Letters to the Editor

Fifteenth International Particleboard Symposium Held at Washington State University *
Structural Products, Special Considerations and Binders

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Some 25 countries were represented at the 15th International Particleboard Symposium held at Washington State University in March-April 1981. The main subjects of discussion were structural products; special considerations, which covered computer controls and collecting fines from dryers; and binders, highlighting formaldehyde release and isocyanate binders.

It is difficult today to discuss only panels when considering the many different types of glued materials now under development or already in the marketplace. An example of a glued product currently in the marketplace is a composite of veneer and particleboard. This is made with veneer on the faces and particles in the core, and is also now being made with veneer on the faces and veneer in the very center of the panel, with layers of particleboard between the core veneer and the face veneers. Molded particleboard has been manufactured for many years in small amounts. It appears that this type of product will be expanded in the marketplace, and components of several different materials will eventually become commonplace.

The nature and supply of the resources used to manufacture structural board products is constantly changing throughout the world. In the United States, the amount of the eastern hardwood and southern pine timber resource is very large and is increasing in volume. The western softwood resource has been declining recently and will continue to do so until the next crop of forest reaches maturity. It has already been noted how the changing timber resource and the emphasis on energy self-sufficiency has changed the softwood plywood industry. These factors are some of the major reasons for the many developments taking place in the area of structural composition board and composite board materials

Work is moving ahead rapidly on developing means for economically harvesting and cleaning previously unused forest residues and trees which previously had a low commercial value. It is well recognized that composition materials made from wood have higher adhesive costs than other forest products. Thus, significant efforts are underway to develop new adhesives systems and to devise means to make the present adhesives systems function more effectively, thus allowing a reduction in the amount of adhesives used in the product. Other efforts are directed toward developing information on the engineering properties of these new structural materials. This must be done in a well organized way so the new materials can be used properly in all types of construction.

Throughout the world, the availability of large trees which will yield clear lumber is rare. Few forests are now being allowed to grow to a size where such lumber can be manufactured. This provides an opportunity for the producers of wood composition materials to produce interior and exterior products as a substitute for clear lumber. Current research is providing the means for producing such material, which has very fine surfaces, of either particles or fiber. In addition, the core layers of the product can have oriented strands to provide both desired strength and dimensional stability.

Research and development on the composite product known as COM-PLY is showing that the panels will require cores made with oriented particles in order to be similar to plywood in dimensional stability. Consequently, the furnishes for the core layers will need to have high proportions of slender particles which can be aligned in the cross-panel direction. Longitudinal linear expansion of such panels will be determined largely by the longitudinal stability of the face veneers. It was

* Previous symposia have been reviewed in Wood Science and Technology as follows: Vol. 1, 1967, pp. 239–240; Vol. 2, 1968, pp. 231–232; Vol. 3, 1969, pp. 175–176; Vol. 4, 1970, pp. 313–314; Vol. 5, 1971, pp. 313–314; Vol. 6, 1972, pp. 314–316; Vol. 7; 1973, pp. 317–320; Vol. 9, 1975, pp. 75–79; Vol. 10, 1976, pp. 155-157; Vol. 11, 1977, pp. 79–81; Vol. 11, 1977, pp. 319–321; Vol. 13, 1979, pp. 311–313; Vol. 14, 1980, pp. 311–313; and Vol. 15, pp. 317–319

found that orientable furnishes, even if prepared from low quality raw materials such as planer shavings, can produce oriented boards with about the same linear expansion and modulus of elasticity as randomly oriented particleboards made from drum-cut and ring-cut flakes. This information illustrates the tremendous upgrading of low quality furnish which can occur as a result of orientation.

Over the past several years, much research and development has taken place to provide a method of evaluating panel durability with respect to structural performance as part of the program for establishing performance-based standards. A method which uses a single-cycle laboratory exposure followed by measurement of structural performance with tests such as concentrated static and impact loads, uniform loads, and fastener holding power as a means for measuring structural-use panel durability, has been developed. Materials demonstrating satisfactory performance after this evaluation should meet the levels of durability found in the North American light-frame construction markets. This does not include a recommendation for use where the products are permanently exposed to exterior conditions. Indeed, from the standpoint of practical field experience, products for this particular market should only be exposed to the elements for a short period of time. For example, six months of such exposure is not recommended, and products should be covered and protected from the weather well before such a time period has elapsed.

For many years, scientists, engineers, and technologists involved in trying to reduce dimensional changes in various types of particleboard due to changes in environment over time, have found themselves faced with a difficult challenge. Dimensional changes resulting from external exposure in virtually all products, including those bonded with phenol formaldehyde, have been found to be considerable. Loss in strength of urea formaldehyde bonded particleboards under changing humidity conditions appears to be due to mechanical fatigue of the adhesives caused by stress induced by the shrinking and swelling of the particles when they absorb or lose moisture. The adhesive itself is not degraded, but the wood product literally tears itself apart. Research is showing that the use of more flexible resins can accommodate such induced stresses.

Improvements in characterizing bond performance appear to depend upon a better understanding of the fundamentals of resin bonding to wood. More meaningful and sensitive durability tests, including accelerated aging tests which study both bond quality and physical properties of the products, are needed.

From the knowledge and information found throughout the industry today, it is apparent that considerable differences are found between the results of exterior exposure tests and the various accelerated aging tests. Many of the accelerated tests are very severe, and some are designed for specific adhesives which makes it difficult to use these tests for developing product standards. Research is showing that at least five years of exterior exposure is necessary to differentiate between various types of board. Present work in the Federal Republic of Germany on the Xenotest process is showing that this test method will provide information predicting about five years exterior exposure after only 24 weeks of Xenotest exposure.

Several economic analyses comparing manufacturing costs, investment requirements, and rate of return on plants manufacturing plywood, COM-PLY, and oriented strandboard, have been performed over the last several years. One recently completed study showed manufacturing costs per 1,000 sq ft (93 sq m) of product was between $ 198 and $ 297 for plywood, $ 175 and $ 203 for COM-PLY, and $ 163 and $ 215 for oriented strandboard, depending upon the size of the plant and the type of panel. Panel thickness was 0.5 in. (12.7 mm) for flooring and 19/32 in. (15 mm) for roofing panels. The after-tax internal rate of return varied between 1.5 % and 15.5 % for plywood, 18.2 % and 28 % for COM-PLY, and 14.3 % and 20 % for strandboard, again depending upon the size of the plant and the type of panel. An extremely important and significant finding was that converting present plywood plants to COM-PLY plants offered the greatest potential return on investment.

As the United States moves more and more into the production of various types of flakeboard, such as waferboard and oriented strandboard, new developments are needed for more economical production of the particles used in these products. Much of the world has gained experience in manufacturing such particles, but the United States, which has developed its particleboard industry on planer shavings, is only now getting into the large scale production of these particles. Many people would like to be able to have nothing but the preferred flake size come from the flaker, however this is a practical impossibility because it does not take into account the varying sizes and quality of the raw materials being fed to the flaker, and the very high costs of producing only the very best flakes from the available raw material. Companies are working very diligently, however, to provide the most economical means for producing such engineered particles. Further development along this line will become extremely important as the industry moves into more sophisticated products for high strength engineering applications.

The use of the computer has grown with dramatic speed throughout the world. It has also had a rapid and successful development within the dry process board plants. It provides substantial savings at a time when material and labor costs are increasing at a very rapid rate. The systems in use may cost over $ 500,000 but the elimination of guesswork from many daily operations provides numerous advantages over the old technology. There is considerable discussion regarding which technology to use, and whether plants should computerize if they are relatively old operations. The discussion on this subject seems to point to the value of using the modern computerized controls in the newer plants, while computerization may have marginal application in older plants which are not as easily modified and also have complete depreciation of the equipment.

Process control of the forming process is one innovation that has received particular attention and has seen widespread application. In one plant, a 2.5 % savings of fiber and resin, an increase in production capability of 3.3 %, and an 80 % former utilization rate were achieved. The costs of this system were paid for in a very short period of time because of these improvement.

Computers, however, are only one of the ever increasing modern technology advances for industrial control. The entire plant control system should be considered as an entity. Thus, it is possible to compare all possibilities and determine the best devices to use within the plant. In plants today, the programmable controllers have significant advantages, and graphic displays of total process operations provide the greatest operator efficiency. The correct application of these innovations to any given situation, however, is most important.

The elimination of system emissions from the dry-type centrifugal collector systems used in particleboard and fiberboard operations is extremely difficult to control. This pollution problem is one faced by plants throughout the world. Older plants were built with minimum attention to controlling such emissions. Today, however, these emissions must be well controlled to reduce or eliminate pollution and to meet federal and state pollution standards. Units which can limit total system emissions to less than 1 1b per hour (0.45 kg) with demonstrated opacity levels at or close to 0 % have been developed. Mathematical models to assist with the efficient design and operation of such collector systems are being applied.

Formaldehyde release remains of great concern today, particularly in plants using urea formaldehyde resin. Industry recognizes the public's legitimate concern about health hazards of formaldehyde and is participating in and supporting efforts to develop sound scientific data on the subject. To date health risks with normal exposure to formaldehyde are unproven, and studies on workers exposed to formaldehyde for many years have shown no excess of nasal cancer or cancer of the upper respiratory tract. Sound scientific information must continue to be developed to form the basis for rational, workable, and cost effective regulations. At the present time, industries which use formaldehyde, such as the particleboard industry, are working on the development of voluntary standards as a responsible method of self-regulation.

In the past, off-gasses from materials such as formaldehyde, were dissipated to the outdoors. Now, with the increased concern for energy conservation, more homes are being weatherproofed, with the unexpected side effect of trapping off-gasses from several sources within homes. Resin manufacturers and board producers have worked to reduce the levels of formaldehyde in their products. Testing methods are being developed, and preliminary correlations with those methods under consideration have been made with large scale testing using simulated single width mobile homes. This test data will be used to develop product standards for the mobile home industry.

Isocyanate is an adhesive which is an alternative to those containing formaldehyde. It is being used in a number of plants throughout the world. In recently completed research on some of the fundamental factors involved in the production of aspen flakeboard using isocyanate, it was found that the single most important process variable was the effect of mat moisture content. In almost all cases, boards pressed at 18 % moisture content were weaker than those pressed at either 4 % or 10 % moisture content. However, the aspen flakeboards could be produced at press temperatures as low as 300 °F (150 °C), given adequate press time. It was found that the difference between an undercured and an adequately cured board could be as little as 15 seconds of press time, and appears to be a function of both press temperature and mat moisture content.

Plant trials have been made using emulsifiable diphenylmethane diisocyanate (EMDI) for the production of waferboard. These trials confirmed laboratory experiments which indicated that waferboard could be made with EMDI at reduced binder levels and at significantly shorter press times than if phenol formaldehyde were used.

Because of its "no tack" characteristic, isocyanate is of interest for use in the medium-density fiberboard industry. Application of tacky type resin is very difficult in this industry and results in poor resin distribution and resin spots, unless the application of the resin is done properly. Preliminary research has shown that this binder system will work for the production of medium-density fiberboard. The economics for using such a system in comparison to presently used systems has yet to be determined.

As mentioned previously, there are plants throughout the world using isocyanate for the production of particleboard. Most of the trials and the production have taken place in Western Europe, although applications have also been made in North America. Boards with properties equivalent to those used with other more common binder systems have been produced in the trials, and are being produced in regular production systems. This work is showing that isocyanates can have a significant place in the composition board industry. Concerns regarding the safety of isocyanate binders have been addressed, and it has been concluded that these binders are safe for use. Work is continuing in many areas to evaluate this binder system for use in the composition board industry.

The properties of composition board materials can be dramatically improved if they are combined with other materials, such as fiberglass. Phenol-resorcinol formaldehyde impregnated fiberglass has been used for products in the plywood industry and the composition board industry in the past. However, further research and development is needed to bring these reinforced type products into wider use. Prediction equations to make such a composite material have recently been developed. Both beam and plate configurations were analyzed elastically. The elastic behavior of the material as plates, and as simply supported beams predicted very well. Failure analysis, however, was inadequate. A new failure model has been suggested, but this will have to be evaluated in future work.

A hardbound Proceedings of all the papers presented at the Symposium is available, as usual, from Washington State University.

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