The Field of Fiber Board for Foresters

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EDITOR'S NOTE: *Since graduating from Iowa State College, Mr. Pecaro has been employed with the United States Gypsum Company, where he is working on the manufacture of wallboards. Mr. Pecaro has spent some time in collecting the information contained in this article, as there is nothing published as yet on this subject. He hopes eventually to gather all the information on fiber boards and put it in book form.*

FIBER building boards have recently assumed a position of importance among the materials used in the building industry, and since a great part of the fiber boards on the market are manufactured from wood, the field offers wide possibilities to the technically trained forester.

Most men connected with the manufacture of lumber or its growth look upon fiber board as a lumber substitute and an encroachment on the lumber industry. This is a mistaken idea, for in reality fiber board is a manufactured lumber designed only for specific applications in building construction. The source of raw materials for fiber board, its preparation and conversion, its manufacture and re-manufacture into standard board, is all as important a part of forestry and the utilization of forest products as logging, lumbering and papermaking.

There are in this country some 13 major manufacturers of fiber board. Nearly all of these manufacturers utilize a different species of raw material and each claims something outstanding in his particular method of forming board. The source of raw materials ranges from a low grade, worthless vegetable fiber to a high grade spruce fiber of exceptional value in the manufacture of fine bond papers. Among the vegetable fibers used are bagasse, straw, cornstalks, licorice roots, etc. Of the wood fibers used, there are spruce, fir, cottonwood, southern pines, saw mill waste, distillation waste and waste paper.

For the purpose of this article in discussing the raw materials, we shall deal mainly with the wood fiber boards, but in the manufacture, we shall include all types of boards, as fundamentally the process of manufacture is the same.

A list of the leading manufacturers of fiber boards in this country and the various raw materials used is shown below.

Trade Name	Plant Location	Raw Materials Used
Arborite	Lisbon Falls, Maine	Spruce and other Northern Woods
Celotex	Marrero, Louisiana	Sugar Cane
Firtex	St. Helens, Oregon	Douglas Fir
Maftex	Camden, N. J.	Licorice Root
Homosote	Trenton, N. J.	Waste Paper
In-Cel-Wood	Lisbon Falls, Maine	Spruce and other Northern Woods
Inso-Board	St. Joseph, Mo.	Wheat Straw
Insulite	International Falls, Minn.	Spruce
Johns Manville	Oswego, N. Y.	Paper Screenings and Northern Woods
Maizewood	Dubuque, Iowa	Corn Stalks
Masonite	Laurel, Mississippi	Yellow Pine
Red Top	Greenville, Mississippi	Cottonwood
Nu-Wood	Cloquet, Minnesota	Spruce, Balsam and Northern Woods
Temlok	Pensacola, Florida	Yellow Pine

The Growth of the Raw Material

The growth of the raw materials for the manufacture of fiber board offers exceptional opportunities for putting into practice, on a commercial basis, the various silvicultural systems recommended by such authorities as Hawley, Frothingham and Recknagel.

Commercial investors are reluctant to invest large sums of money for the purchase of large tracts of timber to be placed under technical management due to the long rotation required for the growth of stock logs, and the long period of deferred income. In the growing of timber for fiber board, the rotation is usually short and the system of cutting is simplified.

Mr. Benson H. Paul, Silviculturist of the Forest Products Laboratory at Madison, Wisconsin, in an article printed in the February, 1932, number of the "Paper Industry," developed some interesting data on slash pine, *Pinus heterophylla*, illustrating the attractive short rotation possible for fiber board. His studies showed data from stands of slash pine, 8 to 16 years of age and from 5 in. to 10 in. d.b.h., which would yield 999 pounds of pulp per cord or approximately15 cords per acre. A stand 27 years of age, thinned at 24 years, would yield 1,232 pounds of pulp per cord or approximately 30 cords of pulpwood per acre.

Studies made by the writer on common cottonwood, *Populus deltoides,* in the Delta region of the Mississippi, showed that cottonwood would grow to a diameter of 10 in. to 12 in. b.h., and to a merchantable height of 50 feet in 15 years. On an acre of timber this age and size there would be a stocking of from 60 to 70 merchantable trees which would yield from 15 to 20 cords per acre. Based on this growth and yield of approximately 15 cords to the acre, the crop rotation would be profitably set at 15 years, making it possible to use a modification of the selection system of cutting to remove the crop.

Preparation of the Raw Material

The method of handling wood in the wood yard of fiber board plants is very similar to that used in paper mills. The wood is cut to suitable lengths with a slasher saw and conveyed from the slasher either directly to a pool or to a standard drum barker. If the wood is purchased barked in the woods, it is often conveyed to the pool after the slasher, unless it is necessary to remove grit and the adhesive cambium left when the barking is not thorough.

Exceptions to this method of handling the raw material depends on the method of conversion employed at the particular mill. At the plant of the Newport-Armstrong Company located at Pensacola, Florida, the raw material is received in a converted form ready for pulping from the retorts of a distillation plant. The distillation plant is operated in conjunction with the fiber plant and supplies the wood chips for the latter process from material which would otherwise be an industrial waste.

This distillation plant uses a system of steam distillation and extraction in their process. The wood used is made up mainly of the stumps of cut-over southern yellow pine. This wood is "hogged" or reduced to small chips as in the case of reducing the wood for making pulp by the sulphite process. These chips are given a system of steam treatment which removes the oils and crude turpentine. After steaming, the chips are subjected to a vacuum to dry them and are conveyed directly to a chip screen and chip bin over the grinder room of the fiber board plant.

The plant of the Oswego Board Corporation located in Oswego, N. Y., uses both raw pulpwood in the form of billets and also paper mill "slabs". The wood follows the usual procedure of slashing ,splitting and barking and is conveyed to the conversion room via the wood pond. The "slabs" are pulped in beaters and refined with the pulp from the wood before entering the stock chests.

Still another plant, the Firtex Insulating Board Company at St. Helens, Oregon, utilizes saw mill chips. These are delivered to the board plant docks in barges. The chips are removed from the barges by a system of conveyors which carry the chips directly to the chip bin over the digestor room.

Conversion of the Raw Material

Conversion by means of digestors is the most common method of reducing vegetable and wood raw material to fiber. The most common type of boiler used is the rotary type illustrated in Figure 1. An example of the reduction of wood fiber by rotary digestors is that of the Firtex Corporation. This plant has an installation of six 18-foot Biggs Rotary Boilers in which the chips are processed. The illustration in Figure 1 shows a similar installation of 14-foot digestors for the Massasoit Manufacturing Company, Lake Charles, Louisiana. After the fiber leaves the digestors at the Firtex Corporation, it is further processed into pulp by being run through hammer shredders, and is finally pumped over to the stock chests ready for the board machine.

A typical example of vegetable fiber reduction is that of the Maizewood plant at Dubuque, Iowa. At this plant four rotary digestors are used for fiber conversion. The process through which the cornstalks pass during the conversion process is as follows. The cornstalks are received in bales of approximately 70 pounds each. The bales are received in a shredder house where the baling wire is removed, and the bales broken into

Courtesy: Biggs Boiler Works Co., Akron, Ohio

Figure 1. Rotary digesters used for the reduction and hydration of vegetable and wood fiber.

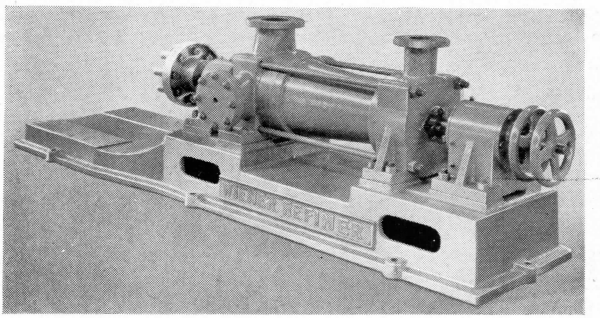
chunks. These chunks are fed into a swing hammer mill shredder where the stalks are reduced into particles 5 inches to ½ inch or finer. This material is carried over a magnetic separator to remove bits of iron and wire, and is blown by a centrifugal fan system to a line of bins. These bins discharge directly into four digestors where the fiber is steam digested at 100 pounds pressure for about two hours. The cook from the digestors is blown into a drain pit, where the liquor is recovered. The pulp is pumped over to a washer and is then reduced to uniform sizes by a cutter machine. After passing through another washer, size is added and the stock is pumped through a Claflin and a Jordan refiner and is discharged into the chests at the board machine.

Fiber reduction by disc pulping machines is common in plants using wood for fiber. At the Arborite plant of the Wood Fiber Board Corportaion a battery of four Bauer disc pulping machines are in operation. The Bauer disc pulping machine consists of two motors mounted on a single frame, facing each other. On the ends of each shaft are attached two discs slotted to receive grinding plates having special corrugated surfaces for reducing chips to pulp. The plates revolve in opposite directions in order to assist in separating the chips into fiber. One disc is so arranged that it can be moved to increase or decrease the gap and so vary the type of pulp produced. A feed hopper is located over the gap to feed the chips between the discs. Steam is blown into the gap to soften the chips and aid in the hydrating process. The resulting product is a pulpy mass of fiber similar in appearance to groundwood pulp, which is discharged directly into the stock pit.

At the plant of the Oswego Board Corporation, the conversion process employs two modified McMillan machines which produce a rough fiber, on somewhat the same principle that excelsior is produced. These machines consist of a movable box mounted over a table beneath which are set four saw mandrels with saws protruding. The logs are dropped into the box, which moves by a crank shaft drive back and forth over the saws and reduces the wood into a rough fiber. The fiber is removed from these machines by a cyclone system to hammer mill, where the material is further reduced to smaller sizes and is then discharged into a chest where it is agitated with water. The resulting pulp is pumped to four Wiener refiners.

The Wiener refiners are manufactured by The Dorr Company, New York, and are the invention of Mr. John A. Wiener, plant superintendent at the Oswego Board Plant, Oswego, N. Y. Although the Wiener refiner resembles a Jordan machine, it is built on entirely new principles. Figure 2 shows a view of the Wiener refiner and illustrates the general construction. Instead

of the stock entering the refiner at the small end and being discharged at the large end, as it would in a Jordan, the process is reversed, which seems to be the more natural operation. By having the stock enter the large end first, the coarser stock first comes in contact wtih the large teeth of the plug, and then as the fibers become separated and smaller they pass on to the smaller finer teeth at the end of the machine and are discharged at the small end. This method of refining the stock secures better hydration and a more finished stock. An added feature to the Wiener refiner over the Jordan machine is the fact that a hydraulic pressure is set up inside the machine by the action of an impeller on the plug, which forces the stock through the machine and out the small end. This hydraulic pressure aids in the hydration of the stock. After the stock passes through the refiners it is pumped to the stock chest ready for the board machine.



Courtesy: The Dorr Company, New York City

Figure 2. The Weiner refiner for refining all kinds of raw stock into a finished pulp.

The United States Gymsum Company plant at Greenville, Mississippi, manufacturing insulating and building board from cottonwood, uses five 3-pocket stone grinders in the conversion process. These are the same type of grinders used in paper mills producing groundwood pulp. The pulp produced is of a high quality, requiring no further refining, and is pumped directly to centrifugal screens and deckered over to the stock tanks. Sizing is added and the stock is pumped over to the machine chest ready for the board machine.

The Masonite Corporation of Laurel, Mississippi, successfully produces insulating and pressed board through a very unusual process in which waste wood chips and cordwood chips are exploded in a fluffy mass and pressed into board under heat. In

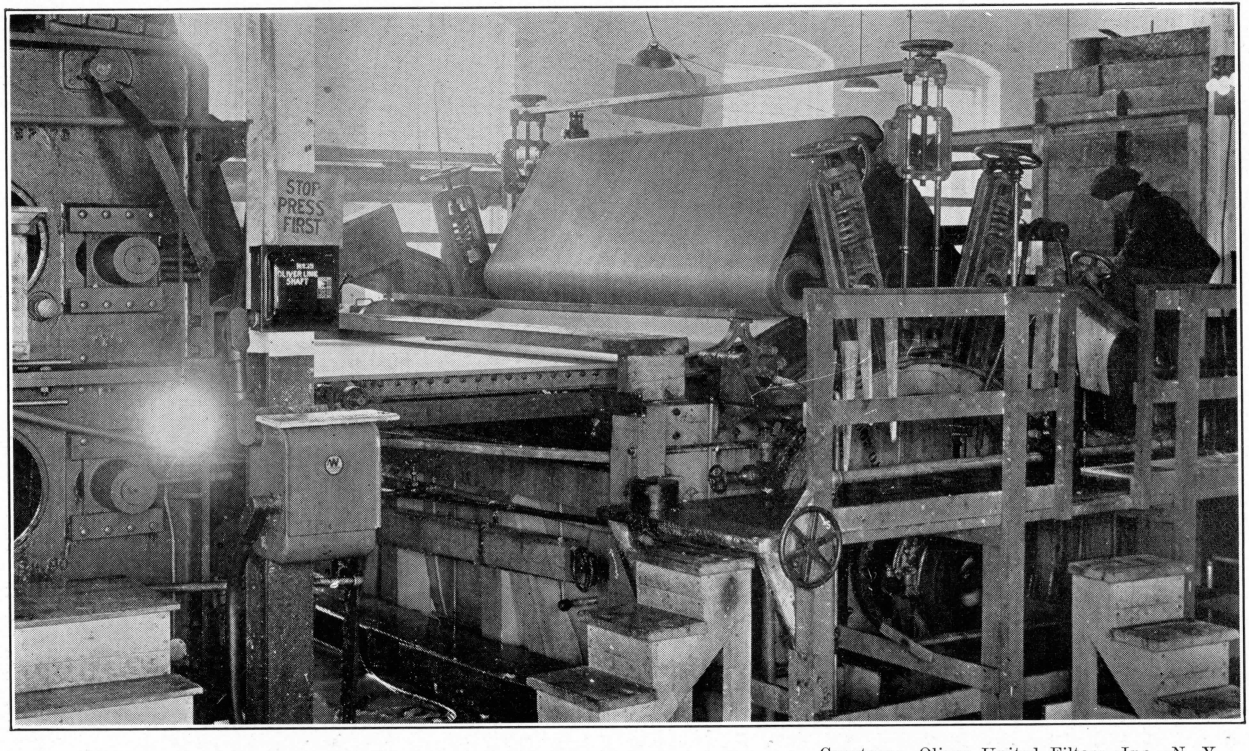
this process the chips are fed into one of a series of long tube-like boilers called "guns", and saturated steam at 800 to 1,000 pounds pressure per square inch is admitted to the gun for a few seconds to soften the natural lignin or binder of the wood and to force the steam into the pores. A quick acting exhaust valve is then opened and the wood is exploded into the exhaust piping at atmospheric pressure. During the exploding operation, full boiler pressure is kept on the gun to clear all the wood through the exhaust port and piping to a cyclone separator, where the steam escapes to the atmosphere, and the fiber drops into a chest where it is mixed with water. Weiner refiners are used in this plant for further refining.

Forming the Board

The process of forming pulp into board in the early days of wall board manufacture was limited to laminating three or more sheets (usually four) of paper board made on an ordinary cylinder paper board machine. The trend today is towards a homogeneous board made on either a screen-like cylinder machine or on a fourdrinier screen machine. Both machines are adaptations of similar paper mill machines.

The leading manufacturer of cylinder board machines is the Oliver United Filters Inc., New York City. This company has pioneered in the manufacture of this type of board machines. Their board forming machine resembles a decker, and consists of a drum covered by a wooden drainage screen, superimposed by a wire screen. This drum revolves in a vat which receives stock from a regulating box called a headbox, and picks up a sheet on the surface of the screen by the action of a vacuum drawn through a hollow shaft supporting the drum. As the sheet is formed it travels in a continuous sheet from the vat and over the drum to a series of light press and felt rolls and off the machine over a "doctor" board into the press section.

Figure 3 shows a view of the Oliver board machine, illustrating the manner in which the board leaves the machine and enters the press section. This particular Oliver has a drum 8 feet in diameter and 9 feet long, although the Oliver Company has constructed Oliver board machines as large as 14 feet in diameter and 13 feet long. The machine illustrated is installed at the plant of the Wood Fiber Board Corporation, Brunswick, Maine. The raw materials used consist of about 90 percent spruce and 10 percent hemlock, the chips being mechanically ground and no cooking process being used. Their board machine will produce 100,000 sq. ft. of board ½ in. thick when dry, and 50,000 sq. ft. of board 1 in. thick when dry, per day. They have also successfully made ¼ in. board at the rate of 150,000 sq. ft. per day.



Courtesy: Oliver United Filters, Inc., N. Y.

Figure 3. Oliver cylinder board machine showing the formed board leaving the machine and entering the press.

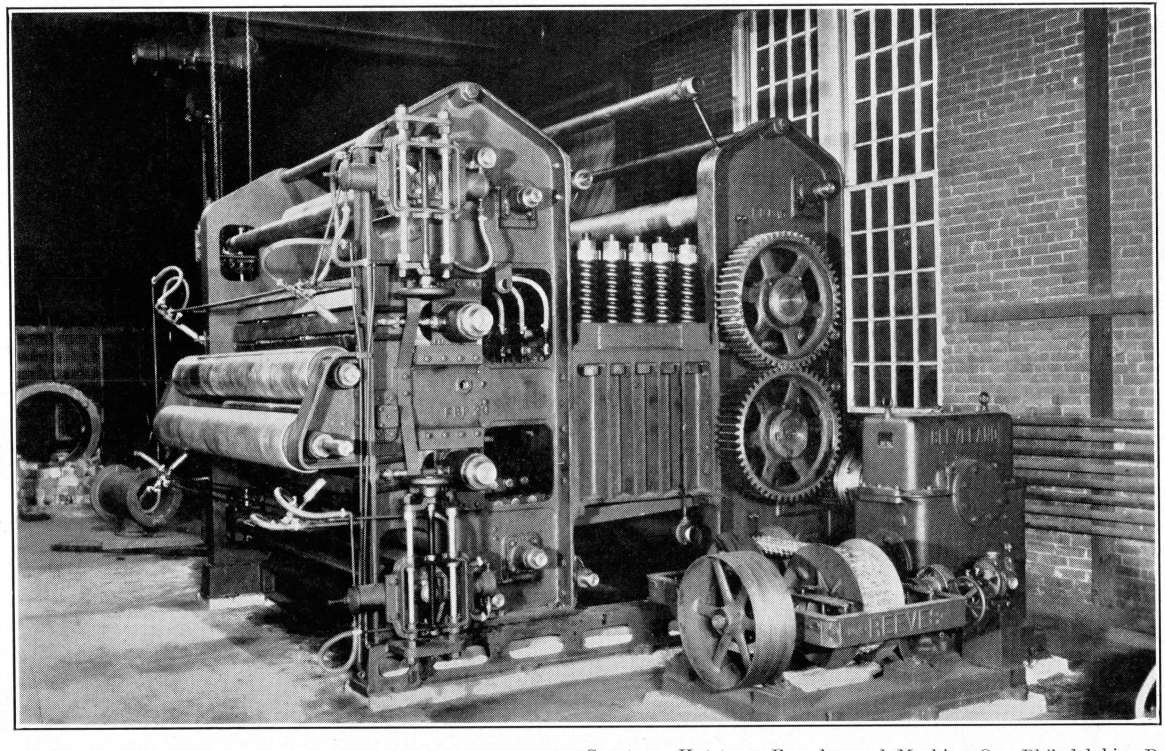
Fourdrinier type board machines have been installed in various plants and have proved successful. Probably the largest type of fourdrinier machine is that manufactured by the Beloit Iron Works, Beloit, Wisconsin, for the Firtex Corporation. This machine consists of a wire 13 feet wide and 100 feet wide, and turns out a board 12 feet wide of 1 inch thickness, semi-laminated.

Downingtown Manufacturing Company, Downingtown, Pa., experimented with a fourdrinier machine consisting of two fourdrinier wires synchronized, one above the other. The stock was introduced at a headbox on one end of the machine and was picked up first by the lower wire upon which the stock flowed from the headbox. The upper wire picked up a light sheet from the top of the stock and met the lower wire at a dam at the end of the stock flow, where the two sheets were formed together in a semi-laminated form.

The majority of board manufacturers use a continual process of forming board, as explained above, and a continuous process of pressing and drying the board. However, there are exceptions. For example, the Oswego Board Plant uses a batch system of forming board by means of a mould. In this method the board must be formed, pressed and placed in the dryer piece by piece, and would be too slow and expensive at most plants.

After the sheet leaves the forming machine on continuous processes, it travels through a press, where the sheet is further compressed and additional water removed. One type of press, The Downingtown Press, consists of a series of rolls gradually increasing in size, through which the sheet passes and is subjected to gradually increasing pressure. A unique type of press is that illustrated in Figure 4, manufactured by the Kutztown Foundry and Machine Co., Kutztown, Pa.; a caterpillar type of press. The press is composed of two heavy steel movable aprons, one on top and the other on the bottom. As these aprons converge the material passing through is gradually pressed, eliminating the water to the extent required for future drying of the board. At a certain point these two aprons run parallel to one another for a limited distance to permanently form the thickness of the board. The pressing zone is supported by two heavy girders and the necessary pressure is regulated by means of heavy springs.

After passing through the press, the sheet is cut to desired lengths by a traveling automatic saw and is conveyed to a continuous dryer. The type of dryer in most common use is the Coe Dryer, which consists of several decks of live rolls on each side of which the wet board is introduced. These rolls convey the sheet through areas of gradually increasing heat until all the water is driven off, after which it passes through a cooling section and emerges from the kiln as dry board.



Courtesy: Kutztown Foundry and Machine Co., Philadelphia, Pa.

Figure 4. The Kutztown press, employing the principle of the caterpillar tractor in pressing wet fiber board to thickness and density required.

The final process through which the fiber board passes in its manufacture is that of re-manufacture, usually termed the finishing process. The dried board is trimmed to desired lengths and widths on a trimmer saw, and follows through various operations of bevelling, tonguing and grooving, sanding and shiplapping according to the use to which it is to be put.

In summing up this article, the writer wishes to stress again the scope of this new field of fiber board for properly trained forestry students. The man who has a fundamental forestry training combined with a general engineering education will find this field of immense possibilities and interest. There is much to be learned in the field of fiber board, many processes to be perfected, new methods to be tried and original thought and hard work to be applied to various problems, but it should be most attractive to trained foresters.

FABLE

The mountain and the squirrel
Had a quarrel,
And the former called the latter 'Little Prig';
Bun replied,
'You are doubtless very big;
But all sorts of things and weather
Must be taken in together,
To make up a year
And a sphere.
And I think it no disgrace
To occupy my place.
If I'm not so large as you,
You are not so small as I,
And not half so spry.
I'll not deny you make
A very pretty squirrel track;
Talents differ; all is well and wisely put;
If I cannot carry forests on my back,
Neither can you crack a nut.'

—Ralph Waldo Emerson.