SEMI-ANNUAL PROGRESS REPORT

USE OF MELAMINE BASED ADHESIVES FOR COMPOSITE PRODUCTS

By

Kenneth D. Roos
Research Fellow

March 1994
Subaccount No. 544252
NRRI/TR-94/08

Prepared for:

Minnesota Technology, Inc.
111 Third Avenue South, Suite 400
Minneapolis, MN 55401

Natural Resources Research Institute
University of Minnesota, Duluth
5013 Miller Trunk Highway
Duluth, Minnesota 55811

Use of Melamine Based Adhesives for Composite Products

Semi-Annual Progress and Financial Report For Minnesota Technology, Inc.

Coordinator: Kenneth D. Roos

Reporting Period: July 1, 1993 - December 31, 1993

Objective: To manufacture and evaluate structural flakeboard (OSB), steam injected composite material and I-joists using a new catalyzed melamine adhesive system developed in Europe.

Background: In the production of structural flakeboard, phenol formaldehyde (PF) adhesives have historically been used. These adhesives are available in both liquid and powder form. They provide for a water resistant bond between the strands. However, these resins are intolerant of high moisture content wood furnish. Therefore, strands used for the production of flakeboard must be dried down to three to five percent moisture content prior to blending. This excessive drying causes problems in both the production and in-service use of flakeboard.

Drying wood strands from green to dry conditions is the largest contributor to volatile organic compound (VOC) emissions from flakeboard mills. The development of moisture resistant resin systems can drastically reduce these emissions. One resin system that can utilize high moisture content furnish is isocyanate (MDI) based. This system, while currently being used in several mills across North America, has a number of industrial hygiene problems associated with it.

Conventional pressing of flakeboard with phenolic resins results in flakeboard panels with very low moisture contents coming out of the press. These panels when placed in service must equilibrate to the moisture content of their surroundings. This often results in excessive edge swelling of the panels; a condition that causes problems in construction. A higher post-pressing moisture content when higher moisture content furnish is used can potentially aid in the reduction of edge swell.

Successful demonstration of a melamine adhesive system in conventional process flakeboard could result in stronger, more dimensionally stable composite panels. Also, the possible reduction of VOCs from processing facilities could aid in the air compliance regulations of these mills. Melamine based adhesives tend to be compatible with a wide range of preservatives. This could allow for the production of treated flakeboard products.

Summary of Progress: This report covers the oriented strandboard work. We have completed all of the panel manufacturing of the oriented strandboard for this project. Most of the testing has been completed and analysis is in progress.

Several parameters were varied in this investigation to best approximate the manufacturing conditions in OSB mills currently using phenolic and isocyanate binders. These were furnish moisture content; experimental adhesive types; adhesive addition levels; and press cycles. Quaking aspen and other mixed species strands were obtained from Potlatch Corporation, Grand

Rapids. The strands obtained from the mill were at 3.5 percent moisture content. This moisture content level and 5 percent and 7.5 percent were used for our three levels. Two melamine formulations were evaluated. These were Dynomel L-420 and Dynomel L-470. Both of these resins were catalyzed with an ammonium chloride solution. The catalyst was applied prior to blending, and applied through a Coil Spinning Disc Atomizer. A wax emulsion was applied to every batch of blended strands. Three resin addition levels were explored for each adhesive formulation. With the Dynomel L-420 these addition rates were 3.75 percent, 4.25 percent, and 5.0 percent solids.

Oriented panels, 24-inches by 24-inches by 1/2-inch thick, with a target density of 40 lbs/cu ft were pressed at a platen temperature of 380°F. Two pressing schedules were followed. The first simulated a conservative phenol formaldehyde pressing schedule of 5.5 minutes and the second a conservative isocyanate schedule of 4.5 minutes.

Thirty-six experimental panel combinations, eighteen for each adhesive type, were produced. Five test panels were pressed for each combination. In addition, five phenolic controls using 3.3 percent resin and five isocyanate controls using 2.0 percent resin were manufactured. All panels were hot stacked for a minimum of twenty-four hours prior to test sample preparation.

Each combination was evaluated for physical and mechanical panel properties. Each panel was cut into two parallel static bending samples; five internal bond samples; five Minnesota Shear Test samples; two water absorption/thickness swell samples; two linear expansion specimens; and control, single cycle, and six cycle durability samples. Panels were evaluated in accordance with ASTM D-1037 and APA P-1, D-4, and D-5 test methods. Descriptive statistics were generated for each property and effect. Combinations were evaluated statistically for significant differences between properties due to effects.

At the time of this report we have finished testing and preliminary analysis of the Dynomel L-420 and will focus our results discussion on this adhesive system.

The L-420 is a water based adhesive system. The resin mixed easily with the catalyst. There were no problems encountered in applying the resin through the spinning disc atomizer. No build-up or clogs were encountered over the several days of panel production. The resin was compatible with the wax emulsion used in this study, therefore, allowing the use of the same application line to feed both the resin and wax. The resin cleaned up readily with warm water, no solvents were needed. The blended strands were clean, non odorous, and presented no handling problems. Mats were easily formed.

During the pressing of the mats no noxious fumes were detected. There was no increase in blown panels detected at the elevated moisture contents and short press time. No sticking problems were noticed with the adhesive. Panels released readily from the caul sheets. The finished panel had a very pleasing aesthetic properties with no detectable resin spots since this resin is a "white resin." No problems were observed in cutting of the panels into test specimens.

Preliminary analysis indicated there was no difference in property values due to the length of the pressing cycle for the melamine adhesive. Therefore, the data from the two press cycles were combined for this report. This situation was not surprising given that the melamine has a lower set temperature similar to isocyanate resins. It was not the intent in this experiment to optimize pressing cycles. However, future research should be conducted to optimize this parameter.

The L-420 resulted in mechanical properties that were very comparable to the PF and MDI resin and in many cases somewhat better. It appears that the L-420 does well with the higher moisture content furnish. While we used 3.75 percent L-420 as our lowest level, the mechanical data suggest that the adhesive level can be reduced somewhat further. In-depth analyses will be performed on the data, and observations reported.

The L-420 resulted in physical properties that are comparable and in many instances somewhat better than either the PF or MDI resin. Also, given the optimal moisture content, it appears that we can further reduce the amount of L-420 while maintaining desired properties. As with the mechanical data, more in-depth analyses will be performed on the data.

We are currently in the process of testing the mechanical and physical properties of Dynomel L-470 adhesive system. At the conclusion of testing and analysis of this resin we will prepare a technical report presenting the technical feasibility and mill considerations of using these two adhesive systems in the production of oriented strandboard.

The LVL and I-beam adhesive evaluations are currently starting. We are scheduled to produce the steam injection panels in late February, early March at the Forest Products Laboratory in Madison, WI. We are currently on schedule with this project and should be finished in June.

Conclusions: The preliminary data indicate that Dynomel L-420 can be used as a binder in oriented strandboard and produced panels with mechanical and physical properties equivalent to other binder systems currently being utilized in the flakeboard industry. Further analysis should lead to more conclusive evidence of the technical viability of this resin system.