copper in the wood.

There are also indications (Rennie, *et al.*, 1987) that the level of copper adsorption is not affected by change in temperature and is independent of treating solution concentration above a threshold value.

Performance of adsorbed copper against soft rot

According to the hypothesis set out above adsorbed copper alone should prevent soft rot cavity formation in wood. The results for leached copper sulphate treated birch given in Fig. 11 go some way to supporting this argument but it is known (Butcher and Nilsson, 1982) that the maximum amount of adsorbed copper resulting from this treatment (0.15% w/w) is insufficient to prevent soft rot attack. However, Rennie (1988) carried out treatments of birch wood blocks with other copper compounds which resulted in higher levels of adsorbed copper after leaching. The results of decay tests against

Chaetomium globosum and in unsterile soil are given in Tables 5 and 6.

These results confirm that soft rot attack was prevented in the soil test. The results of the soft rot monoculture test indicate that some decay may have occurred at the highest level of adsorbed copper, but only microscopic examination of the wood blocks will confirm whether or not soft rot cavities were present. Other causes of loss in weight of the wood such as erosion (soft rot decay type 2 (Corbett, 1963)) may have occurred. Since erosion does not involve T-branching and therefore does not involve T.I. sites there is no reason why adsorbed copper, which is thought to act by blocking T.I. sites, should prevent this type of decay.

Modifications of C.C.A. preservatives

Since adsorbed copper has been shown to play a major role in preventing soft rot attack in birch methods of optimising it in C.C.A. preservatives other than by using C.C.B. + A were

EFFECT OF PH ON COPPER ADSORPTION IN BIRCH

Fig. 19. Copper sulphate.

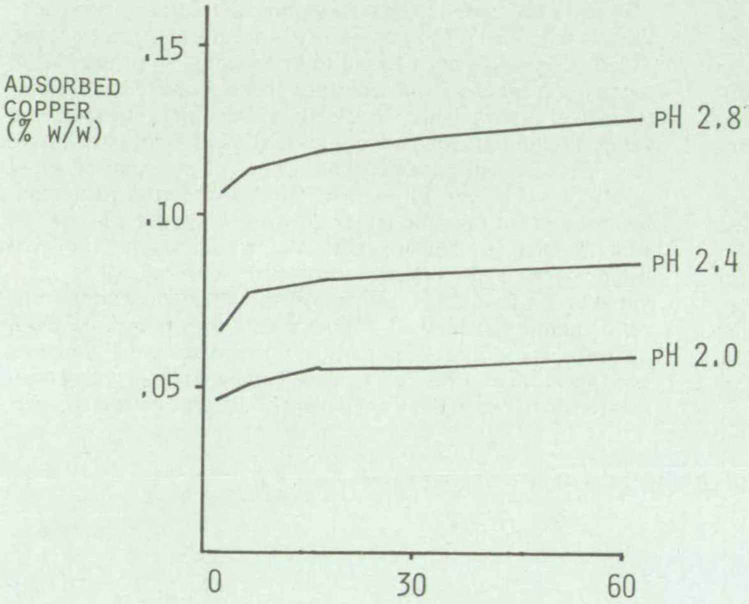
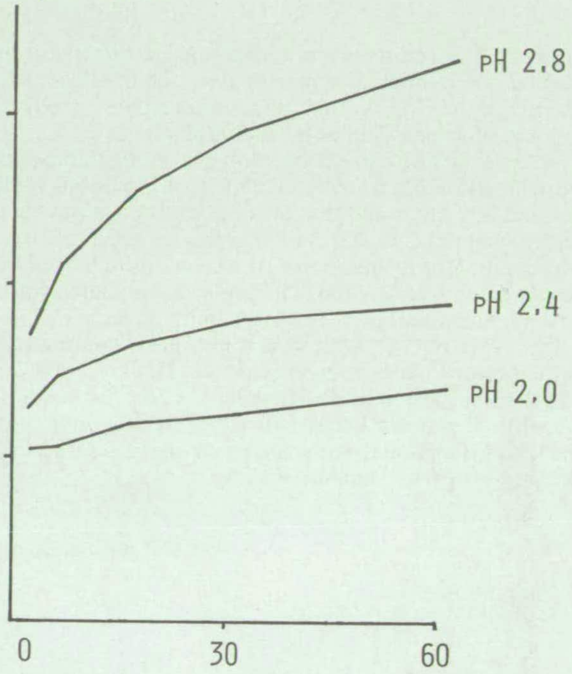


Fig. 20. C.C.A.



TIME (MINUTES)

EFFECT OF PH ON COPPER ADSORPTION IN PINE

Fig. 21. Copper sulphate.

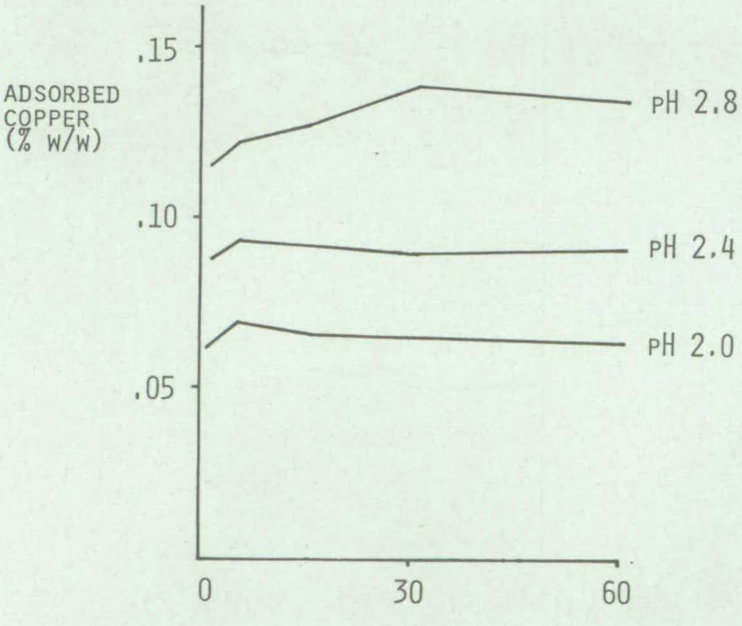
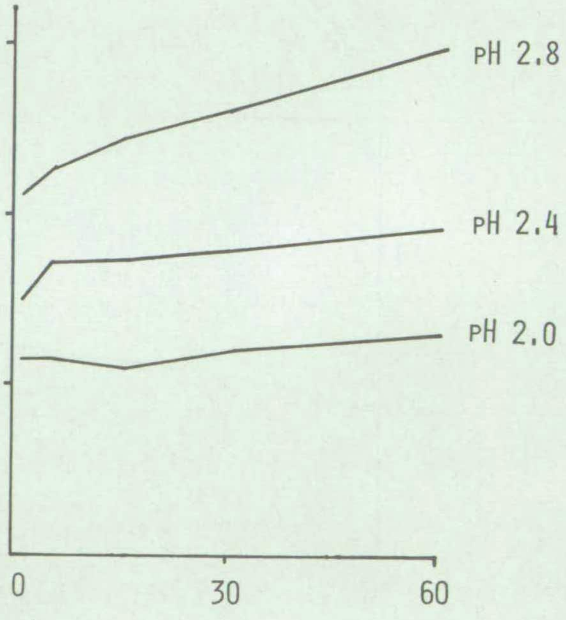


Fig. 22. C.C.A.



TIME (MINUTES)

TABLE 5

Performance of adsorbed copper against *Chaetomium globosum*

Copper Compound Treating Solution Concentration (% W/V C.C.A. Eq.)	*Copper Retention (% W/W) From Analysis*	*Weight Loss (%)*
0.18	0.031	41.79
0.36	0.048	39.28
1.79	0.203	12.23
3.57	0.268	3.85
7.14	0.445	3.49
Untreated	–	41.85

TABLE 6

Performance of adsorbed copper in unsterile soil

Copper Compound Treating Solution Concentration (% W/V C.C.A. Eq.)	*Copper Retention (% W/W) From Analysis*	*Weight Loss (%)*
0.18	0.031	32.01
0.36	0.048	22.85
1.79	0.203	3.96
3.57	0.268	1.14
7.14	0.445	1.36
Untreated	–	37.78

studied. The results given above suggest that there may be several possibilities of achieving this, one of which is to raise the pH of the C.C.A. treating solution either by reducing the amount of arsenic acid or by adding alkali.

Rennie (1988) carried out soft rot monoculture and soil burial tests on birch treated with C.C.A. solutions of pH 2.0, 2.4 and 2.8. He found that at some concentrations treatment with higher pH C.C.A. resulted in greater resistance to soft rot attack but improvements in performance as indicated by these tests were not substantial. The problem associated with trying to optimise Tanalith C is its solubility at higher pH values. Other types of C.C.A. however, may provide more scope for optimisation. There is some evidence (Hedley, 1984; Nilsson, 1984) to suggest that low arsenic C.C.A. formulations like Tanalith C provide better soft rot protection and tunnelling bacteria protection to softwoods than high arsenic C.C.A. formulations such as Tanalith N.C.A.

4. DISCUSSION

The work presented here has summarised investigations concerned with the role of copper in waterborne preservatives. Fixed copper has been found to be essential to protect birch against soft rot and fixed arsenic has been found to be essential to protect birch against attack by copper tolerant brown rot fungi. Treatments where copper was applied as copper chrome (e.g. C.C.B.) and arsenic (when present) was applied separately (e.g. C.C. + A) provided birch with better protection against soft rot than did treatments where copper and arsenic were applied together (e.g. C.C.A.). In addition treatments of birch which resulted in higher levels of adsorbed copper provided better protection against soft rot. When present in sufficient quantity, adsorbed copper on its own protected birch against soft rot. The copper adsorption properties of a range of hardwood species were determined and a positive correlation was found between the level of copper adsorption and the per-

EFFECT OF TREATING SOLUTION ON COPPER ADSORPTION

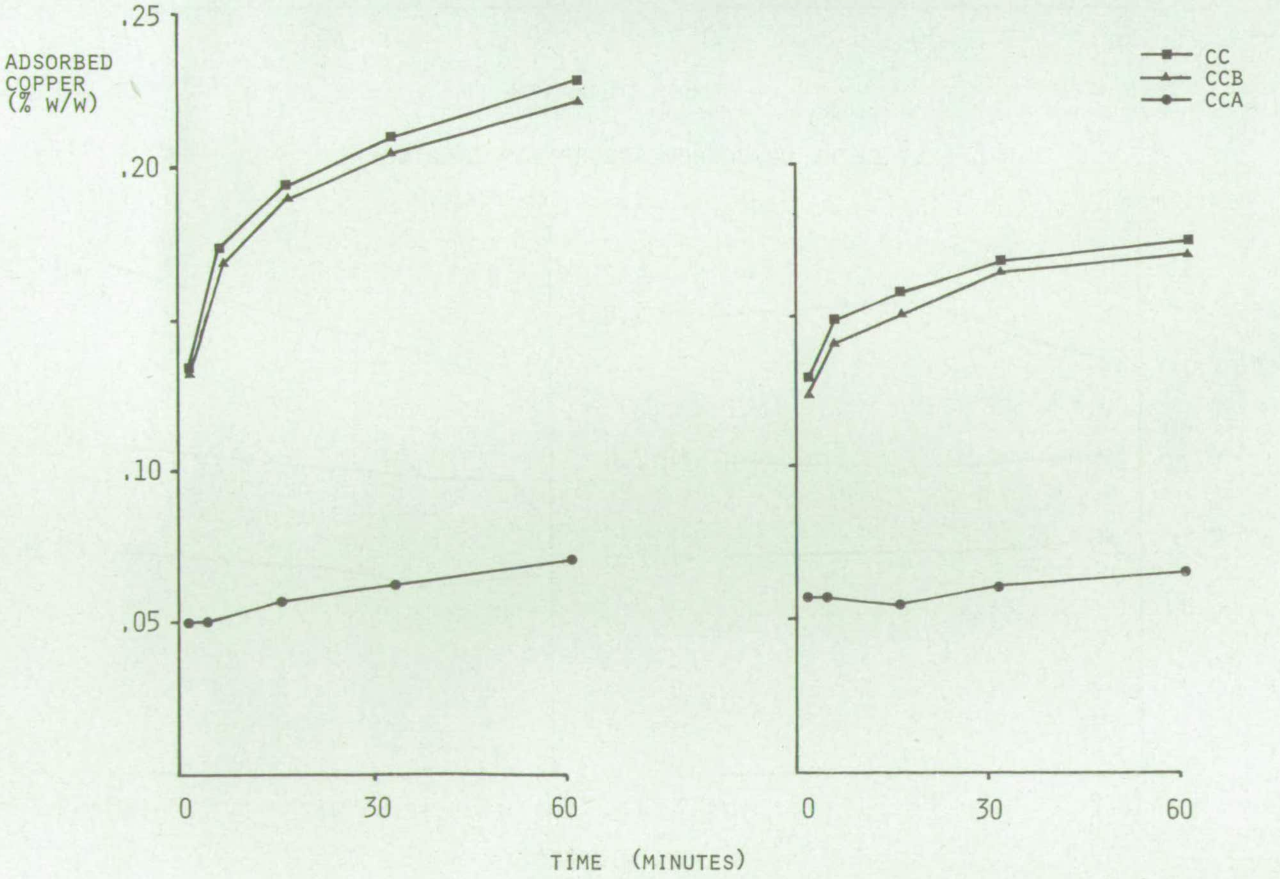


Fig. 23. Birch.

Fig. 24. Pine.

formance against soft rot when treated with C.C.A. These findings are consistent with the hypothesis that adsorbed copper prevents the initiation of soft rot attack in the S_2 layer of the fibre cell wall. However further investigation is necessary to establish the exact location of the adsorption sites and the mode of action of adsorbed copper.

The amount of copper adsorbed by all of the timber species tested was found to increase with rise in pH of the treating solution. Thus levels of adsorbed copper can be controlled by adjustment of the treating solution pH. In C.C.A. type formulations however, the scope for pH manipulation is limited by the stability of the preservative.

Better protection of hardwoods which currently fail to soft rot when treated should be possible by increasing the level of adsorbed copper resulting from preservative treatment. Where adequate protection is already assured, increasing the level of adsorbed copper provides the opportunity to reduce the total copper retention. This work has identified what we consider to be the principal factor that influences soft rot control in C.C.A. type preservatives in the absence of problems of treatability. Furthermore it has illustrated that while optimisation of the effectiveness of a preservative to part of the fungal decay hazard can be achieved, a fully effective preservative formulation can only be derived from consideration of the total decay hazard.

ACKNOWLEDGEMENTS

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DISCUSSION ON PAPER 6

Chairman: Dr. C. R. Coggins

THE CHAIRMAN: Thank you, Dr. Gray. I have asked Dr. Dickinson to join Dr. Gray so the co-authors are available for answering your questions. It is open to you, Ladies and Gentlemen.

PROFESSOR H. M. BARNES (Mississippi State University): Scarlette, thank you for that fine paper. I have a question. In your paper, you dealt with leaching of solvents. Did you look at the change in the preservative content after exposure in these or earlier tests. Secondly, you made no mention of the fact that micro-distribution of C.C.A. type preservatives in hardwood timbers certainly is a factor, and I should like to hear your thoughts on that.

DR. GRAY: To answer the first part of that question, no, we did not look at the preservative retention after exposure. Perhaps David would like to answer the second part.

DR. DICKINSON: I think the micro-distribution is only another way of measuring these effects. We are probably actually looking at adsorbed copper at the cell wall level when we look at it by micro-distribution techniques such as x-ray analysis. They are part and parcel of the same thing. Of course, this work is a direct continuation of our earlier work on micro-distribution. This, we think, is what might be causing those effects.

DR. R. J. ORSLER (Princes Risborough Laboratory): Thank you, Scarlette, for a very clear presentation of your work. Listening to it, there are quite a few chemical points that are there for discussion. Perhaps I can ask a question on two small ones. The first one is a point of clarification. To me adsorption with a "d" is a surface phenomenon and I should like to know whether you are actually talking about copper which is bound purely to the internal surfaces of the wood structure or are you actually talking about copper which is bound in some way through the depth of the cell wall.

The second point is, you postulate an ion exchange mechanism for the binding of this copper, which would seem to imply if you shake copper sulphate up in wood sawdust you end up with sulphuric acid. Have you ever measured a marked drop in pH when you do this?

DR. DICKINSON: Your first question was about surface adsorption. I believe we are talking about a porous medium and the wall is a porous medium as well. So what is the surface. It certainly is not just the lumen surface.

DR. GRAY: In answer to your second question, no, we have not measured any changes in pH of the solution during adsorption, but we intend to do so.

DR. A. F. BRAVERY (Princes Risborough Laboratory): I should like to ask you, or confine my comments any way, Scarlette, to a couple of points about the technique. For reasons which you will not need long to guess, I am interested in the extent to which the methodology can be used for predictive purposes. So there is one aspect of its reliability I should like to ask about and the other is a comparative issue between your pure culture and soil bed. The first point is that in using your strength criterion you did not mention whether you accommodate for variation in the moisture content of the samples when they are lifted from the soil and placed into the strength testing apparatus. At least if you did, or if you have written it, I missed it. Do you do that, because the strength properties can vary at different moisture contents.

DR. GRAY: All of the stakes were above fibre saturation point because they were buried to within a centimetre of their length, and the top one centimetre did not form part of the span of the beam when it was loaded. The drier part of the stake lies beyond the support and therefore is not tested.

DR. BRAVERY: You are content, are you, that being above fibre saturation point is enough and they do not have to be fully saturated?

DR. GRAY: You mean during the test?

DR. BRAVERY: During the application of the strength measuring process.

DR. GRAY: They are at about sixty per cent moisture content or more, and I feel that is adequate for strength testing.

DR. BRAVERY: Looking at your Tables 5 and 6 which are the ones which compare the performance of adsorbed copper against *Chaetomium globosum* in pure culture and then the performance in the unsterile soil test, if I read the tables right the *Chaetomium* pure culture test seems to be quite a bit more aggressive than the soil tests, and that is something which we, anyway in our work, had begun to think was not the case, which is why we went to natural soils. Can you comment on that. Am I reading it correctly?

DR. GRAY: It is not a natural soil, which is one factor which might influence it. It is a potting compost. We also thought that the mono-culture test would be more severe and I think it is with some formulations. The mono-culture test tends to be more affected by the formulation than the soil burial test does. So on some occasions it would appear to be more severe and on others less so.

DR. BRAVERY: Could I deduce from what you have just said the soil burial test might be more reliable because it is more consistent.

DR. GRAY: Yes.

DR. DICKINSON: There is far more variability in the mono-culture testing than the unsterile soil, but occasionally the mono-culture testing is very aggressive with certain formulations.

DR. JOHN MORGAN (Princes Risborough Laboratory): At the risk of asking too many B.R.E. questions I hope you will not mind if I get up and ask one now. I am particularly interested in the hypothesis of selective adsorption of copper at the sites of the T branching and soft rot attack. Have you carried out any other sort of examination to see whether there is selective adsorption of copper at certain sites in the cell wall and have you observed this in the electron microscope?

DR. GRAY: No, we have not looked at that, but we would like to.

DR. DICKINSON: It is planned, I think, John, if we can raise the funds from the S.E.R.C. later.

THE CHAIRMAN: I should just like to ask a question about the control of brown rots. Mike Barnes threw a bit of cold water on our assumptions of the past about the relevance of copper tolerant brown rots. You have rather emphasised the importance of having some means of controlling them where copper is performing alone. Would you like to comment on that in relation particularly to what Professor Barnes said yesterday.

DR. DICKINSON: It is a point which I obviously have to take up with Mike. He is with us for a year and so perhaps we can change his mind on this issue. I do not think there is any doubt that certainly in northern Europe we recognise a major problem from copper tolerant brown rot organisms. I think as we move towards looking for new preservatives it is going to be the copper tolerant brown rot organisms which are going to be the one of the chief obstacles in re-designing formulations. If we relied on copper alone I am sure we would have some pretty catastrophic failures of treatments if we did not take other precautions to take care of the brown rot fungi.

MR. T. SCUTT (Fosroc Ltd.): Do you feel it is in any way safe to predict the form of other species of hardwoods from the results you have achieved with the ones you selected?

DR. DICKINSON: We chose our hardwoods from a whole range of hardwoods which have any potential for commercial use, and we do have ground contact data for all those species. Obviously we could not look at everything. We have tended to work with these five hardwoods, which represent the five performance classes which are emerging. I think it is going to be up to the wood chemists to take our work and start looking for the wood chemical explanation for what is going on. There are already indications that this can be linked with the amount of lignin certainly in the hardwoods. Other factors need to be looked at. Built into this at the same time is the inherent soft rot susceptibility of the species. It is all part of the same story, and I think one of the most interesting aspects of all this work, including the micro-distribution work, is that they are all parts of the final explanation. These are not theories which are in conflict with other theories; they are just another way of looking at it, and I think that if the wood chemists really took Scarlette's biological work, and the data coming over from the I.R.G. field trials, and really started to look for good wood chemical answers and theories, those theories can soon be tested.

THE CHAIRMAN: Okay, Ladies and Gentlemen, if there are no more questions then I really, I think, would like to sum up by saying, as has been pointed out, we are now fifty years after the first commercial use of C.C.A. preservatives and we are now beginning to unravel some of the fundamentals of the way in which these classes of preservative work. It is only now that we are doing so because we have the techniques available and the knowledge from previous studies of wood chemistry and preservative chemistry inter-actions, and indeed the resources have been made available to carry out this sort of work. It is a pity that we are facing the prospect of restrictions or even the loss of preservatives of this type to the industry for the protection of timber for the future.

It may be that this is another part of the argument that we will have to use to defend the position of these materials. One has obviously got to respond to the environmental concerns, and I think perhaps the previous paper this morning demonstrating a practical and visionary approach, if I may say so, to the control of pollution of treatment plants, is something which has all got to the taken into account. But it is a pity if we are going to move into a era where perhaps the improvements that we could see coming through C.C.A. anyway would be almost irrelevant because we are not allowed to use it. Of course, it does form a firm basis for development, which is the bright part of that particular difficulty.

I think the paper has been an excellent example, Ladies and Gentlemen, of detailed and industrially relevant work that regularly comes out of the Imperial College Timber Technology team, clearly without sacrificing any fundamental approach to investigations of this nature. I should like you to join with me in thanking both authors and particularly Dr. Gray for an excellent presentation. *(Applause).*

B.W.P.A. ANNUAL CONFERENCE 1988

A VIEW OF ALL ASPECTS OF DAMPCOURSING IN THE UK

by A. Pretty
— *Cementone-Beaver Limited*

1. Introduction

The history of the remedial industry as it exists in the U.K. today dates from between the wars and whilst it is difficult to be more specific than this, it would seem reasonable to accept the 1930's as the period when in-situ treatments became established as a separate and specialist sphere of work.

Originally, these treatments were essentially concerned with insects and fungi affecting timber but dampness – as the cause of fungal decay – has always been recognised as a major contributor to deterioration.

At the same time, however, dampness within a property can severely reduce the living standards of the occupants, maintenance can be an increasingly expensive problem and with an official policy of improving existing housing stock, dampness has become, more and more, a problem in its own right.

In this context, treatment of rising dampness is one of the major factors and work of this nature now forms a significant proportion of the day to day activities of the average remedial contractor.

This paper is written against the background of the proposed merger of the British Wood Preserving Association and the British Chemical Dampcourse Association, with a view to summarising the nature and extent of the 'dampcoursing' treatments being carried out at the present time.

History

The Public Health Act of 1875 with its requirement for the incorporation of a damp-proof course into the walls is always quoted as the origin of D.P.C.'s although some work of this nature must have been carried out prior to this date for the information to be available.

Once the benefit of these measures was appreciated, the natural consequence was to introduce remedial works in existing buildings and some of these are briefly described below.

Cutting-in

Whilst this clearly comes under the broad heading of a remedial measure, it is perhaps more correctly a building operation in the sense that sections of wall were cut out, a physical D.P.C. was laid and the removed wall area was then replaced. Only small sections could be done at one time and the operation was progressively moved along the wall – a rather long and tedious process and according to Gratwick (1), one which was not without problems.

Providing that the mortar courses are adequate, a modern alternative is to cut a slot with a saw to receive the introduced D.P.C.

Syphon tubes

A very basic factor governing the extent or degree of rising dampness is the balance between absorption (from the ground) and evaporation (from the wall).

Syphon tubes – originally and perhaps more correctly, Knapen tubes – are based on the latter and in this process, hollow abosrbent tubes are introduced into the wall (see Appendix). The angle is important in that when the dampness absorbed by the tubes evaporates into the hollow centre, the resultant cool, damp and therefore heavier air takes a downward and outward path to the atmosphere and by drawing in air, induces a continuing drying cycle.

This process was invented by Professor Knapen, a Belgian engineer and widely used on the Continent. It has been used in the U.K. but it is understood that the present use is generally directed towards drying out a wall as opposed to the creation of a damp-proof course.

Electro-osmosis

1 *Passive*

It is an accepted fact that there is a difference in electrical potential between the top and bottom of an area of rising damp. If it is then accepted that this is the cause of the rising damp it is then necessary to discharge the electricity and at the simplest, passive osmosis can be described as a means of providing an effective earthing system (see Appendix).

2 *Active*

Whilst again based on the effects of electricity, this process depends on an electrical current being passed through the wall changing the direction of the water flow and thus negating the capillary rise. The diagram in the Appendix shows a simplified layout, in practice the power source is a transformer/rectifier and part of the circuit will be earthed.

This system is in use in the U.K.

Current Practice

Chemicals

Whilst some of the systems outlined above are in current use, the present dampcoursing market is completely dominated by chemicals and it is in this area that most investigations and practical work has been done and consequently there is now considerable documentation.

Since early published documentation is rather sparse, however, it is again difficult to be completely exact historically but a booklet published by Stanley Richardson in 1969 (2) pinpoints the introduction of a chemical dampcoursing system based on a petroleum wax as 1936. This process resulted from earlier work on water-repellent treatments and whilst the wax solution performed well on wall surfaces it was found that the product separated and would not diffuse satisfactorily where the wall was too damp or cold and the treatment was eventually rejected as being impractical.

The booklet also refers to other contemporary dampcoursing systems and this period (the 1930's) would seem to show the beginnings of the chemical D.P.C. as we know it today.

The first major development came after the war in the mid 1950's with the introduction of silicones as a water-repellent material. These were based on organic solvents and consequently, when used for dampcoursing, it was necessary to use pressure injection to obtain the required distribution through a wall. A diagram in the Appendix gives the conventional approach to a 230mm brick wall where this is accessible from both sides but where only one side is available, treatment will be on a progressive basis, the nearest skin being treated first followed by drilling through to treat the far skin. Similar progressive treatment is carried out where thicker walls are encountered. Where bricks of very low permeability are found, it may be necessary to carry out drilling and treatment in the mortar course and broadly, the same overall process is also applicable to stone walls.

Another material which became available was sodium methyl siliconate (potassium methyl siliconate is now general) and being waterbased, the original application was by diffusion, the quantity introduced being governed by a measured container, one such system being illustrated in the Appendix. Currently, the majority of siliconates are introduced under pressure and apart from the fact that most of this work is carried out in the more permeable mortar courses, this is generally as outlined in the previous paragraph.

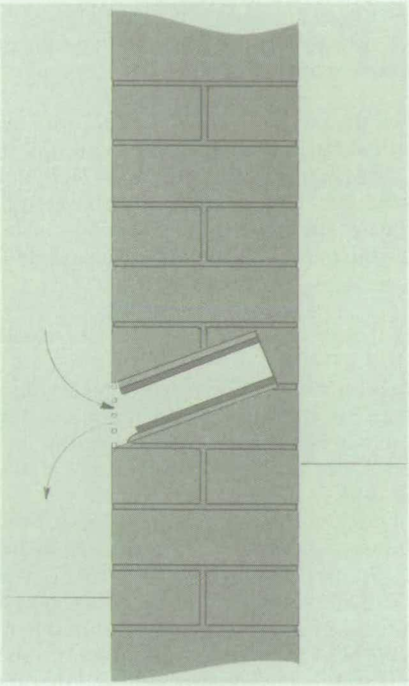
In 1969, products based on polyoxaluminium stearate were introduced and being organic solvent based application procedures are the same as the organic silicones.

Injection mortars provide aother process which is in current use. Originally introduced into the U.K. in the early 1950's, they are based on a cementitious slurry which is considered to have considerable benefits in 'difficult' stone walls where the quick setting nature of the material limits its distribution in comparison to the possible loss of the more mobile fluid materials. The essential part of the injection mortar treatment is the migration of chemicals within the slurry into the wall where subsequent crystallisation provides a pore blocking effect.

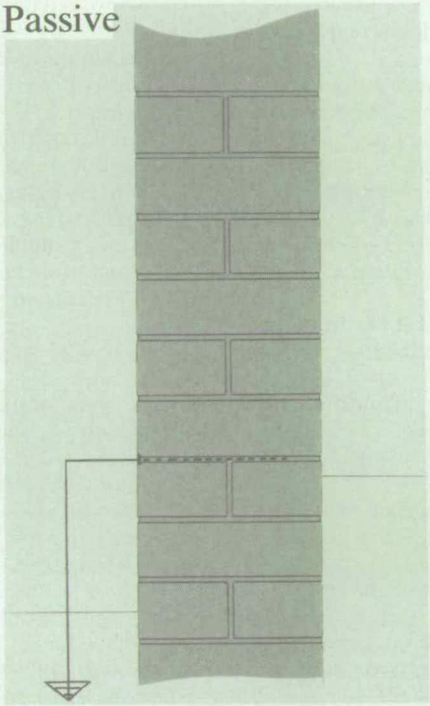
THE MARKET

Whilst the increasing number of materials and processes extended the scope of the industry, there can be no doubt that the most significant single factor has been the change of official policy where during the early 1970's the earlier approach of 'lets

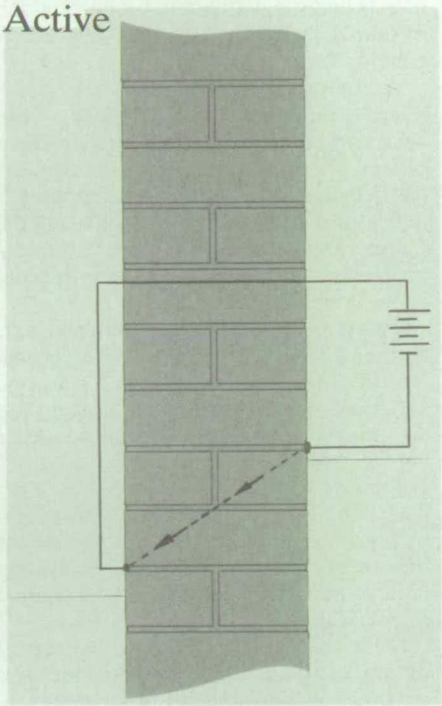
Syphon tubes



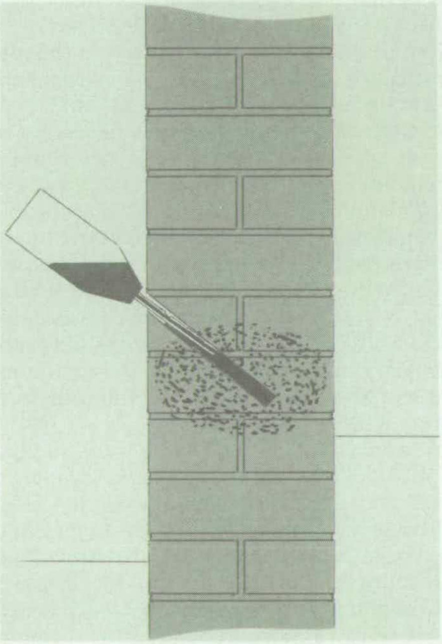
Electro-osmosis Passive



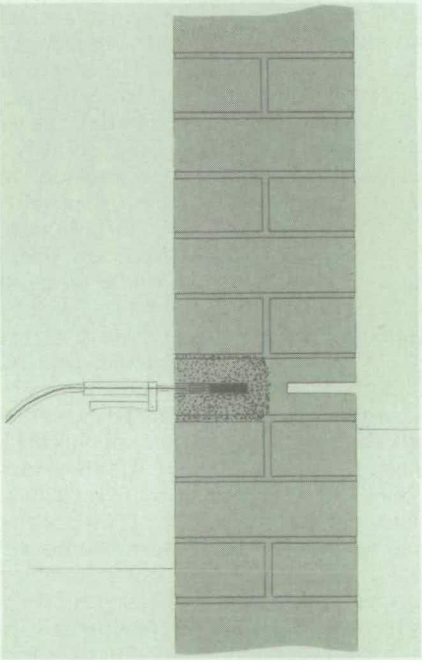
Electro-osmosis Active



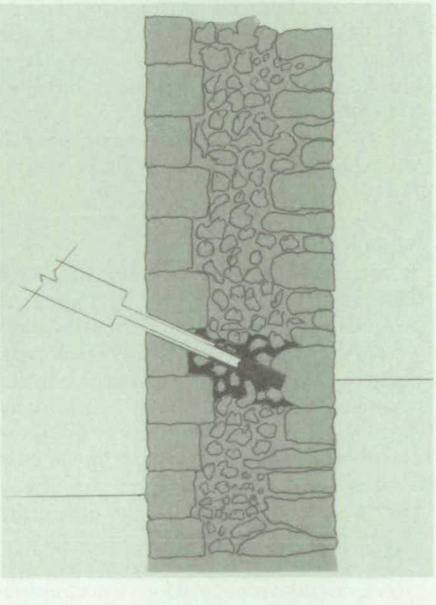
Gravity diffusion



Pressure injection



Injection mortar



tear it all down and start again' gave way to the retention and rehabilitation of the older housing stock. This policy of renovation was taken up by Local Authorities, Housing Associations and the private sector, an added incentive being the availability of improvement grants.

Although there has been a decline since those days it is still estimated that there are some 1500/1800 firms engaged in dampcoursing in the U.K. (at the same time, due allowance must be made for an appreciable fringe element where one or two jobs per month – if not less – is the norm).

Any realistic estimate of the market value is almost impos sible but it is interesting to note that Kyte and Bricknell (3) refer to £5M for the treatment of rising damp in 1974 and in 1986 Bricknell (4) refers to £150M for remedial treatments as a whole. A draft Guidance Note issued by the Health & Safety Executive in 1987 refers to some 100,000 properties undergoing remedial timber preservative treatments per annum.

ASSOCIATIONS (etc)

In parallel with the expansion of the trade, there has been a corresponding increase in support from associated bodies.

Building Research Establishment

Information issued by the Building Research Establishment is a well established feature in the building trade as a whole and rising damp and its treatment has been referred to in various documents. At the same time, these throw an interesting sidelight on the change in attitude over the years when references is made to B.R.E. Digest 27 issued in 1962 which states 'Work at the Building Research Station on the injection of setting resins is not yet sufficiently advanced for any conclusions to be drawn". At the present time, B.R.E. Digest 245 is a standard reference for the diagnosis and treatment of rising damp.

British Board of Agrement

A very big step forward to creating acceptable standards of treatment came in 1974 when the British Board of Agrement (as it is now) issued the first Agrement Certificate for a dampcoursing system. The current issue of the BBA Publications montly (May 1988) now shows 46 Certificates with the prospect of this figure reaching the "half century" within a very short time. In the general context of these Certificates, a point which could well be emphasised is that they apply to a system and not just to a product and the correct procedures throughout treatment must be applied to conform with good practice.

British Chemical Dampcourse Association

Without doubt, however, the most important contribution to the professinalism of the industry came in 1977 with the formation of the British Chemical Dampcourse Association by the amalgamation of the Association of Chemical Damp Course Manufacturers, the Federation of Midland Dampcourse Specialist and the Federation of Northern Dampcourse Specialists. This is a trade association which at the same time makes it quite clear that membership is only given to those companies who are prepared to meet the Association's standards.

The prime purpose of the Association is to set standards and one of its first commitments was to compile a Code of Practice, the first draft appearing in the same year. This was published in 1978 (subsequently updated) and this document is now backed-up by a series of Technical Information Circulars (5). These deal with a whole range of associated issues – e.g. the use of moisture meters, re-plastering to overcome problems of hygroscopic salts, condensation, safety, advice on writing reports etc.

Another important area of interest is training and whilst the Association is not directly involved, earlier co-operation has resulted in the availability of specialist courses at Colleges at High Wycombe and Oldham (in addition to in-house training provided by the larger companies and some manufacturers). It was realised, however, that some tangible evidence of training was required and as a result an examination syllabus was drawn up with the first B.C.D.A. Surveyors Examination being held in March 1983. Since that time, 17 examinations have taken place with a total of 360 candidates of whom 283 have been successful. The failure rate of 21% is a clear indication that a good standard of knowledge is required.

Guarantee Protection Trust

A major concern of any trade association is to ensure, as far as possible, the stability of its membership and this is particularly true of the B.C.D.A. where the contracting members (and of course the trade as a whole) are expected to issue long term guarantees after dampcoursing treatment. With a current membership of 200 firms and an estimated annual loss of two per cent, the B.C.D.A. has a very good record in comparison with figures quoted by *Which* magazine which, looking at the remedial trade as a whole in the late 1970's, concluded that out of 870 companies, 600 had ceased trading to be replaced by 900 new firms over a period of 2.5 years. Nevertheless, the commercial world is an uncertain world and bearing in mind that the disappearance of a firm results in worthless guarantees, the B.C.D.A. co-operated with the B.W.P.A. in sponsoring the Guarantee Protection Trust. Membership is restricted to B.W.P.A. and B.C.D.A. members (although the G.P.T. is completely independent of either) and with contributions from the participants and insurance backing, the purpose is to honour guarantees registered by a member, should that member cease trading.

British Standards Institution

Two British Standards have a direct relevance to the insertion of a damp-proof course:-

B.S. 6576 : 1985 – British Standard Code of Practice for the Installation of a damp-proof course.

This document is based on the earlier B.C.D.A Code of Practice and similarly, guidance is given on all aspects of the insertion of a chemical D.P.C. This includes – assessment of buildings, diagnosis of rising damp, associated problems, preparatory works, the installation (all existing chemical processes) and all finishing measures.

CP 102 : 1973 – Code of Practice of Protection of buildings against water from the ground.

This defines the relationship between the D.P.C. and ground level.

As an extension of Government policy of encouraging quality in business, the B.S.I. System for the Registration of Firms of Assessed Capability has been in existence for many years and in 1983 a scheme was drawn up for chemical dampcoursing.

This is sub-divided into categories covering:-

Scheme 1 – Manufactures
Scheme 2 – Independent installation contractors
Scheme 3 – Registration of a manufacturer's approval scheme and assessment of the approved installers.

Under all schemes, firms are required to have a documented quality sysem which complies with the appropriate part of B.S. 5750 and to the Quality Assurance Schedule which is relevant to the particular scheme.

THE FUTURE

The principles and processes used for chemical damp courses are now well established. On an overall basis, no radical changes are aniticpated – certainly in the near future – although it would seem likely that the effects of evaporating solvents will play an increasing part in the choice of materials.

Acknowledgements

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T.I.C. 2 – Plastering in association with damp-proof coursing
T.I.C. 3 – Condensation
T.I.C. 4 – Methods of analysis for damp-proof course fluids
T.I.C. 5 – Chemical damp-proof insertion – the attendant problems
T.I.C. 6 – Safety in damp-proofing
T.I.C. 7 – Chemical damp-proof courses in walls – detection techniques and their limitations
T.I.C .8 – Damp-proofing barriers (tanking) in association with chemical damp-proof coursing
T.I.C. 9 – Guidelines to survey report writing.

DISCUSSION ON PAPER 7

Chairman: Mr P. D. North

THE CHAIRMAN: Ladies and Gentlemen, we have about six or seven minutes for questions.

MR J. M. BRICKNELL (Consultant): First of all, Mr Chairman, may I remind you that you cannot use bat's blood under the Wild Life and Countryside Act. Alan, may I congratulate you on your paper and welcome you to the elite group of people who have had the cheek to give papers on damp-proofing at the B.W.P.A. Convention.

MR BRICKNELL: As a consultant I am regularly faced with the problem of people who still have dampness in their houses after they have had their dampcourses inserted and when we turn to B.R.E. for advice or to the British Standards or to the Code of Practice we read that with a damp-proofing course residual moisture will dry out in about 12 months or under 12 months. I, personally, think in many cases residual moisture takes far longer than that to dry out particularly when you have an internal plastering system which is designed to prevent the migration of hygroscopic salts and possibly external renderings which you showed in the last but one slide. May I ask for your comments on how long you think drying out is likely to take. Do you think 12 month period is reasonable?

MR PRETTY: There is only one direct answer to that, John, and you know very well what it is going to be. It is 'How long is a piece of string'. Seriously, it is quite a problem and I do take the point of what you are saying. It is difficult from the point of view of how long it is going to stay there. It is also very, very difficult, as I am sure you are all too well aware, how you assess what there is there; how much there is there and really what it means. It is not a happy situation. I anticipate this question coming in a slightly different form but I quite anticipate something of the sort. I would be most unwilling to tie anybody down to the length of time the wall is going to stay wet. We all talk very glibly about one month per inch thickness of the wall. I think that would be under ideal conditions. It is obviously going to be affected by how much water there was in the first place. I quite agree that although we obviously have to put on a fairly hard, a fairly tight finish to hold back the salts, at the same time that does affect and restrict drying. If you like it is a many faceted problem.

I think the only clue we have or the only hope we have of solving the problem in the future is that the B.S.I. are actually looking at a standard for the assessment of dampcourses which have been inserted, and fairly obviously this is one point which is going to be brought up: not only the question how long the water stays there, but how much there is, how important it is and all these points. It is not an easy one to answer, not an easy one at all.

MR G. B. MORRISON (M.P.S.): Would you like to comment on the migration of the various damp-proof courses upwards as well as backwards and sideways and forwards. In other words, how much of the damp-proof course is dissipated by the fluid actually going upwards in the wall and not staying where the contractor expects it to stay.

MR PRETTY: If we look at the organic waste materials, the stearates and the silicones, I think you can feel very happy that they cure on contact with water and there they stay. This is all part of this argument which we see in timber treatment as well, the continuing argument of water based material against organic based materials. With the organic based I do not think there is any doubt at all, whether it be silicone or whether it be stearates, they cure where they are put and there you are. So that is one argument which a lot of people would put in favour of it.

There is a far longer curing period with the siliconates. Again, it is difficult to quantify. I think under average circumstances the average type of wall we are treating which you, as a contractor will quite well realise is not all that wet, I would not think there really is a fundamental problem with the siliconates. Certainly the point has been made, and I have seen it happen under laboratory conditions, where if you have a very wet wall and the water is moving, then the siliconate will actually move up from there, but I have a feeling it is more of a theoretical problem than actually something which occurs in service.

MR MORRISON: Could I ask something more on that. What about the temperature sensitivity of damp proofing products.

MR PRETTY: Temperature sensitivity. In what sense, George?

MR MORRISON: Depending on the time of year, which product in your opinion is best used and when?

MR PRETTY: I go back to some advice I originally read, and I cannot honsetly recall where I saw it but I think it was virtually an official document, which made the point – I am sure it was a B.R.E. document – that irrespective of whatever system you were using the drier the wall the better the system is going to be. I think we can all realise that point. The point was then made – it is not much joy to the contractor because I can see fantastic problems – that ideally treatment should be carried out late August or September. I know it is the holiday season, but nevertheless that point was made. Again, the whole trouble here is that we are looking at these material, these products, these processes, from two points of view. We are looking at theoretical points and we are looking at practical points. With all due respect to the questions you have raised, I think, in practice, they probably will not matter very much at all.

Mr Morrison: There is no harm in using stearate in cold weather?

Mr Pretty: No. Well, when I say no harm, they are more difficult to use in cold weather. There certainly is that point. I am sorry I thought you were looking at the efficacy rather than when to use them, but certainly, yes, this is an accepted point. If you have stearates they are more difficult to use, they cure more heavily, they throw off more solid as silicones do. I think this is a point which ought to be recognised, that treatment with stearates can be more difficult because if you put them in walls you get very heavy curing and sometimes you get pore blocking, and again the point is always being made and certainly recognised, and it comes back to practise, that stearates tend to thicken up slightly in cold weather and again you have this difficulty of pumping in. This certainly is a point to consider.

The Chairman: Can we leave the last question, please.

Dr D. A. Freeman (Guarantee Protection Trust): I should like to ask Alan Pretty a question about the confidence of property owners in the installations that they commission. In view of the residual dampness problems mentioned by John Bricknell would it not be prudent to let guarantees of this service run from the time that the residual dampness has been cleared?

Mr Pretty: Oh dear! I had some feeling before I started and I anticipated I would be asked the sort of questions where I would require further advice, where I would require support. We always look at guarantees from a commercial point of view and I am very tempted to be a coward and say this is a commercial aspect which should be dealt with in a technical meeting. On the other hand, I do take your point. It is quite a valid point, that the guaranteess could run from the time that the wall ultimately dries out, but it is going to be an awful lot of work for the contractor. I do not think in practice it would work. We are so used to the idea of guarantees applying from the time treatment is carried out and I think providing the paperwork submitted by the contractor – this is a point which always worries me – the reports are adequately written to explain the situation to the customer, that they must expect some dampness until that wall dries out, I do not think the question would arise.

I think what the question hinges on is really the ability of the contractor to advise the customer as to what to expect. I think that is a point which wants clarifying. So that guarantees will apply from treatment rather than your idea of when the walls dry out.

The Chairman: Ladies and Gentlemen, we have run out of time. If I may I should like to refer to my analogy an hour ago about marriage. In my own mind there is no doubt at all of the inevitability of the merger of the B.W.P.A. and the B.C.D.A. I think rather as a child struggles into sleep so we will struggle into this merger although it will not necessarily take as long as my children used to take to go to sleep. As a trailer for the B.C.D.A. and as a reminder of what the general situation is about damp-proofing I am sure you will all agree that what we have just heard is as good an example as any and I should like you to show your appreciation of what Alan has done for us. Thank you very much. *(Applause).*

B.W.P.A. ANNUAL CONFERENCE 1988

ASSESSMENT OF EFFICACY OF WOOD PRESERVATIVES

by J. W. W. Morgan
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1. INTRODUCTION

At last year's Convention Dr Sue Hubbard of the Health and Safety Executive presented a paper on the Food and Environment Protection Act (FEPA) 1985 and the Control of Pesticide Regulations (CoPR) 1986. These regulations placed on a statutory basis the procedures for safety assessment which until then had been carried out under the voluntary Pesticides Safety Precautions Scheme (PSPS). However, the new regulations were broader in scope than the earlier scheme, and introduced the need to assess efficacy and humaneness as well as safety in use. Indeed full approval cannot be obtained without demonstration of the efficacy of a pesticide to the satisfaction of the registration department.

This additional requirement means different things for different sectors of industry and the implications for wood preservatives are quite distinct from those for agricultural pesticides. For products already on the market, and approved under PSPS it has been suggested in a Consultative Document[1] that those which have approval under ACAS (agricultural products) or which 'meet an appropriate BSI standard' (some wood preservatives) may be regarded as having demonstrated their efficacy. Others would need to provide data to support their claims. However, as we shall see later, in the wood preservation field claims of efficacy need to be explicit (e.g. in terms of the organisms controlled) and it is doubtful whether British Standards can act as a surrogate for an approval scheme. It is also doubtful whether tacit approval *via* this route would be acceptable in other European countries, which together with the U.K. are moving towards a harmonised approach to wood preservative approval through the European Homologation Committee (EHC). There needs to be in place, therefore, an approach to wood preservative approval which meets both U.K. and wider European needs.

An attempt was made by the British Board of Agrément (BBA) in 1974 to develop and launch a national wood preservative evaluation scheme related solely to efficacy. This first approach proved too elaborate and it was supplanted in 1983 by a simpler scheme which is described in BBA MOAT No 10. However, few preservative manufacturers have chosen to apply for BBA certification, and the scheme remains little used. Whilst BBA certification could be taken as evidence of efficacy under the Control of Pesticide Regulations it would be difficult to make it a requirement since it is independently charged, and the charges cover aspects (e.g. quality control) not required under the regulations. The HSE decided, therefore, to look to BRE for advice on the efficacy of wood preservative products submitted for approval. In preparation for this BRE has had to introduce a framework for a systematic approach to assessment, and to develop guidelines for evaluating the test data. The purpose of this paper is to explain the way in which BRE has tackled the problem and to invite discussion on the intended approach.

BASIS OF APPROACH

It was necessary at an early stage to decide the scope of the efficacy assessment to be made. The basis for clearance under the CoPR is that pesticidal products are approved, and not treated wood, hence the assessment is associated with the formulated preservative. However, since effectiveness will vary with the method of treatment and the environment of use these factors must be considered in coming to a judgement. Nevertheless detailed treatment requirements for end use remain firmly a matter for British Standards.

Another factor which has a significant effect on the performance of an applied preservative is timber species, but to consider this adds a level of complication which would be quite unacceptable. Hence, assessments will be made in relation to the ability of the preservative to protect a vulnerable, readily treatable timber e.g. pine sapwood. The matter of species effects will again be left to British Standards.

The criteria to be adopted in judging efficacy also need to be settled, and this rather more complicated issue will be dealt with later. Suffice it to say here that the Consultative Document[1] speaks of a minimum efficacy standard, and the HSE will be looking for a 'yes' or 'no' answer.

The starting point for any assessment of efficacy will be the claim made by the manufacturer on the label of his product. Clearly each claim must be supported by test evidence, and it is the manufacturer's responsibility to provide this to the Registration Department. This may take the form of data from specific tests carried out on his product, and in some cases he will be able to call on supporting published information. It is expected that he will submit this in the form of a reasoned case based on the test evidence, and not simply as a bundle of test reports.

Having said that assessments would be made of label claims, it is immediately obvious that such a system cannot be given a free rein. Clearly one could not assess the blanket claim 'wood preservative for house and garden use'. Even more specific claims could give rise to difficulty. For example, suppose the claim was for fencing. Is the product intended to be used for fence posts as well as rails and panels, and what about the method of application? Also is it intended to protect against decay, or staining organisms or both? Clearly label claims will need to be put on a systematic basis so that the applicant unambiguously states what he claims for the product, and so that the user is left in no doubt about what it can be expected to do.

Approvals under CoPR are for specific formulated products, and this applies to efficacy as well as safety assessments. However, this does not imply a need for separate testing of specific formulations, since in many cases assessment will be possible on the basis of active ingredients. A condition of approval is that full formulation details must be notified, and it is only where changes in formulation can be expected to lead to changes in activity, that additional testing may be required. This is likely to be more significant for remedial treatment formulations. For most pre-treatment preservatives, however, once a full efficacy evaluation has been carried out for an active ingredient, at a given concentration it is not anticipated that much further testing will be needed. However, it must be borne in mind that if the information on which the assessment is made is not in the public domain, the test data may be the property of the applicant, and his permission will be required before it can used by others. This situation is likely to arise mainly with new products on the market, since most of the evidence of effectiveness of established preservatives is already published.

Another consideration is that any U.K. scheme for assessing efficacy must be compatible with the guidelines on approval procedures which are now emerging from discussions within the EHC. This is particularly important at a time when the pace of harmonisation of standards is increasing in Europe, with 1992 set as the date for completion of the internal market.

Framework for Assessment

At an early stage it was apparent that we would need to set up a small panel within B.R.E. to deal with efficacy assessments. The panel, as presently constituted, consists of Dr. Orsler, Dr. Bravery, myself and Professor John Levy who has been invited as a non-government independent member. All commercial information coming before the panel will be handled on a confidential basis, but the principles for assessment need not and should not be restricted, and may indeed benefit from wider debate.

One of the first actions of the efficacy panel was to derive a framework for assessment so that applications could be considered on a consistent basis. The information required to classify the product (from an efficacy viewpoint) has been set out as an application form. The form together with associated notes and tables of available standard test methods has been commented upon by B.W.P.A. and it is now with H.S.E. for printing and distribution. A copy of the form is attached as Appendix 1. Whilst the application form is fairly straightforward certain features of it deserve explanation. The first is that efficacy requirements do not sub-divide clearly into the three categories used for safety clearance – industrial, professional and household. In assessing efficacy (section 4) it is necessary to distinguish between timber pre-treatment and remedial treatment which roughly equates to industrial and professional use; but household use spans both categories. In addition it is useful to retain protection of green timber as a separate category, although this is also an industrial use. The reason for this breakdown is to achieve a separation of applications into three categories for which the evidence will be significantly different. Hence it is suggested that a separate application form should be filled out for each of the categories identified.

The other sections to note 7, 8 and 9 reflect the complexity of assessing efficacy. Section 8 lists the types of organism which can attack wood, and the applicant must decide exactly what pesticidal action is being claimed. In some cases only one type of organism will be involved, but where multiple action is claimed it will be necessary to ensure that the test evidence supports each claim.

It was noted earlier that the method of application also needs to be taken into account in evaluating efficacy. We are all familiar with the importance of depth of penetration for aggressive service conditions. For this reason details of the method of application are asked for in section 7. The primary purpose of this section is to distinguish between treatment types, but details of the schedules recommended are requested to avoid any confusion.

In section 9 information is sought on the intended service environment in which the preservative will be deployed. Since the demands placed upon the preservative treatment vary considerably with the environment of use, this is another factor in the assessment of effectiveness. The categories of exposure listed in section 9 can be tied into the hazard categories currently defined by the EHC, and take on more recognisable form in the examples given in the Appendix (Table 1).

Evidence Of Performance

Whilst it is the responsibility of the applicant to carry out tests, assemble data, and to construct a convincing argument in support of the efficacy of his preservative product, general guidance has been given on the type of evidence expected. This falls into three types.

(i) documented evidence of long term service performance
(ii) field trials simulating service conditions
(iii) laboratory tests of biocidal effectiveness

Clearly evidence of performance based on service or field trials will be more convincing, owing to the difficulty of representing the conditions of service in a laboratory test. For this reason it was decided to require limited field trial experience for preservatives used under the more hazardous conditions of ground contact or exposure to water. This again ties in with proposals in the EHC. Where preservatives have only laboratory test data, efficacy assessment will be confined to the remaining less aggressive service situations, but it is anticipated that this will apply mainly to newly developed products.

For those unfamiliar with the compendium of test methods available for the different organisms encountered, these have been listed in the Appendix (Tables 1, 2 and 3) in relation to the service environment for which efficacy is to be demonstrated. Only test methods based on European Standards have been listed, but other test data may be submitted, and its acceptability will need to be judged in individual cases. This is particularly appropriate where there are no European or British standard tests. Not surprisingly this features more strongly in Appendix Tables 2 and 3 which refer to the remedial/*in situ* use of wood preservatives.

Interpretation Of Test Data

The interpretation of the evidence submitted is the most difficult part of the exercise. There are few recognised performance targets for wood preservatives, and there are no established correlations between laboratory tests and field or service performance. Moreover, many of the preservatives in common use have a widely differing performance in laboratory tests. Against this background one is required to establish a defensible set of criteria against which a formulation can be said to be effective or not effective as a wood preservative. It is clearly impossible to do this on a fully objective basis unless arbitrary criteria are used which may be either unfair or grossly permissive. The assessment of data will always require some subjective judgement, hence the need for the efficacy panel referred to earlier. However, it is unsatisfactory for such a panel to operate without some guidelines and points of reference, and some possible approaches are described here.

For service evidence it is impossible to set criteria since this in no way can be regarded as a test. It is more a case of whether the evidence is acceptable or not and it should be noted that it is a requirment that such evidence is well established and documented. Unsupported assurances, market size and absence of customer complaint will not be regarded as evidence. Despite its primary place, in order of importance, this will probably be the most difficult evidence to produce, except for a few long established preservatives.

Ground contact field trial data will be more readily available for many of the established preservatives, but it is only recently that any attempt has been made to produce a standard procedure. It is likely therefore that most field trial data will have to be evaluated in relation to the design of the test from which they originate. An essential requirement of any trial would be that untreated controls were included and a suggested performance level is that the average life of the treated stakes should be 'n' times that of the untreated controls. Suitable values for 'n' are likely to vary with the nature of the field trial, but a factor of four to five in ground contact would be equivalent to uprating a 'perishable' timber to 'durable' in the Natural Durability classification.

In more recent times it has been the practice to include stakes treated with CCA as an internal standard. This principle is incorporated in EN 252 (Field test method for determination of the relative protective effectiveness of a wood preservative in ground contact) and a comparison of the rate of decay of the stakes treated with test preservative and those treated with CCA is possible throughout the test period. In the absence of any long term experience with this procedure, an arbitrary requirement has been included, that the test preservative should equal the performance of the CCA control after the test has run for a minimum of five years.

There are other types of field trial, in particular those out of contact with the ground, but it would be difficult and misleading to try to develop general criteria for assessment in view of their diversity.

For a number of preservative formulations, particularly the newer ones, there will only be laboratory test data available for evaluation. There are many laboratory tests and I do not propose to deal with all of them, but I have chosen examples from both fungal and insect tests to illustrate a feasible approach. The results of basidiomycete tests using EN 113, or the former BS 838 test, are expressed in terms of toxic values. These are the preservative loadings which span the loading which just controls decay under the conditions of the test. The toxic values may be different for different test fungi. The problem is, then, to use this information to prescribe a solution concentration at which the preservative under test can be expected to be effective in service. It is suggested that this can be accomplished in three steps:

1. Convert the toxic values to a single toxic index
2. Identify one toxic index from those yielded for different fungi
3. Compare this with a similarly derived toxic index for a standard preservative

This is essentially the same logic used in the old Princes Risborough Laboratory Technical Note No 24, where five per cent pentachlorophenol was the reference preservative, on the grounds that it had proven effectiveness in above ground field trials. At the time that technical Note 24 was launched this was considered to be equivalent to one per cent TnBTO, but more extensive testing now suggests that this should be nearer two per cent TnBTO. The question must be asked, therefore, whether TBTO is being used at too low a concentration *or* whether five per cent PCP is too high a standard as a general benchmark. As an alternative the following procedure is suggested:

1. Define the toxic index as the mid-point (kg/m^3) between the toxic values. If there is more than one test for each fungus, take the mean of the indices to give a mean toxic index.
   A maximum acceptable weight loss (10 per cent) at the lower toxic value will prevent undue bias due to the particular choice of solution concentrations.
2. Take the highest mean toxic index thus derived for the four fungi specified in the test (TN 24 took *Coniophora puteana* primarily).
3. Use this value to calculate a toxicity factor (F) where – solution concentration = F × toxic index

   Values of F for a representative selection of O.S. preservatives of established performance (i.e. for which there is good field or service experience) are listed in the table below. The table gives values for both aged and unaged tests, and the aged value (usually the lowest) is taken as the appropriate one for comparison where available. On this basis a toxicity factor (F) of 1.00 could be taken as a reasonable benchmark. Thus if for a new preservative the toxicity factor exceeds 1.00 at the proposed concentration it could be accepted. If it is less than 1.00, either the solution concentration should be increased or justification for its use at the lower concentration supported by other more compelling evidence of performance.

Preservative	*Normal in-use concentration % m/m*	*Toxicity factor (F)*		
		Unaged	*Leached*	*Evap. aged*
PCP	5.0	3.85	2.56	2.63
TnBTO	1.0	1.54	1.67	1.28
CuÑ (as Cu)	2.0 (D.vac)	0.93		
	2.75 (dip)	1.29		
ZnN (as Zn)	3.0	0.97		
1-PCP	6.25	<0.39		

Toxicity factors (F) for some common preservatives

For wood boring insects the various test procedures are more easily related to service conditions, but different principles for assessment need to be adopted for pre-treatment and remedial treatment protection.

An example of how *pre-treatment* protection might be assessed for a contact insecticide is as follows:

1. Determine toxic value for eggs/egg larvae of the appropriate insect, for the active ingredient.
2. Use profiles of distribution of the active ingredient, applied by the proposed method, after ageing.
3. Calculate the solution concentration for the active ingredient which ensures that a 2 mm thick zone exists after ageing in which the upper toxic value is exceeded.

Ageing could be natural exposure for several years or accelerated evaporative ageing which for other insecticides (e.g. γ-HCH) had been shown to achieve surface depletion to the same extent.

The same logic can be applied to tests of formulated products, but formulation testing is not expected to be a routine requirement. In some cases the applicant may choose to submit such data to claim enhanced activity, and in others the panel may require reassurance that efficacy is not impaired.

The preceding examples provide a rationale for assessing preservatives that are well served by standard tests. For a number of purposes where wood preservatives are used there are no standard tests and efficacy will need to be judged on the evidence submitted in individual cases. This particularly applies to in situ/remedial treatments where the onus falls on the applicant to establish that the preservative when applied as instructed has the action claimed.

Remedial treatment involving insecticides are better served that others by test procedures to demonstrate eradicant action. However, at present such action is regarded as formulation-specific since there is no basis for grouping formulations in terms of their eradicant properties. For *Hylotrupes* control, an immediate eradicant action is regarded as essential in view of the potential for structural damage if the infestation is allowed to proceed to emergence, and formulations will need to demonstrate this capability. For *Anobium* it is desirable though not always essential, provided there is control at emergence, hence formulations for *Anobium* control do not necessarily have to have immediate eradicant action.

This section of the paper should be regarded as thinking aloud by the panel, and it provides an opportunity for wider discussion. It, by no means, covers the whole field, and it is preliminary thinking. It should not be taken as committing the panel to a particular approach to data assessment since it is breaking new ground, and I suspect will need to be modified in the light of experience. However, the principles outlined above appear to provide one route through the maze, and it remains to be seen whether there are insuperable barriers as yet unforseen.

THE EUROPEAN DIMENSION

The EHC was originally an unofficial body of experts concerned to use common principles in the evaluation of wood preservatives in the countries of its members. Early in its life it saw the need to have common methods of test, and it asked the European Standards Organisation, CEN, to set up TC 38 to draft harmonised test procedures. In 1976 the EHC defined its membership as the national approval bodies (BBA for U.K.) of its member states, although meetings could also be attended by nominated technical experts. The objectives were:

1. to establish common technical principles for the approval of wood preservatives in Europe.
2. to facilitate exchange of information between Approval Authorities in the different countries in order to promote mutual acceptance of such principles.

Thus the EHC is not itself an approval body, but a forum for discussion and harmonisation of national requirements.

The U.K. efficacy assessment scheme has taken account of the EHC guidelines in its development, but it must be borne in mind that there is now a parallel European initiative to develop a harmonised approach to standardisation of construction products by 1992. To accomplish this for wood preservatives the remit of CEN TC 38 has been expanded to cover a wider field of wood preservative standardisation. Over the next few years a set of European standards for wood preservation will be developed, which may well have implications for change in the U.K. In addition the interaction of EHC and CEN will be brought into sharper focus, and the U.K. efficacy scheme may need to be modified to accommodate further changes arising from European action.

Reference

1 Pesticides: Implementing Part III of the Food and Enviornment Protection Act 1985 MAFF November 1985.

Appendix

Efficacy Assessment of Wood Preservatives under the FEPA Regulations

Wood preservatives are now controlled as pesticides under the Food and Environment Protection Act (1985) which gives Government the power to regulate the sale, supply, storage, usage and advertisement of such products. The Control of Pesticides Regulations 1986, made under this act, came into force in October in 1986, and replaced the old Pesticides Safety Precautions Scheme (PSPS) with statutory powers to approve pesticides. The new regulations include a requirement to demonstrate efficacy, thus introducing the need for an assessment procedure to cover this aspect. The assessment will be made only in relation to the claims of the manufacturer for the effectiveness of his product. However, this will need to be sufficiently detailed to enable an assessment to be made taking into account the organisms to be controlled, the method of application, and the service environment.

Applications for a wood preservative to be assessed for efficacy should be made on form EP/1C. The format has been designed to provide a structured approach in which the completed form together with evidence for the effectiveness claimed provide the basis for the assessment. Although approval under the Regulations is given to a declared specific formulation, efficacy may be judged from test data on the active ingredients within that formulation, unless there is reason to suspect that the effectiveness is modified by co-formulated ingredients. The demonstration of effectiveness against the intended target organism is the responsibility of the applicant. If required, guidance on the type of evidence that will be acceptable can be provided on request; in general it will be of the following types:

(i) documented evidence of long term effectiveness in service. This must be well established; unsupported assurances and absence of customer complaint will not be accepted as evidence.

(ii) field trials of products carried out under simulated service conditions. These must have been running for a period sufficient to demonstrate effectiveness.

(iii) laboratory tests of biocidal effectiveness, together with some demonstration of permanence where necessary. British or European Standard test methods should be used wherever possible. In addition, information on physical attributes (eg penetrability, stability) may also be requested.

Since standard tests are likely to be the most common form of evidence, especially for new biocides, assistance is given in the selection of suitable tests for each intended target organism. These are essentially biological challenge tests and have been tabulated (Tables 1-3) in a form that relates to the format of the application submission.

Table 1 (Document EP/2) lists those tests appropriate for pretreatment systems. It is presented in terms of the categories listed in box 9 of the application form. Most of the tests are carried out in the laboratory and relate to the organisms for which biocidal effectiveness is claimed. It should be noted that where the preservative formulation is intended for use in a relatively severe environment, ie in ground contact or the marine environment, field trial results as evidence of effectiveness are an essential requirement. Such field trials should be continued beyond the minimum requirements laid down in Table 1 for use in subsequent revisions of the approval.

Tables 2 and 3 list tests for insecticidal and fungicidal formulations respectively intended for remedial and in situ applications. Their recommendations are presented in terms of the categories in box 7 of the application form due to the wide range of likely treatment methods. The testing of these treatment systems will be more complex since both eradicant and preventive action need to be considered.

APPLICATION FOR EFFICACY ASSESSMENT OF A WOOD PRESERVATIVE UNDER THE FEPA REGULATIONS

EP/1C

The notes for guidance (page 6) should be read in conjuction with this form.

1 APPLICANT

2 ADDRESS

3 PRODUCT DETAILS (AS SOLD)

NAME

LABEL CLAIMS

Tick boxes as appropriate

CONCENTRATE		READY FOR USE	

SOLID	
LIQUID	
PASTE	
OTHER (BRIEF DESCRIPTION)	

4 FIELD OF APPLICATIONS

Tick one box only

TIMBER PRE-TREATMENT	
IN SITU/REMEDIAL	
PROTECTION OF GREEN TIMBER BEFORE CONVERSION OR USE	

5 FULL DETAILS OF FORMULATION (AS SOLD)

6 METHOD OF PREPRATION FOR USE (IF CONCENTRATE)

7 METHOD OF APPLICATION

Tick boxes as appropriate

BRUSHING AND SPRAYING	
LOCALISED IMPLANT/INJECTION	
IMMERSION	
DIFFUSION	
DOUBLE VACUUM/LOW PRESSURE	
HIGH PRESSURE	
OTHER (BRIEF DESCRIPTION)	

8

CLAIMED EFFICACY AGAINST

Tick boxes as appropriate

BLUE STAIN FUNGI (IN SERVICE)	☐
MOULDS AND SAPSTAIN FUNGI (GREEN TIMBER)	☐
WOOD-ROTTING FUNGI	☐
MARINE BORERS	☐
COMMON FURNITURE BEETLE	☐
HOUSE LONGHORN BEETLE	☐
DEATH WATCH BEETLE	☐
POWDER POST BEETLE	☐
TERMITES	☐
OTHER INSECTS (SPECIFY)	☐

9

SERVICE ENVIRONMENT OF TREATED TIMBER

Tick boxes as appropriate

ABOVE GROUND AND COVERED (DRY)	☐
ABOVE GROUND AND COVERED (RISK OF WETTING)	☐
ABOVE GROUND NOT COVERED BUT COATED	☐
ABOVE GROUND NOT COVERED OR COATED	☐
IN THE GROUND, GROUND CONTACT, OR IN FRESH WATER	☐
IN SEA WATER	☐
WHEN FRESHLY FELLED, IN FOREST OR SAWMILL	☐

Notes for guidance

1 The full name of the marketing company is required.

2 Address to which all correspondence dealing with efficacy testing and clearance should be directed. It would be of assistance if a contact within the company could be named.

3 These details should be restricted to the product as sold by the marketing company. The label claim should include all claims advertised on the labels for which the formulation requires efficacy clearance. Alternatively, a copy of the intended label may be attached to the application form.

4 *Particular attention is drawn to the requirement under this heading that only one box must be ticked. Should more than one field of application be envisaged for the formulation under consideration a second form must be completed to cover this.*

Preservative preparations are seen as falling into three broad categories.

Timber pretreatment includes all processes carried out on timber prior to its intallation where some degree of future protection is intended.

In situ/remedial covers all aspects of eradicant and preservative treatment carried out on timber while it remains in its original service position.

Protection of green timber defines those processes which are applied to timber while in the green state or generally before use either to prevent the growth of moulds and staining fungi or to prevent attack by powder post beetles.

5 The full details of the product's formulation, as sold by the marketing company, must be entered here. This should list all ingredients on a percent m/m basis to give a total of 100 per cent. Descriptions of ingredients must be specific.

6 For those materials defined as concentrates (see note 3 above) full details of the method of preparation for use should be entered here.

7 Full details of the method of application (eg the recommended schedules) should be attached. Some methods may have to be repeated regularly to achieve the protective action claimed by the manufacturer. In such instances the interval between treatments should be included.

9 It is necessary to specify the end-use of preserved timber as this gives some indication of the different attributes required of the preservative. Examples of the categories listed are:

Above ground and covered (dry). Domestic pitched roof timbers.

Above ground and covered (risk of wetting). Swimming pool roofs, some flat roofs.

Above ground not covered but coated. Painted external joinery.

In the ground, ground contact or in fresh water. Fence posts, transmission poles, duck-boards, river lock gates and jetties.

In sea water. Marine piling, harbour and sea defence works.

TABLE 1

Tests available for the assessment of efficacy of pretreatment wood preservative systems

Service environment of treated timber	*Equivalent EHC hazard category*	*Example*	*Moulds*	*Stains*	*Wood-rotting fungi*	*Marine borers*	*Insects(1)*
Above ground and covered (dry)	1	Domestic roof timbers	NA	NA	NA	NA	EN insect ± EN 73
Above ground and covered (risk of wetting)	2	Roof timbers subject to condensation	BS 3900; part G6(2)	EN 152: part 1 or 2	EN 113 ± EN 73	NA	EN insect ± EN 73
Above ground, not covered but coated	3	Painted external joinery	NA	EN 152: part 1 or 2	EN 113 ± EN 73	NA	NA
Above ground, not covered or coated	3	Fence rails	BS 3900: part G6(2)	EN 152: part 1 or 2	EN 113 ±EN73 and EN 113 + En 84	NA	NA
In the ground ground contact, or in fresh water	4	Fence posts, transmission poles	NA	EN 152: part 2	EN soil bed(3) EN 252(4)	NA	NA
In sea water	M	Marine piling	NA	NA	EN(3)	EN(3)	NA
Freshly felled, in forest to sawmill		Green timber	NST	NST	NST	NA	NST

NA = Not normally applicable.

NST = No standard tests available. Effectiveness may be derived from the toxicity of the product to target fungi and the penetration and distribution achieved by the treatment. The latter evidence is also useful as a supplement to the standard biological tests to establish likely long-term performance.

(1) The preservative should be tested against those insects for which effectiveness is claimed, eg *Hylotrupes* EN 46 or EN 47, *Anobium* EN 21 or EN 49.

(2) The standard specifies a method for testing the mould resistance of paint films applied to wood. Adaption of the method for testing the mould resistance of preservative products may be possible in individual cases. For external use the test must preceded by some form of weathering, either natural or artificial. In addition, the NST footnote applies.

(3) European standard tests to be defined later.

(4) This test must be run for a minimum of five years.

TABLE 2

Tests available for the assessment of efficacy of remedial/in situ wood preservative systems
Insecticidal systems

Method Application	*Target Insect*	*Eradicant Action*	*Preventive Action*
Spray, brush or mayonnaise(1)	Anobium Hylotrupes Xestobium(2) Lyctus Termites	EN48(3) EN22 NST N461E NST	EN21 or EN49 ± EN73 EN46 or EN47 ± EN73 NST EN20 ± EN73 EN117 or EN118 ± EN73
Localised injection	Xestobium	NST	NST
Gas/vapour diffusion	All wood borers	NST	NA
Smoke	All wood borers	NST	NA

NST = No standard tests. Effectiveness may be derived from the toxicity of the product to target insects and the penetration and distribution achieved by the treatment. The latter evidence is also useful as a supplement to the standard biological tests to establish likely long term performance.

NA = Not normally applicable.

(1) The standard tests listed do not cover mayonnaise treatments, but the methodology can be adapted for a non-standard assessment.

(2) Efficacy would normally be derived from Anobium Data.

(3) Dilute emulsion products do not normally have immediate eradicant action. In such cases evidence that they have the ability to prevent post-treatment emergence will be required, but there is no standard test that can be recommended.

TABLE 3

Tests available for the assessment of efficacy of remedial/in situ wood preservative systems
Fungicidal systems

Method of Application	*Eradicant Action*	*Preventive Action*
Spray or brush		
– internal constructional timber		
anti-mould	NST	BS 3900: Pt G6(1)
anti-rot	NA	NST
– external timbers		
anti-mould	NST	BS 3900: Pt G6(1)
anti-stain	NST	EN152 Pt 1
anti-rot	NA	NST
Mayonnaise – internal constructional timber	NST	NST
Injection or implants – external joinery	NST	NST
Bandages – poles and heavy structural timber	NST	NST
Gas/vapour diffusion – poles and heavy structural timber	NST	NST

NST = No standard tests. Effectiveness may be derived from the toxicity of the product to target fungi and the penetration and distribution achieved by the treatment. The latter evidence is also useful as a supplement to the standard biological tests to establish likely long term performance.

NA = Not normally applicable.

(1) The standard specifies a method for testing the mould resistance of paint films applied to wood. Adaption of the method for testing the mould resistance of preservative products may be possible in individual cases. For external use the test must be preceeded by some form of weathering, either natural or artificial. In addition the NST footnote applies.

DISCUSSION ON PAPER 8

Chairman: Mr. J. David

THE CHAIRMAN: Thank you very much, John. Dr. Morgan will answer questions, I am sure.

DR. MORGAN: And my colleagues.

THE CHAIRMAN: Can I suggest that if anyone has thought of bringing up the question of confidentiality it be left on one side in view of the ruling of the Court of Appeal yesterday in *Rv. The Licence Authority ex parte Smith, Klein and French Ltd.* which I think has thrown a considerable spanner into the works. No-one knows what it means, but what it means is that confidential information in the hands of Government is no longer confidential where safety is concerned.

DR. MORGAN: Could I make a point there, Joe. In fact, that was after the patent had run out. I think the confidentiality is maintained for a period.

THE CHAIRMAN: It is not actually; it is extended and the general rule is applied. Anyway, can we leave the question of confidentiality on one side, and can I have the first question.

MR. A. R. M. BARR (Catomance): My question refers to the setting of standards in the context of the climate, the philosophy, of moving away from highly aggressive environmentally unacceptable materials towards less aggressive, more environmentally acceptable materials. Can I refer to the table in your paper and the specific reference to lauryl-pentachlophenol. This is a material which, according to the figures we see from you, is likely to be less aggressive, more environmentally acceptable and therefore may be the criteria of one, based on those results, would be in fact artificially too high. May I have your comments.

DR. MORGAN: I know this is a difficult question and I hoped it would be one which would get an airing and some discussion. The view of the H.S.E. and all those concerned with assessing products for safety and efficacy is that in some cases you can trade off a fall in efficacy against a highly desirable product. This is an argument which you can make and you can set the level as low as you like, but sooner or later someone has got to set a level. It seemed to us that if we looked at the general run of preservatives that were available then the level seemed to fall about one.

I think in the case of the particular concern that you have with lauryl penta it would be one where you would be looking then to the other evidence that you could provide of performance. We know, everyone knows, it is weak in test; it always has been. However, we have got to settle on a value, I think, which has some credibility. If we go too low in test, then virtually everything passes and it is no longer a test. I think we have got to set the level at a sensible average or a mean or all-embracing level which encompasses most of the preservatives that we have commercially at the present time and then take it from there and look at the additional data.

MR. J. H. M. WORRINGHAM (Cuprinol Ltd.): I am afraid my question rather mirrors the one that has gone before. Perhaps unsurprisingly I have chosen as an example copper naphthenate. If one looks at the F value you derive for unaged timber then certainly the value is above one, but if you consider the possibility of aging it is quite likely the figure might go below one. There are certain indications from service trials both in the States and certainly here that the relative performance of five per cent pentachlorophenal is wildly different, almost in extremes. I was wondering what would be your comments on how you would view wildly differing types of tests.

DR. MORGAN: I do not think you have told me in what direction it is wildly different.

MR. WORRINGHAM: I think it is fair to say that if you look at the actual test data you are talking about an F value of three to four for five per cent P.C.P., as against approximately one and one point five for copper naphthenate. We certainly have field and L joint test data which indicates you have a reversal of the situation, that, in fact, two point five per cent copper would behave better than five per cent P.C.P.

DR. MORGAN: Well you have not got any worries in that case. The point is that the laboratory tests really are the sort of evidence you have for a new product. If you have got no other evidence to go on, then you have got to use the laboratory test data. If you have got field evidence as well which shows that the laboratory test or some particular quirk of the test procedure does not bring these out in the right order, then you can use that other evidence. I mean, that would override it. Field test evidence would override the laboratory test data. So I do not see any problem for that particular preservative.

MR. WORRINGHAM: I think you have probably answered the question. My concern was the way in which you would view the relative importance of the two types of test.

DR. MORGAN: Well, I said at the beginning that we see the service evidence as being the supreme evidence of performance, but it is very difficult to substantiate. Field trial evidence is the next layer and then finally one goes down to laboratory evidence if you have nothing else.

DR. D. J. DICKINSON (Imperial College): Many of the new compounds which are coming on to the market, John, are being used in the field of post harvest deterioration and sapstain. Would you like to outline the procedures of acceptance there?

DR. MORGAN: We have discussed this in the Panel, but we have not got the same kind of criteria that I have put on the board. I think one of the characteristics of these products is that they can show their effectiveness fairly quickly in a trial whereas most other preservatives cannot. You do not have to wait years twenty years to see if they are any good. So one would really be looking at some form of trial to back up any sort of laboratory tests which were done. I do not think laboratory tests on their own would be sufficient. Do you wish to add to that, Tony?

DR. A. F. BRAVERY: Only to support what you have said and just add one point. The principle of internal reference standards is something we have established in that context as well.

DR. MORGAN: Would you like to say what it is.

DR. DICKINSON: I assume it is P.C.P., is it not.

DR. BRAVERY: Sodium P.C.P. Can I also, if I might, take the opportunity to come back and support what you were saying just now in response to Justin Worringham and Alan Barr, but putting it perhaps the other way round to lend emphasis. If we were to establish F values for some of the newer materials which are coming along now, they would be at a level where many of you would say we cannot possibly accept an F value lower than one; they do not have the field evidence, they have not stood the test of time. I hope that helps to clarify it.

MR. K. THOMAS (Catomance): I think you would agree that however efficacious the products might be in terms of laboratory or whatever other testing, that an incorrectly applied material, however good the product is, would be ineffective in practical use. In view of the difficulties of applying products in a remedial situation, how would you consider evaluating the relative importance of the application and the efficacy of the product from the laboratory test, and furthermore, in view of your comments on penetration, how in a practical, remedial situation would you envisage the penetration tests being carried out?

DR. MORGAN: I think if you look at Tables 2 and 3 which refer to the remedial situation you will see a whole list of N.S.T.'s which stands for "no standard test". We are scratching our heads in the same way as you are. We feel that anyone who operates a remedial process should perhaps have as many ideas as we have on how to establish the effectiveness of the test procedure. I did say that as far as insecticides were concerned the situation is a little easier because there are standard tests, but when it comes to fungicidal products then we would be looking, I suppose, for basic fungicidal activity – I will just look up the table – and some evidence of penetration. However, I really must admit we are still working out our criteria on the remedial side and in some of the other test procedures which we have not dealt with yet, one of which is mould.

MR. L. D. A. SAUNDERS (Fosroc Ltd.): I should like to thank Dr. Morgan for a very lucid presentation of what could all too easily become a very complex subject. I should like to raise a question which, even as I raise it, I realise you may not be in a position to answer. The date upon which all the submissions of data have got to be made may seem a long way away at the moment, but one could envisage a situation where a company submits a product for your clearance. On looking not at the active ingredient but at the full formulation you make the judgement, which it seems only your Panel is in a position to make, that one of the other ingredients in the product gives you cause to suspect that there may be a reduction in activity. Presumably therefore you would send it back to the manufacturer saying you want more test data.

That will take time to generate. The manufacturer may generate data which indicates that the product needs adjustment. Of course the manufacturer will be anxious to adjust the product there and then but the H.S.E. will not be wanting adjustment of that product for some eight to ten months while the clearance is granted. Do you know whether one would be required to suspend sales of a product which you judge deficient or would one be allowed to continue sales of the existing prduct whilst the registration formalities are followed through?

DR. MORGAN: I clearly do not know the answer to that. It is a matter for H.S.E. I do not know if Geoff Wilson is in the audience and whether he would be prepared to have a stab at the answer.

MR. G. WILSON (H.S.E.): Yes. I think the simple solution would be that we would carry on granting that product provisional approval. We would still probably do that and a condition of the provisional approval would be that further efficacy testing was carried out.

THE CHAIRMAN: This must now be the last question.

MR. N. R. TASKER (Buckman Laboratories): In Table 2 of your paper you give as a type of application, spray. Is there any intention of differentiating in the future between an atomised spray and what we class as a discrete droplet type spray or deluge?

DR. MORGAN: I think in terms of our scheme, no, but if you were able to demonstrate that there was a considerable difference in efficacy because of that then there is no reason why you should not introduce it. What we have tried to do is to keep this scheme as simple as possible. The last thing we want to do is to burden the industry with a massive scheme which is almost impossible to operate. So we take it down to being as basically simple as we can. However, if you have evidence that one particular form of application by spray is better than another then produce it by all means and we will consider it.

THE CHAIRMAN: Ladies and Gentlemen, it being 4.30 p.m. and this being the last paper of the Convention I have to draw the proceedings to a close and to thank Dr. Morgan for his presentation. I hope that he will, and I am not being blasphemous, always remember the words of Cromwell to the Council of the Scottish Churches, "I beseech thee in the bowels of Christ think it possible you might be mistaken". He has probably pulled the largest audience of the Convention together, he has given us a very interesting paper, and I think we would like to express our great thanks to you and to do so in the usual way. *(Applause).*

CLOSING ADDRESS BY THE PRESIDENT

We come to the close of the 1988 Convention. If I go briefly through the papers I do so in order to compliment the authors for I trust that you have done your homework. I am not setting out to emulate the Readers Digest.

The trends which I mentioned at the beginning of the Convention with regard to the environment, health and safety and overseas interests with the internationality of wood preservation, have been very adequately borne out by the papers we have heard.

The first paper from Dr. Michael Barnes: copper naphthenate revitalised. You will understand, this was a paper close to my heart. It did concern a type of treatment little used in Europe. Whether it can be used in Europe in the future I think depends on economics and technicalities. This could be a field of conflict in the future. I was disappointed in Dr. Barnes's paper. Where is he? I was disappointed in his presentation. You really do not have the sexy low drawl of all the southerners in the soap operas!

We then come to Dr. Van Steertegem. His written paper was an extremely clear, lucid paper in English which sets out clearly and concisely what is really a very complex situation: what is going to face us in 1992. But if anything exceeded the clarity of his written paper it was the clarity of his spoken presentation. It made one think that when, in future years, Churchill's "History of the English Speaking People" comes to be revised there will have to be a real, deep re-think. The English speaking people are not what they were.

Then to Professor Willeitner and I am sorry he is not here today. He again gave us a very good explanation of the problems that Germany is facing. These are deep problems. I was sorry there was no-one else from German industry here who felt fit to comment on them. We must be aware that these problems could face us over here. It is a situation which is on our threshold. We need to manage it very carefully. We must hope we will do everything we can to avoid that problem coming into this country, but it may do, and it may come in due to factors which are not within our control. If it does, and if this industry is to survive, we must have alternatives in place. I know I am being contentious here, but at the right time, and the time is critical, we must be prepared to tell customers that we have the right materials.

The last paper yesterday was presented by Dr. Valcke on wood staining. He, again, presented excellently in English some very detailed work which provided a sound basis for the Belgium system of assessing their woodstaining and their surface treatments.

This morning we had a Dutch paper from Mr. de Jong and Dr. Kuijvenhoven. This showed another approach to environmental problems. It showed control through a change in the processing of timber and through changes in machinery. I did think you missed a point in the presentation. You showed an example of creosote pollution on water. This is indicative of the level of pollution we have to worry about these days, those beautiful rainbows only come from films whose thickness can be measured in half wavelengths of light. They were very thin films indeed.

The last paper this morning came from Imperial College and the duo of Dr. Dickinson and Dr. Scarlette Gray. My apologies to you, and to Scarlette in particular who presented the paper. Yours was the only paper I missed. I can only plead that I was doing my duty elsewhere talking to the remedial treatment section or being talked to by the remedial treatment section is probably a better way to put it. However, I have reports that this was one of the outstanding presentations of the Convention and I am quite sure that C.C.A. and the authors from Imperial College can stand on their own two feet without my help.

Mr. Pretty presented a very practical paper and a very realistic paper, to introduce those of us who are more concerned with wood preservation to the damp-proofing side. It was well illustrated and a good presentation.

That brings me to Dr. Morgan. John apologised for not having some very pretty slides. All I can say is that he did not need them. This could turn out to be one of the most significant papers that the Association has heard for many years. It may superficially seem that it was of prime concern, only to manufacturers. It was, but you know the rest of the industry can only use what the manufacturers can make. If we cannot make or supply anything then there is nothing that the rest of the industry can use.

John did not talk about Europe. He touched on it. However, I think there is one thing that we have to carry into Europe with us and that is the attitude of our Civil Service. We are going to face more bureaucracy in Europe. There is no way of avoiding this, but we have, and I get the impression it is almost unique within Europe, a Civil Service as a whole and members of the Civil Service personally who are prepared to come and stand in front of an audience such as this and expose their thinking. Thinking at this stage, or so I am assured, is advanced thinking perhaps but it is still thinking. They give us every opportunity to make all the points we want and we know they will take them into consideration. This is something we do not always appreciate. We criticise our Civil Service, sometimes justly, but sometimes unjustly. This they do, and this we must maintain.

This is likely to be John's last paper for a Convention, certainly I believe, John, whilst you are in full-time employment with P.R.L. We may bring you out of retirement. Who knows. It is tempting therefore to refer to it as his swansong. I do not think that would be right. I would like to mix my metaphors a bit and say that, much like the weather of some months in the year: John is going out like a lion.

So, Ladies and Gentlemen, I think we have had an excellent Convention. I bring the formal proceedings of the Convention to a close. I wish you all a good evening in both senses of the word. I hope you will have a good, healthy but not necessarily sober time tonight.

THE BRITISH WOOD PRESERVING ASSOCIATION
1988 ANNUAL CONVENTION – 28th June-1st July

LIST OF DELEGATES AND VISITORS

Total number attending 197

Name	*Company or Organisation*
A	
Anderson, Dr. D. G.	Hicksons World Timber Ltd.
Appert, J. L.	Xylochimie SA
Ashton, C. D.	Homecure Consultants Ltd.
Aston, Dr. D.	Hickson Timber Products Ltd.
Ayris, A.	Cementone-Beaver Ltd.
B	
Baines, Dr. E. F.	Rentokil Ltd.
Bardeleben, W.	Tanalith Ringen
Barnes, Prof. H. M.	Mississippi State University
Barr, A. R. M.	Catomance Ltd.
Baxendale, A.	Cementone-Beaver Ltd.
Beauford, Dr. W.	Bio-kil Chemicals Ltd.
Belford, Dr. D. S.	Personal member
Belford, Mrs. D. S.	Partner
Benni, Dr. L.	Sayerlack Industria
Best, J.	Buckinghamshire College of Higher Education
Betts, W. D.	British Tar Industry Association
Birrell, D.	Rentokil Ltd.
Black, J. F.	Koppers Co. Inc.
Blancquaert, J. P.	Buckman Laboratories
Blow D. P.	Fosroc Ltd.
Blunsom, Ms. J.	Concorde Damp Proofing Co. Ltd.
Braidwood, G. D.	Bitmac Ltd.
Braithwaite, C.	Hickson Timber Products Ltd.
Bravery, Dr. A. F.	Princes Risborough Laboratory
Brennan, D.	Gloster Woodworm Control Ltd.
Bricknell, J. M.	Private Consultant
Briggs, T. D.	Hickson Timber Products Ltd.
Brooks, Dr. F. W.	Fosroc Ltd.
Buchan, E. M.	Hon. Treasurer B.W.P.A.
Buchan, Mrs. E. M.	Partner
Byford, M. D.	Sadolin (UK) Ltd.
C	
Calver, B.	Eastern Electricity
Carmo, Dr. J. M.	Anglo Portuguesa PQ.
Chalmers, I. M.	Calders & Grandidge Ltd.
Chamberlain, J. A.	Catomance Ltd.
Chapman, R.	Schering Chemicals Ltd.
Cheales, N. V.	Rentokil Ltd.
Chiddle, T. C.	Fosroc Ltd.
Christie, Dr. J. R.	Hickson World Timber Ltd.
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Clarke, D. J.	Homecure Consultants Ltd.
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David, Mrs. J.	Partner
David, R.	Rentokil Ltd.
de Jong, D.	Private Consultant
de Jonge, J. T.	Private Consultant
de Mey, C.	Hickson Garantor
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Dicker, P.-E.	Prolignum AB
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Mullen, T.	Koppers Australia
Murphy, Dr. R. J.	Imperial College

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