RECONSTITUTED PRODUCTS FROM OAK

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ABSTRACT. "Reconstituted" describes a family of panel products made from fractionated oak, bonded with either a synthetic resin or a natural lignin bond. Several current commercial fiber panel products from oak are described, and the status of research on experimental products and processes is presented. Recent technological developments are removing the stigma associated with the use of oak as raw material for reconstituted panel products. It is probable that in the future reconstituted panels will be manufactured by a dry rather than a wet process.

FOR LACK of a better term, "reconstituted" is used in this paper to denote a family of panel products made from fractionated oak, bonded either with a small percentage of synthetic resin or a natural lignin bond supplemented with additives. The discussion is limited to the use of round wood. Primary emphasis is given to commercial fiberboard, hardboard, and particleboard, with a discussion of some promising experimental products and unique methods of breaking down oak round wood into prescribed particles.

Technically, a hardboard or an insulating board can be made from oak or any other lignocellulosic raw material. The term lignocellulose is used here because the woody tissue of other plants must be included. There are successful plants in other parts of the world where bagasse (sugar cane fiber), papyrus, flax straw, and cereal straw have been or are being used for fiberboard (insulating board and hardboard).

In the United States, the hardboard and insulating board industries have developed primarily around the use of low-density hardwoods and conifers. The conifers were used first in insulating board materials, and it was the consensus 25 years ago that one of the requirements for a suitable insulating board was a long-fibered softwood. Research and experience have shown that, with the proper equipment and conditions for fiber manufacture, the shorter fibered hardwoods can be used to make insulating boards with quality comparable to those made from softwoods.

Hardboards with some more desirable properties, such as surface finish, can be made more easily from hardwoods than from softwoods. This preference for low-density hardwoods over the more dense

ones in the United States is based on practical and economic reasons. In other areas of the world, where low-density species are not available in the quantity needed, high-density species like beech are used successfully.

COMMERCIAL FIBER PANEL PRODUCTS FROM OAK

Oak has been and is being used in the United States for both insulating and hardboard manufacturing. Examples include the following:

- Temple Industries, at Diboll, Tex., blend a substantial amount of oak into the furnish for their insulating board products. This plant, one of the newer ones in the United States, has been successful, and is expanding production.
- The U.S. Plywood-Champion Papers Corp. plant at Catawba, S. C., was based on the use of oak as the major raw material. They make a fully competitive line of medium-density and high-density hardboard products. Some products are made exclusively from oak; for other products oak is used in blends with other available species.
- Societa Italiano Rueping, of Naples, Italy, who use oak slabs for hardboard, are cited because of the problem they have had with acceptance of their product in competition with the lighter colored board prevalent in Europe. Not only was the darker color objectionable, but uniform color was more difficult to maintain because of the extractives in oak.
- Alton Box Co., of Alton, Ill., use substantial portions of oak in their furnish for corrugating medium and linerboard. This use is cited because the method of pulping and the fiber requirements are similar to those needed for insulating board or hardboard.

INDICATORS OF USING OAK FOR FIBERBOARD

It has been said that the main reason for using low-density hardwood or softwood has been economic rather than technical. To support this statement it is desirable to cite literature that indicates the technically oriented possibilities for using oak or similar dense hardwoods.

S. L. Schwartz *(1943)* described research in which he used white oak from eastern Virginia. He described how the pulp was produced, using Defibrator equipment, how more alum or other fixing agent was required to set the size because of the tannins present, and how (when hot water removal of tannins was used) board size could be fixed with one-third the chemical, though lower strengths resulted.

Schwartz and Baird *(1952)* demonstrated that both insulating board and hardboard of reasonable quality could be made from sand hickory.

S. Hunter Brooks, Rust Engineering Co., in a paper presented at the Mid-South Section Meeting of the Forest Products Research Society in October 1970, showed some interesting possibilities for oak and oak bark. His hardboard was based on the Miller-Hofft system of producing fiber by a pressurized refiner, and curing a fiber-based board with about 8 percent urea-formaldehyde binder with high-frequency heat. Here the properties were comparable to or exceeded commercial standards for medium-density hardboard or particleboard when the board was made from either kiln-dried oak hogged fuel or green oak pulp chips. Brooks stated also that a board made from 100-percent oak bark had fair physical properties, enough so it passed minimum values for floor underlayment.

DRAWBACKS TO OAK FOR BUILDING MATERIAL

So far all indications are that more oak could be used for building fiberboard products than is being used. Why then has not the practice developed more than it has? Some of the reasons are:

1. The consumer associates quality with color, particularly in insulating board, and he wants a light color. But an oak-based board is usually dark-colored. In hardboard this darkness is grayish or black as compared to tan or brown for boards from other species.

2. Plants are designed and built based on past experience. For most insulating board and some hardboard the groundwood process is used, but it does not produce as good fiber from a dense hardwood as a lower density one. The other predominant method for fiber preparation has been the Asplund defibrator. It too does not produce as good a fiber from dense woods unless a semichemical treatment is used. A newer development for fiber manufacture, that of producing fiber by refiner methods under pressure (pressure-refiner) sometimes referred to as chip groundwood, offers distinct promise of producing better fiber more economically.
3. All insulating board and much of the hardboard is produced by the wet process. The extractives present in oak and the sugars produced from more severe steaming, cooking, or temperatures used during refining require more water for washing (and thus more water pollution) than when conditions are milder with a lower density species. Even when a dry process is used, the presence of these soluble materials with their variability affects uniformity in manufacture.
4. Oak as a species is plentiful, but much of it is of the "scrub" variety. It is small in diameter, irregular in shape, and apt to have a high frequency of knots. Yields and conversion are poor because of the form and shape.

If comparative costs of other raw materials change enough, and oak becomes more economical, then more oak will be used for board products. This relative balance of cost continues to shift. Many raw materials being used today were impractical and uneconomical yesterday.

EXPERIMENTAL PRODUCTS AND PROCESSES

Use of Oak in Particleboard

Ever since the beginning of the particleboard industry in this country, about 20 years ago, a stigma seems to have been attached to the use of oak. Many researchers have found that, in general, the best particleboard can be made from the low-density woods. Thus the domestic oaks, hickories, and some maples are certainly not on the preferred list. When a comparison is made with flake-type boards, using bending strength as the criterion, a plot of strength versus density of raw material is an ascending line with decreasing species density. In spite of this, there is limited use of mixed hardwoods, including oak, in the cores of commercial three-layer particleboards, probably for economic or availability factors, but sometimes because of a basic difficulty with some competing species.

A far more intriguing potential for using dense woods in particleboard, again illustrating the extreme flexibility of the process, is the current trend toward smaller fiber-like particles, such as those produced by attrition milling. Commercial boards of this type, primarily from softwoods or low-density hardwoods, have been on the market for some time and have been variously called particleboards or dry-formed hardboards. More recently, experimental boards of this type were made from dense hardwoods by similar processes, and they appear to be entirely satisfactory for furniture core stock. The edges of these boards are tight (often a problem when working with oak) and the density and resin content are normal for core stock. If subsequent pilot-plant evaluations substantiate the findings of exploratory work, particleboards of this type could develop a sizable market for oak round wood.

Exploratory work at the Forest Products Laboratory has developed some promising properties in particleboards made from fine splinters, as well as bundles of fibers, torn out of Douglas-fir by what might be described as a modified groundwood process. Progress in this direction is temporarily halted because of equipment difficulties; therefore, no evaluation of oak by this process has been made. If future tests on oak yield particle geometries similar to those already produced from Douglas-fir, the properties of the oak boards should be similar to those of the Douglas-fir boards already tested. Thus the process could offer

a means of producing fiberlike particles directly from round wood without depending upon knife cutting.

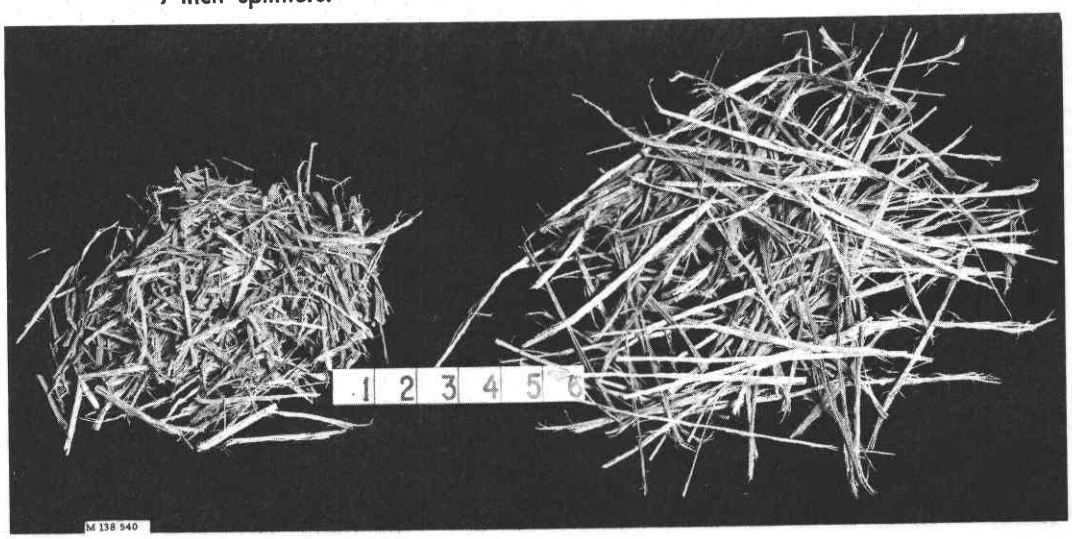
Oak Splinters Developed by TVA

The Timber Harvesting and Processing Section of the Tennessee Valley Authority, Norris, Tenn., is exploring several approaches to the problem of better utilization of low-quality oak logs. One of these studies is concerned with breaking down oak logs into coarse, rather long particles that perhaps can best be described as "splinters." These splinters are produced on equipment designed and built in their own facilities to demonstrate the principle; later this may provide design information for prototype equipment. It is TVA's hope that private industry, through a licensing procedure, will develop a prototype machine and possibly production equipment.

Their present equipment involves a set of heavy rolls to break down the wood. Surfaces of the rolls are machined in a special pattern to promote crushing, separating, and spreading of the fractured oak. After several passes through these rolls, an oak log is reduced to a mat of loosely attached splinters. This mat is then cut into shorter lengths, which are in turn fed through a machine called a "scrubber." In the scrubber the reciprocating action of two inclined serrated plates separates the splinters and further reduces them in size.

Having demonstrated that splinters of this type could be made, TVA approached the Forest Products Laboratory for suggestions on the possible uses for particles of this type. A conference on the possible uses was held, with particular reference to the capability of the process to produce splinters of specified sizes. It appeared that smaller splinters for use in pulping would probably be impractical; therefore, products made from coarser splinters were surveyed. Two approaches were considered: (1) using splinters about 3 inches long (left in figure 1) in a phenolic-bonded particleboard designed for house-wall sheathing; and (2) using splinters about 7 inches long (right in figure 1) in a cement-bonded board or as the core of a cement-bonded board having conventional excelsior faces. Both approaches yielded test results that look exceedingly encouraging, and the work is being continued with emphasis on promising variations.

Figure 1.—Oak "splinters" produced by TVA: left—3-inch splinters; right —7-inch splinters.



CONCLUSIONS

Recent technological developments, improved fiberizing techniques, and current research on fiber and particleboard processing are rapidly removing the stigma so long associated with the use of the oaks and other dense hardwoods as raw material for reconstituted panel products. The future expansion of the market for oak round wood in reconstituted form, therefore, will be determined by economic considerations, availability, and increasing scarcity of low-density species rather than a lack of technical knowledge. With increasing concern over controlling and reducing water pollution, it is probable that in the future reconstituted panels from oak will be those designated by the terms dry-formed hardboard or particleboard.

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