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RESEARCH INSTITUTE OF WOOD INDUSTRY (CRIWI), CHINESE ACADEMY OF FORESTRY (CAF)

Synthesis of novelty borate compounds for wood preservatives: Laboratory test of leachability and decay resistance

IRG/WP 10-30520

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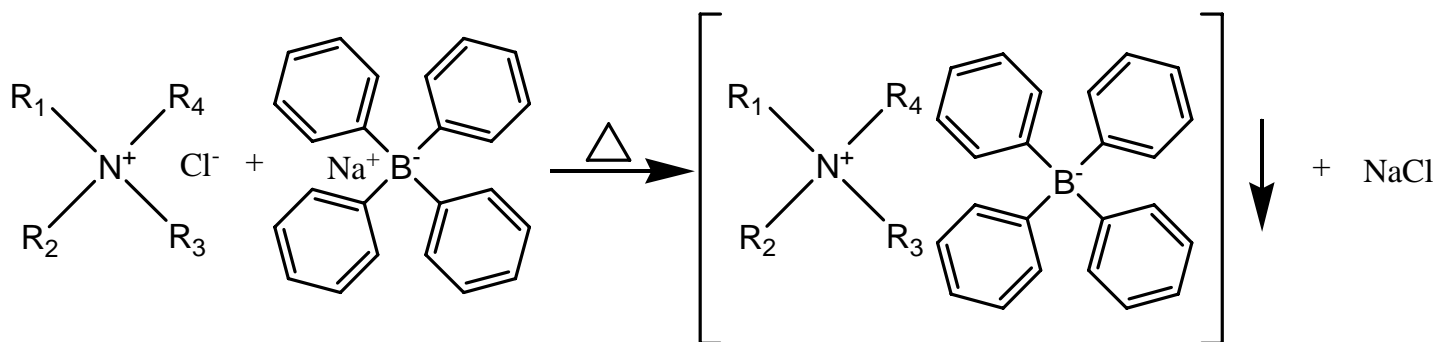


1. INTRODUCTION

- Inorganic borates are effective and environmental friendly as wood preservatives and offer good protection to timber in indoor applications.
- Borates can not be used in exterior circumstance for they are likely to leach out from treated wood
- In order to look for borates in exterior applications, the present research was conducted.

2. EXPERIMENTAL METHODS

■ 2.1 Synthesis of ammonium tetraphenylborate (ATB) and borate chemical compounds (BBC)



DDAT: C 85.55, H 10.61, N 2.17, B 1.67 (wt %, calculated); C 85.83, H 10.67, N 2.27, B 1.23 (found). m. p. 90.5-90.9°C.

BAT: C 86.65, H 9.37, N 2.25, B 1.73 (wt %, calculated); C 86.78, H 9.41, N 2.22, B 1.59 (found). m. p. 140.0-141.3°C.



2.1.2 Synthesis of borate chemical compounds (BBC)

BBC were synthesized by the reaction of fluoroborate sodium aqueous solution and quaternary ammonium compound

2.2 Wood specimens and treatment

- The samples for leaching test:
Masson pine (*Pinus massonina*) sapwood,
20(L)×20(T)×20(R) mm, 4 replicas.
- 20×20×10 (L) mm for decay test
- 25×25×6 (L) mm for termite test

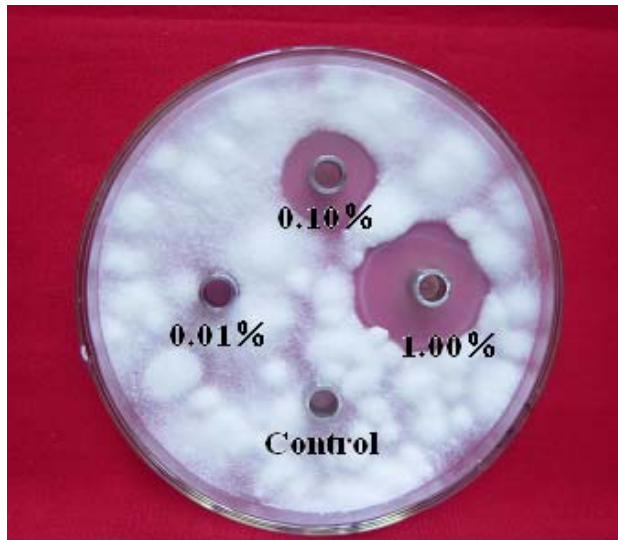


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2.3 Leaching procedure

- According to AWPA 2007 E11
- **Vacuum process:** at 8×10^3 Pa for 5-10 min, at atmospheric pressure for 20-30min
- The total retention was calculated based on the preservative absorption and density of the samples.

2. 4 Test of inhibition zone



Oxford cup method

White-rot fungus
Phanerochaete
chrysosporium (P. C.)

Brown-rot fungus
Gloeophyllum trabeum
(G. T.)

According to test method of Drug Compendium appendix XI A (2000) of China.



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2. 5 Decay Test

- According to Chinese standard GB/T13942.1-92 and LY/T 1283-1998
- White-rot fungus *Coriolus versicolor* (C.V.)
Brown-rot fungus *Gloeophyllum trabeum* (G. T.)



2. 6 Termite Test

- According to AWPA standard E1-09.
- Termites (*Coptotermes formosanus* Shiraki.).



3. RESULTS AND DISCUSSION



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3.1 Leachability of ATB and BBC

Preservatives	Concentration (%)	Retention (kg/m ³)	Boron leaching rate (%)
DDAT	2	10.50	2.7
	1	5.07	6.7
BAT	2	10.22	2.1
	1	4.89	5.9
BBC1	2	12.14	57.8
	1	6.17	59.0
BBC2	2	12.49	23.3
	1	6.81	35.0



- Formulation of DDAT and BAT had the lowest boron leaching rate, it was less than 6.7%.
- Boron leaching rate of BBC1 and BBC2 were 57.8-59.0 % and 23.3-35.0 %, respectively.
- The higher retention of the formulation with the lower boron leaching rate from the wood.



CRIWI 3.2 Test of inhibition zone

Fungicides	Concentrations (%)	Diameter of inhibition zone(mm)	
		G. T.	P. C.
DDAT	0.01	8.9	0
	0.10	17.9	0
	1.00	17.5	10.1
BAT	0.01	0	0
	0.10	0	0
	1.00	22.5	14.7
BBC1	0.01	13.4	15.6
	0.10	26.2	21.6
	1.00	33.1	27.4
BBC2	0.01	11.4	12.8
	0.10	41.5	20.3
	1.00	55.6	23.6



- BBC could almost inhibit all the fungi at all test concentrations (0.01%, 0.10%, 1.00%).
- DDAT was effective for inhibiting G. T. and P. C. at the concentration 1%, but no effective for inhibiting P. C. at the concentration of 0.01% and 0.1%.
- BAT was only effective for inhibiting G. T. and P. C. at the higher concentration of 1%.



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3.3 Decay test

Preservative	Concentration (%)	Retention (kg/m³)	C.V. weight loss (%)	G.T. weight loss (%)
BBC1	1	7.04	2.5	1.4
	2	14.80	0.3	0
BBC2	1	7.16	3.8	2.6
	2	14.78	3.2	1.2
BAC	1	6.59	9.7	11.5
Untreated	/	/	43.1	60.7



- Mass loss of masson pine sapwood treated by BBC1 and BBC2 solutions were 1.4% -2.6% (by G. T.) and 2.5%-3.8% (by C.V.) at the retention around 7.0kg/m³
- Mass loss of BAC treated wood were 11.5% (G. T.) and 9.7 % (C. V.) at the equivalent retention.
- Mass loss of untreated wood was 60.7% (G. T.) and 43.1 % (C. V.).

3.4 Termite test

Preservatives	Retention (Kg/m ³)	Termite level	Weight loss (%)	Mortality rate of termite (%)
DDAT	23.06	8.5	13.79	100.0
	9.86	7.5	16.88	99.3
BAT	20.77	8.5	13.27	100.0
	9.80	7	25.64	96.6
BBC1	22.86	10	8.56	100.0
	9.82	9.67	10.18	98.1
BBC2	23.85	10	2.87	54.3
	10.09	9.5	4.76	59.6
Untreated	/	4	30.34	37.8



- Termite level of untreated wood was 4, mass loss was 30.3%
- Termite level of BBC treated wood were 9.5 ~ 10, mass loss were between 2.7 ~ 12.8%
- Termite level of DDAT and BAT treated wood 7 ~ 8.5, mass loss were between 13.3 ~ 25.6%.
- BBC with better anti-termite properties than ATB



4. CONCLUSIONS

- Ammonium tetrphenylborate (ATB) and borate chemical compounds (BBC) were synthesized and confirmed by micro-elemental analysis and melting points.
- Boron leaching rate of ATB formulations was 2.1% - 6.7%, while that of BBC formulations 23.3% - 59.0%.
- BBC could inhibit G. T. and P. C. at all the concentrations by laboratory inhibition zone test, while DDAT and BAT had poor effect on the two test fungi.
- At the retention around 7.0kg/m^3 , mass loss of masson pine sapwood treated by BBC1 and BBC2 solutions were less than or around 3.0% by G. T. and C. V..
- Termite level of BBC treated wood were 9.5 ~ 10, ATB was only 7 ~ 8.5.



Acknowledgment:

**This research was supported by
China national 11th five-year plan project
2006BAD18B09.**

Thank you for your attention!

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