From Wood Waste to Particleboard
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March 1972
4 pages

Extension Bulletin E-735 Marketing Series March 1972

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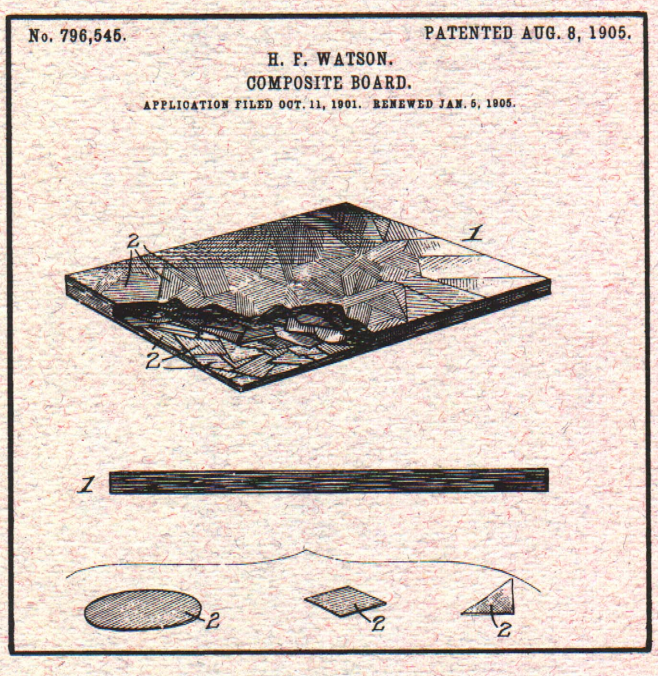

Figure 1. Patent drawing from Watson Patent, 1905.

by Otto Suchsland, Department of Forestry

Wood waste occurs in many forms and in enormous quantities starting in the woods with logging, in the sawmills and in the multitude of secondary manufacturing operations.

Several times the quantity of wood present in a chair, cabinet, or nearly any other wood product has been lost along the way in the form of waste. As state and federal legislation, designed to protect the environment, puts more and more restrictions on the methods of waste disposal, producers are being forced to spend more money on waste disposal. These expenditures either reduce profits or cause price increases. Methods and processes that promise profitable utilization of at least some part of the wood waste have therefore attracted considerable attention.

The particleboard process is a good example. Not only does it use large amounts of wood waste as the major raw material, particleboard is rapidly increasing in demand. This bulletin explains particleboard manufacture, including some important technical and economic factors.

Invented Long Ago

Particleboard was invented 70 years ago by Henry Watson of Valparaiso, Indiana. A basic patent was issued by the U.S. Patent Office in 1905. The Watson Patent drawing (Figure 1) illustrates the basic structure of particleboard. One can readily see that particleboard consists of small wooden elements randomly distributed and oriented, arranged in layers and glued together to form a composite board. In the particleboard process, suitable small particles of wood are coated with an adhesive, formed into a mat which is compacted in a press to the desired thickness and density, at a temperature that allows the adhesive to cure and form a permanent bond. The quality of this product is determined largely by the quality of the glue bond (its completeness and permanence), by the geometry of the particles and the species of wood used.

The particleboard industry in this country had its start in the 1950's and has grown to be one of our major forest products industries, producing over two billion square feet in 1970. Most particleboard today is manufactured in heated presses similar to plywood presses, with the laminating pressure applied perpendicular to the plane of the board (Figure 2). Less than five percent of the total particleboard production is not pressed in steel platen presses but is extruded (Figure 3). Extruded boards have real cost advantages, but their application is somewhat limited due to certain structural characteristics.

There are a number of different manufacturing techniques for flat pressed or mat-formed particleboard. These differences are in the formation of the board mat or in the type of press used. Some processes use single-opening presses, producing one board per press cycle, others employ multi-opening presses accommodating as many as twenty board mats per load. All of these different processes involve a number of basic steps:

a) preparation of suitable particles either from roundwood or waste
b) drying of particles
c) application of adhesive to dried particles
d) formation of board mat
e) pressing of board mat in heated presses
f) trimming of board
g) sanding.

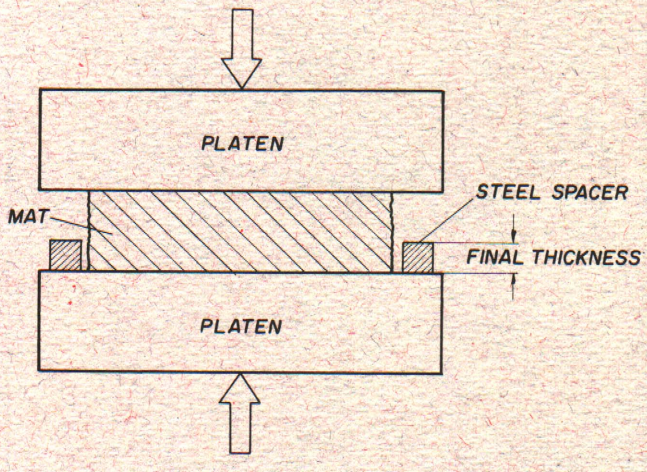

Figure 2. Principle of pressure application in the manufacture of mat-formed particleboard. The mat is compressed in the heated press to the thickness of the steel spacers.

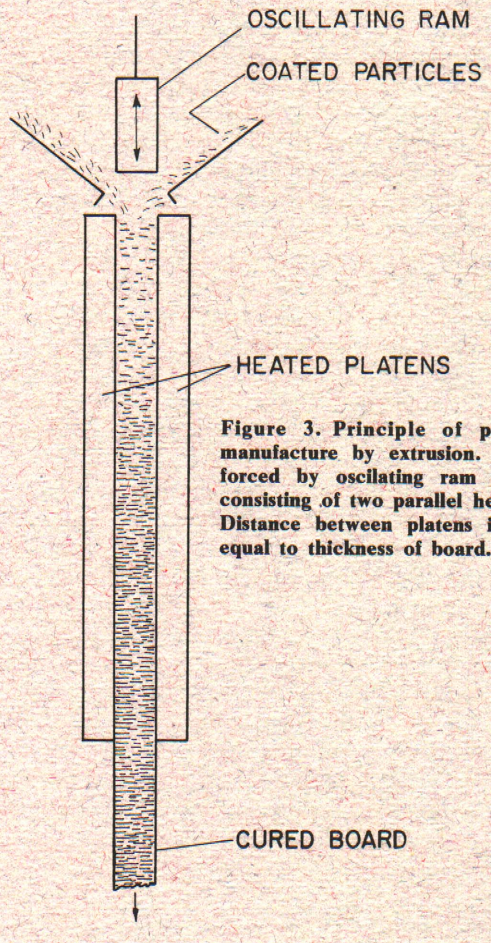

Figure 3. Principle of particleboard manufacture by extrusion. Particles are forced by oscilating ram through die, consisting of two parallel heated platens. Distance between platens is fixed, and equal to thickness of board.

Of these steps, the application of the adhesive (the blending or mixing operation) is probably most critical. Relatively small amounts of liquid resin glue must be distributed over the enormous surface area presented by all particles, so that a uniform gluebond can be established between the particles. These resins are generally atomized and sprayed into a stream of particles that are constantly agitated and turned mechanically.

The formation of the board mat is a continuous process (Figure 4). The adhesive-coated particles are deposited uniformly on a moving belt conveyor. Thickness of the mat depends on the desired board thickness and its density. But, certain important modifications are possible. The mat can be deposited in three layers by three successive forming stations, with the material in the face layers different from that in the center or core layer. This could result in improved surface properties and increased stiffness and bending strength.

The final board size is determined by the press size. Common sizes are 5 by 16 feet or 5 by 20 feet. Most particleboard is pressed in multi-opening presses, like the one illustrated in Figure 5. Each individual press platen is heated. Press temperatures are around 325°F. After pressing, the boards are cut to size and sanded according to their application.

Various Thicknesses

Particleboard is made in various thicknesses ranging from ¼ to 1¼ inch. Most common are ⅜ and ¾ inch (Figure 6). Minimum board properties, sampling and testing procedures are specified in Commercial Standard CS236-66.*

More than one half of all particleboard produced is used by the furniture, kitchen cabinet and store fixture industries, usually in the form of cores in veneered or otherwise overlayed panel materials. About one third of the total production is used in construction, mainly in the form of floor underlayments. Other important uses are floor deckings for mobile homes and pre-manufactured houses.

Most particleboard is "interior" which means it is manufactured with an adhesive which is not water-proof. When exterior particleboard is made with the same adhesive that makes exterior plywood water-proof, it may be used for certain exterior applications but is not as water resistant as exterior plywood.

Particleboard has, from the beginning, been looked upon as a solution to the wood industries' waste problem. The first particleboard was actually made from sawdust. It was soon discovered, however, that superior quality board could be made from thin flakes cut to uniform thickness and size. The generation of such particles requires relatively large waste pieces or roundwood.

Only in the last 5 years, or so, have particleboard manufacturers turned to much cheaper waste

Obtainable from the National Particleboard Association, 2306 Perkins Place. Silver Spring, Md. 20910.

materials, particularly softwood planer shavings. Per dry ton, planer shavings cost less than one fourth the price of particles produced from roundwood. Use of wood waste as raw material is expected to increase until within a few years practically all particleboard will be made from waste.

Particleboard manufacturers have a definite preference for softwoods, like Douglas fir, and the western and southern pines. This is because the quality of a softwood board at a given board weight is considerably higher than that of a board made from heavy hardwoods, like maple, birch, beech, etc. In other words, hardwood boards must be heavier, to be of the same quality as a softwood board. Aspen and other light-weight hardwoods are, of course, exceptions. This preference has resulted in a heavy concentration of the particleboard industry along the west coast of the United States, and more recently, in the southern pine region. Major particleboard markets, however, are located in the Midwest and the East. Increased freight rates have put a heavy burden on particleboard shipped from the West and at the same time have focused attention on low cost raw materials in the hardwood regions of the Midwest and East. A new process, called the medium density fiberboard process, reduces waste material to fiber and has succeeded in producing a medium weight board of superior quality. Moreover, it seems possible that this method would allow use of wood wastes like tops, thinnings, etc., without prior debarking.

Such developments and the increasing demand for particleboard might encourage the establishment of particleboard manufacturing facilities in the Midwest and East.

The particleboard process has become a very sophisticated, mechanized and partially automated process. The minimum plant size for economic

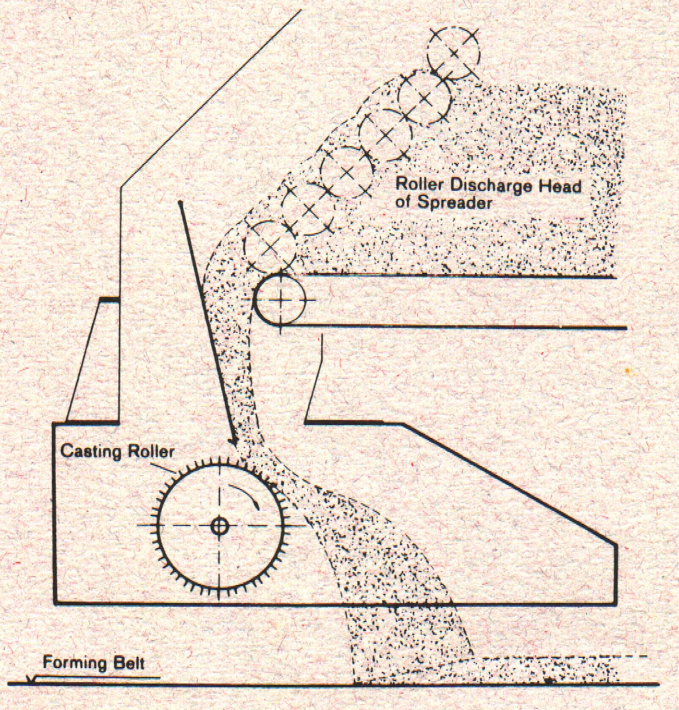

Figure 4. Example of particle mat forming machine. Particle mat is built upon moving conveyor (from left to right). Various rollers assure uniform distribution of particles.

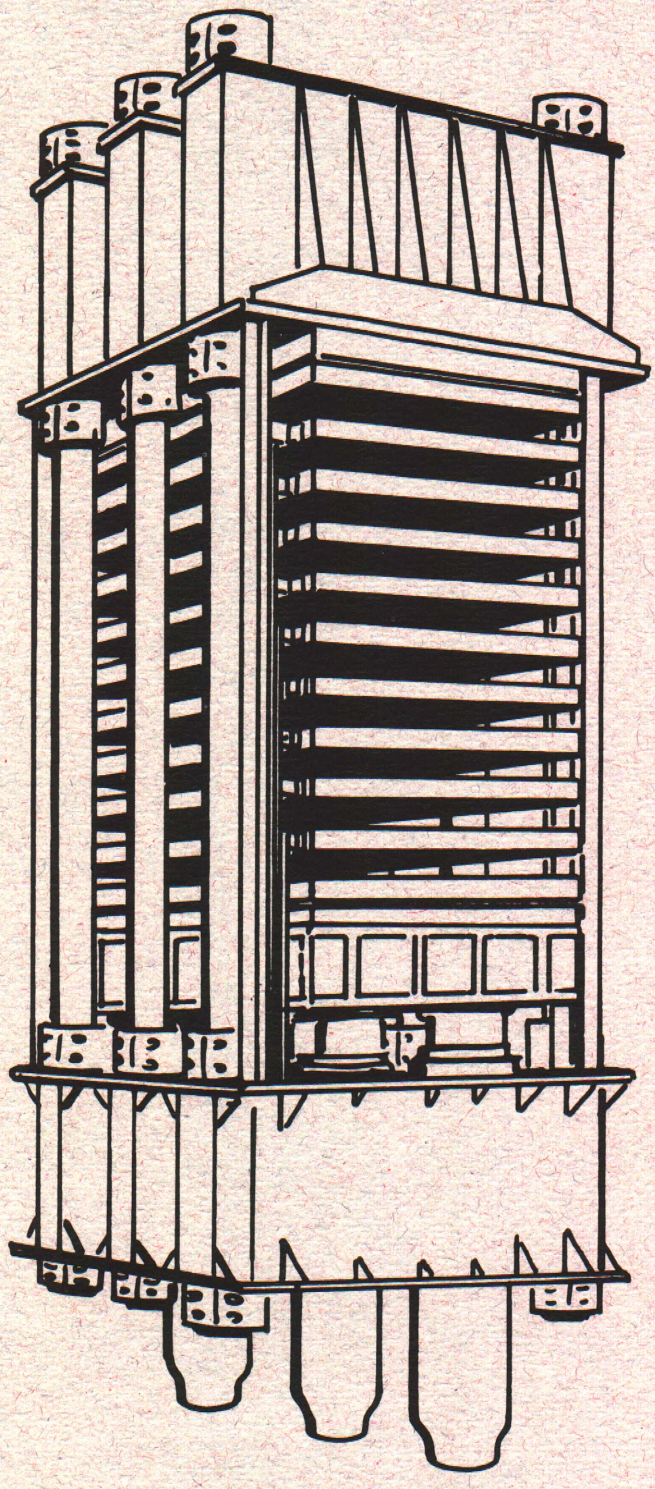

Figure 5. Ten-opening particleboard press. All platens are heated. When all openings are filled with particle mats, press closes automatically, pressing 10 boards simultaneously.

operation has increased steadily over the years. With the exception of a captive plant, where all the plant output would be used by the producer, a new particleboard plant should have a capacity of at least 300 tons per day. This would roughly be equivalent to 300 cords of raw material per day. The yearly output of such a plant would be around 60 million square feet of ¾ inch board. Total investment could be as high as $10 million, or more. It is obvious from these figures that the particleboard is not an easy answer to the wood waste problem, but it is also clear that in a large integrated operation the particleboard can contribute significantly to its solution.

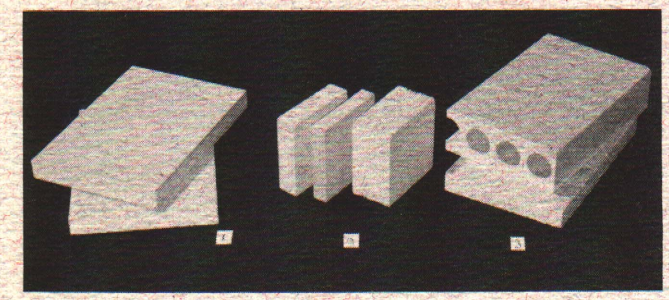

Figure 6. Samples of commercial particleboard. 1: three-layer boards; 2: single-layer boards; 3: extruded boards.

Issued in furtherance of cooperative extension work in agriculture and home economics, acts of May 8, and June 30, 1914, in cooperation with the U.S. Department of Agriculture. George S. McIntyre, Director, Cooperative Extension Service, Michigan State University, E. Lansing, Mich.

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