Termiticidal Performance of Zinc Borate-Incorporated Particleboard: Effects of leaching on efficacy

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Background

- Increased utilization of WBC
  - Depletion of high quality wood
  - Wide acceptance in construction
  - New composite technologies
- Protection requirements for WBC
  - moisture, weather, biological agents (decay fungi, insects, and marine borers) and fire when used in the exposed outdoor environments

WBC Treatment methods

Post-treatment

- Advantages
  - Easy to apply
  - No or minimal modification in manufacturing process
  - Processing of treated material not an issue
- Disadvantages
  - Envelope protection only
  - No processing after treatment
  - Effects on mechanical and physical properties

In-process treatment

- Advantages
  - Protection throughout the cross section
  - Processing at anytime
- Disadvantages
  - Chemical interaction with adhesion
  - Effects on mechanical properties
  - Emissions during manufacturing and processing

Why zinc borate?

- High toxicity to wood destroying insects, fungi
- Low mammalian toxicity and excellent environmental record
- Thermally stable up to 290 ° C
- Resistance to leaching
- Stable to UV radiation
- Very minor modifications in the manufacturing process
- Relatively low cost
- Odorless, colorless , non-corrosive and near natural pH

Objectives

- to examine feasibility of ZnB in particleboard manufacturing
- to investigate the effectiveness of ZnB retention levels on decay and termite attack through laboratory tests
- to evaluate addition of ZnB on mechanical properties
- to monitor leaching characteristics of Zn B

Materials and methods (1)

Raw materials

- Wood particles; mixed wood species generated from demolished construction material.
- Adhesive; pMDI
- Biocide; zinc borate ($2ZnO.3B_2O_3.\ 3.5H_2O$), white, odorless, powder.

Chemical analysis

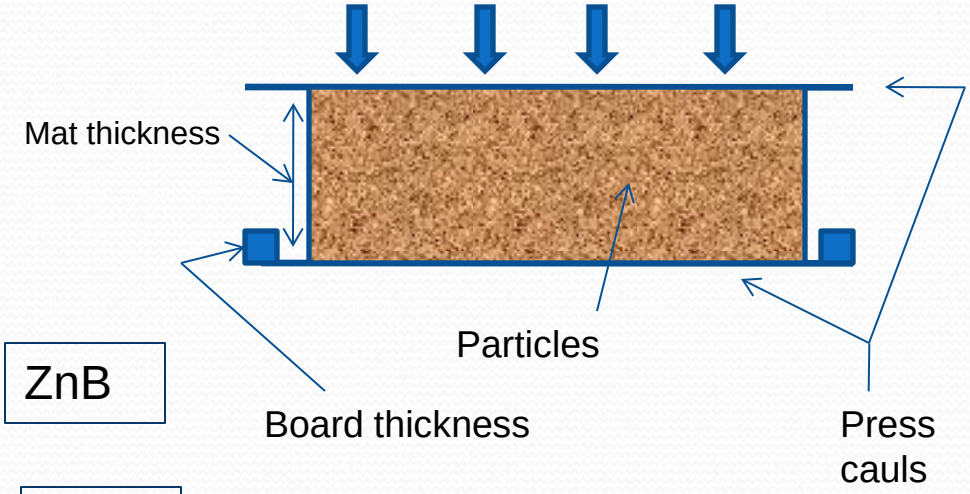
- AWPA A-7 “wet ashing process in boiling nitric acid”
- ICP (Inductively Coupled Plasma) spectrometer

Manufacturing process

Raw material → Screening → Air drying → Blending → Mat forming → Cold pre-press → Hot pressing → Conditioning

ZnB → Blending

resin → Blending



Materials and methods (2)

Mechanical properties

- JIS A 5908 “static three-point bending”
- Determination MOR and MOE

Materials and methods (3)

Leaching test

- A robust leaching procedure, leaching water amount 10 times of the specimen volume
- 10 cycles, 8 h immersing in DI water followed by 16 h drying at 60°C in a circulating type dryer.

Laboratory decay and termite resistance

- Laboratory decay test according to JIS K 1571
- Specimen size 28 x 20 x 15 mm, 9 replicates for each treatment
- Laboratory termite tests according to JWPS-TW-P.1
- Specimens size 20 x 13 x 15 mm, 5 replicates for each tretament

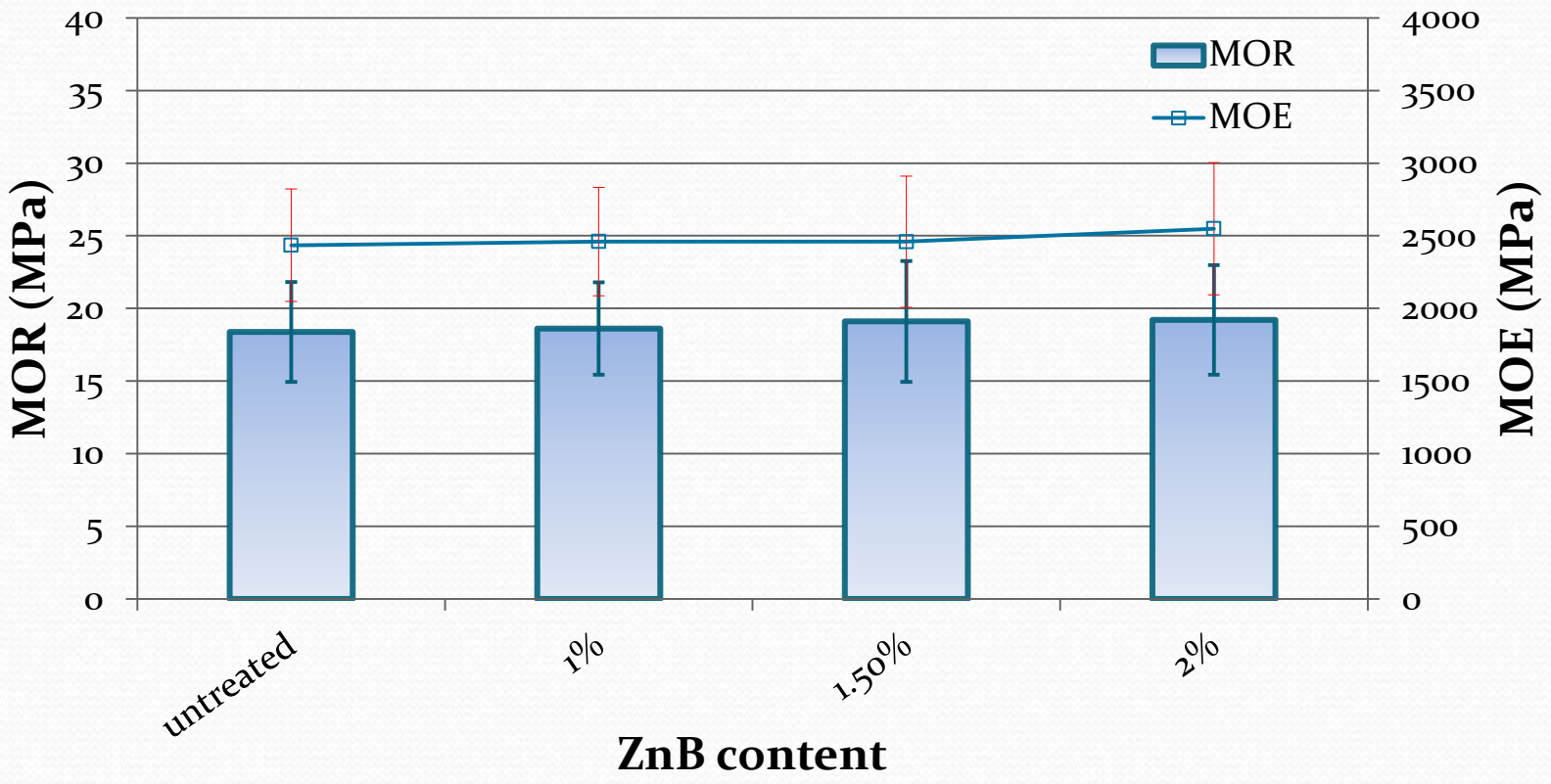
Results (1): Chemical analysis

Mean zinc borate contents (as % BAE, Boric Acid Equivalent) in particle boards before and after leaching procedure (mean of 3 replicates- values in parentheses are standard deviations.)

Target ZnB content (w/w)		**Measured ZnB content, Unleached**		**Measured ZnB content, Leached**	
As % ZnB	As % BAE	Based on B	Based on Zn	Based on B	Based on Zn
0.00	0.00	0.01 (0.02)	0.02 (0.02)	0.01 (0.02)	0.02 (0.02)
1.00	0.85	0.87 (0.10)	0.87 (0.10)	0.38 (0.17)	0.90 (0.08)
1.50	1.28	1.46 (0.10)	1.46 (0.10)	0.76 (0.21)	1.41 (0.07)
2.00	1.71	1.85 (0.13)	1.86 (0.10)	1.14 (0.15)	1.89 (0.17)

Results (2): Mechanical properties

Effects on mechanical properties (MOR and MOE)
(error bars indicate ± standard deviation of 9 replicates)



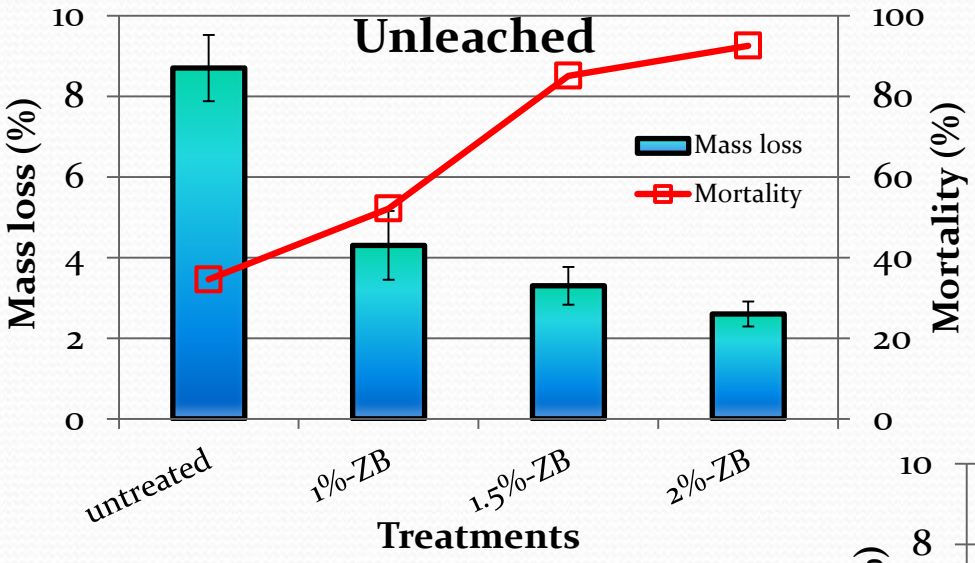
Results (3): Decay test

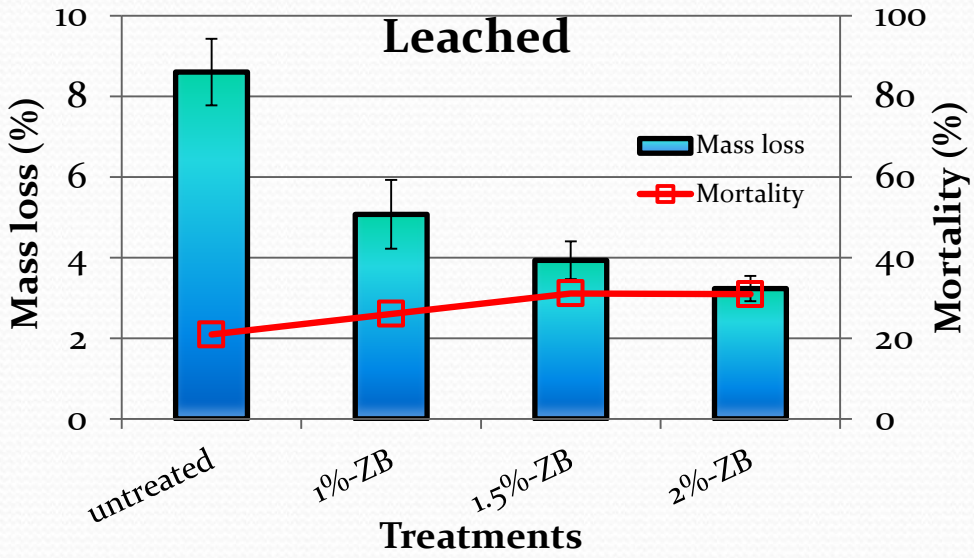
Mean percent mass loss of zinc borate–incorporated particle boards exposed to *Trametes versicolor* and *Fomitopsis palustris* for 12 weeks (mean of 9 specimens – values in parantheses are standard deviations).

ZnB content (%)	***T. versicolor***		***F. palustris***	
	Unleached	Leached	Unleached	Leached
0	4.5 (5.52)	24.8 (2.48)	4.4 (2.16)	18.1 (3.98)
1	0.1 (0.10)	0.0 (0.00)	0.0 (0.00)	13.2 (12.40)
1.5	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.4 (0.28)
2	0.0 (0.00)	0.0 (0.00)	0.2 (0.26)	0.1 (0.28)
Sugi sapwood	38.2 (3.68)	-	41.4 (3.54)	-

Results (4): Termite tests

Mean mass loss (%) and morality (%) of zinc borate –incorporated particle boards after exposure to *Coptotermes formosanus* for 3 weeks.





Termicitidal performance

Visual rating and comparison

Clockwise from upper left; untreated, 1%, 1.5% and 2%

Conclusions

1) In-process incorporation of ZnB proven to be feasible in protecting particleboards from decay and termite attacks
2) ZnB was not lost during the manufacturing process
3) No detrimental effect on MOR and MOE was seen
4) Threshold value for decay protection would be 1.5% ZnB for both unleached and leached specimens
5) Termite protection requires a minimum of 2% ZnB
6) In general , ZnB is resistant to short-term robust leaching but some boron (B) lost was detected.

Thank you for your time.

Questions & comments ?