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ANCILLARY PROPERTIES OF VAPOR BORON-TREATED COMPOSITES

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ANCILLARY PROPERTIES OF VAPOR BORON-TREATED COMPOSITES[1]

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Abstract
This paper discusses the water absorption, thickness swelling, and internal bond strength of North American composites treated using a vapor boron treatment process. For oriented strandboard, high boron loadings led to lower internal bond strength and lower thickness swelling. Water absorption results were variable but no deleterious effect of treatment was noted. For medium density fiberboard, the highest loadings led to reduced internal bond strength. Thickness swelling decreased with increasing boron level, but not significantly. As with OSB, water absorption results varied.

Introduction

Composite products, like oriented strandboard and medium density fiberboard, are increasing in today's building practices. These products are used as sheathing and siding material for buildings, which exposes them to wood destroying insects and fungi. Companies that manufacture wood based composites are interested in treating the panels with wood preservatives that prevent insect and fungus damage.

Problems can arise when preservatives are added to composite board furnish prior to manufacture including poor gluebond quality, interference with resin curing, and reduced mechanical properties (Laks and Palardy 1993). Post-treatment addition of preservatives can result in thickness swelling, over-absorption of preservative, and disposal problems. Vapor phase boron treatment (VBT) eliminates many of these problems (Bergervoet *et al.* 1992, Burton *et al.* 1990, Murphy *et al.* 1993). The major problem with VBT is the production of methyl alcohol during the treatment phase.

The objective of this work was to evaluate some of the physical properties of VBT composites made with North American wood species, and to ascertain the effect of the treatment on the board properties.

Methods and Materials

Materials--Oriented strandboard (OSB) manufactured from mixed southern pine and southern hardwood furnish (SO) or from mixed northeastern conifer and hardwood furnish (NE) was acquired from commercial producers. The SO-OSB was bonded with liquid phenol-formaldehyde resin and the NE-OSB was bonded with a powdered phenol-formaldehyde resin. Commercial medium density fiberboard (MDF) intended for the siding market and manufactured from southern hardwood furnish (SO) or northern hardwood (NO) furnish were included in the study. The SO-MDF was a wet process board and the NO-MDF was a dry process board. Both were bonded with a phenol-formaldehyde resin.

Treatment--The composites were shipped to the Imperial College of Science, Technology and Medicine in London, England where they were vapor phase treated with trimethyl borate as has been described elsewhere (Hashim, *et al.* 1992, 1994). Each type of composite was treated to different retention levels in a 0.8 m^3 treatment vessel. Samples were separated by

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3-mm stickers and loaded into the vessel. The vessel was evacuated to 5 mbar and a metered amount of trimethyl borate sufficient to achieve the target retentions was admitted. Gas contact time was 8 h for the high retention and 40 min for the medium retention level. Comparison was with untreated controls.

Testing Methods--Standard ASTM D1037 (1997) testing procedures were followed for the internal bond, water absorption, and thickness swell tests except that the samples used in the water absorption and thickness swell tests were 75 x 75 mm x nominal thickness of the panel. Five test specimens from each composite at each treatment level were tested in the internal bond and water soak tests. Test specimens were cut from the remnants of mechanical property tests conducted in another phase of the study. Data were analyzed using analysis of variance and mean separation techniques.

Results and Discussion

Internal Bond Strength--The results of the internal bond tests are shown in Table 1. Internal bond values decreased as the treatment level increased in both the SO and NE boards. Statistical analysis indicated that both boron retention level and mill location were significant main effects, but the interaction between the two was not significant. Mean comparisons are shown in Table 2. Treatment to the highest boron retention significantly reduced internal bond strength, but at the medium retention which is effective against decay and termites, no significant reduction was seen. The board from the southern mill had a significantly higher IB strength. This is attributed to the difference in furnish type

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Table 1. Comparison of mean internal bond test results for VBT oriented strandboard and medium density fiberboard.

Mill Location	Treatment Level (%w/w BAE)	Density (kg/m^3)	Internal Bond (kPa)
Oriented strandboard			
SO	High (6.46)	721	234
SO	Medium (1.08)	721	400
SO	Control (0.00)	721	448
NE	High (5.78)	689	221
NE	Medium (0.82)	689	338
NE	Control (0.00)	689	352
Medium density fiberboard			
SO	High (4.08)	977	938
SO	Medium (0.86)	977	1,152
SO	Control (0.00)	977	1,234
NO	High (5.68)	913	469
NO	Medium (1.04)	913	655
NO	Control (0.00)	913	634

Table 2. Comparison of mean internal bond values for OSB and MDF.

Mean	Internal Bond (kPa)
Oriented strandboard	
Retention	
Control	398 A
Medium	372 A
High	230 B
Location	
SO	362 A
NE	304 B
Medium density fiberboard	
Location	
SO	1,108 A
NO	587 B
Means not followed by a common letter differ one from another at p = 0.05.	

The internal bond results for medium density fiberboard are shown in Table 1 with mean comparisons in Table 2. Analysis of variance indicated that mill location was the only significant factor affecting IB strength. This is attributed to not only furnish differences, but also to process differences. The SO-MDF was a wet process board compared to the NO-MDF which was a dry process board. One might reasonably expect better fiber-fiber bonding in the wet process board. Treatment had no deleterious effect on the IB strength of MDF.

Thickness swelling/water absorption--The results of the water absorption and thickness swelling tests are shown in Table 3. There was a significant interaction between mill location and treatment level for both 2-h and 24-h thickness swelling values. Comparison of mean values for OSB indicated no deleterious effect of treatment on 2- or 24-h thickness swell. All mean thickness swelling and water absorption values for treated OSB were equal to or lower than the untreated controls. This is thought to occur because most of the irreversible thickness swelling in the OSB samples occurred during the treatment phase where methanol is produced. According to Stamm (1964), the relative swelling of wood in methanol compared to water is 95%.

Table 3. Mean thickness swelling and water absorption values after two and 24 hours of exposure.[1]

Mill Location	Treatment Level (%w/w BAE)	2-Hour Thickness Swell (%)	2-Hour Water Absorption (%)	24-Hour Thickness Swell (%)	24-Hour Water Absorption (%)
Oriented Strandboard					
SO	High (6.09)	5.45 C	21.90 B	11.17 C	41.45 B
SO	Medium (1.21)	5.06 C	10.39 B	14.54 C	30.80 B
SO	Control (0.00)	16.07 A	34.20 A	27.16 A	59.88 A
NE	High (5.74)	5.36 C	16.22 B	12.36 C	38.85 B
NE	Medium (0.78)	12.00 B	20.22 B	21.28 B	46.67 B
NE	Control (0.00)	11.34 B	20.57 B	20.84 B	47.00 B
Medium Density Fiberboard					
SO	High (4.19)	2.00	3.21	8.16	9.84
SO	Medium (0.91)	3.09	3.16	9.03	9.23
SO	Control (0.00)	2.67	2.77	9.39	9.14
NO	High (5.71)	2.73	3.79	6.37	12.61
NO	Medium (1.13)	2.86	2.67	5.47	9.07
NO	Control (0.00)	3.59	2.98	7.41	10.81

[1] Means not followed by a common letter are statistically different at $p = 0.05$.

A slightly different result was obtained with the medium density fiberboard. For the 2-h thickness swell, only treatment level was significant. The control swelling value (3.1%) was significantly higher than the high retention value (2.4%) with the medium retention value (3.0%) between the two. Again, treatment had no deleterious effect as discussed above. For the 24-h exposure, mill location was the only significant variable. This is interpreted as being a result of furnish and process differences.

For 2-h water absorption in OSB, there was a significant interaction between mill location and treatment level. Mean comparisons showed that the SO control was significantly higher than all remaining combinations. The same was true for the 24-h soaking period thus no deleterious effect of treatment on water absorption was demonstrated.

There was no significant effect of treatment level, mill location, or their interaction on 2-hour water absorption in medium density fiberboard. For the 24-h period both mill location and treatment level were significant. Comparison of means showed that the high retention level (11.2%) was equal to the control (10.0%), but significantly higher than the medium retention (9.2%). This is interpreted as indicating no increase in water absorption as a result of treatment. The furnish type/process effect was shown in the significant difference between mill locations (SO-9.4% vs. NO-10.8%).

Conclusions

The results from this study helped to define the effects of vapor phase boron treatment on the physical properties of different wood composites. OSB internal bond values were negatively affected by the treatment at the highest retentions, but for retentions effective against termites and fungi no deleterious effects were noted. For MDF no retention effects were noted. Mill location effects in OSB were attributed to furnish differences. In MDF, mill location effects were also attributed to process (wet vs. dry) differences. No negative effects of treatment were found with thickness swelling or water absorption for OSB or MDF. In general, treated boards have less thickness swelling and water absorption than treated boards. This was attributed to the swelling due to methanol production during the treating phase.

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