THE FIBER BOARD INDUSTRY

By

Hans Rhiger

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INTRODUCTION

From the time of the invention of paper-making in China 1800 years ago the progress in paper-making has been most rapid in recent years. The evolution of paper-making processes, the use of new materials, the varied utilization of power, the development of transportation and communication, and the industrial applications of chemistry and physics, has led to great advancement in the manufacture of paper and related products. The tremendous strides of the past fifty years in the utilization of forces and materials have come chiefly from laboratories in which trained scientists with ample equipment and working facilities have solved problem after problem in physics , chemistry, and electricity. Through this diligent research the various fields of wood utilization have been explored.

HISTORY

For the purpose of improving the properties of wood as well as to obtain other specific properties for heat insulation, acoustics, decreased density, and certain decorative effects, products of various kinds are manufactured from wood. These products go under the general names of wall and insulating board, although some of them are not boards and many of them are not used in walls. Nevertheless, it is convenient to group them together as a more or less closely related industry engaged in the manufacture of products used in building construction.

In the early history of wall-board manufacture, paper or "papier mache" was largely employed. During the eighteenth century panels, trays, and other highly ornamented objects made of paper were common. Since 1858, over 150 patents relating to wall board have been issued in the United States (5). These include laminated boards made by cementing sheets of paper or pulp together with sodium silicate, asphallum, tar, gypsum, and other materials.

Wall board became an article of commerce about 1906, but it was not extensivley used until the World War; the insulating boards are of still more recent development.

In a survey of patent literature relating to boards consisting of a single layer there are listed 57 patents together with 22 relating to lath boards. There are already fifteen commercially important insulating boards manufactured wholly or in large part by wood fiber. Many of these are widely advertised and have come into extensive use. The insulating material industry was born about 19 years ago. The first board was such a success that in the last few years more than a dozen similar products appeared on the market. In general, the manufacture of fiber building boards from wood has assumed a great diversity in nature and form of products.

The growth of the industry and its importance are indicated by value of the products of the industry for recent years. The total value of fiber wall board and insulating board and of flexible fiber insulation produced in the United States during 1929 was $29,337,909 and the total value for the depression year of 1931 was $19,296,169 (9,p.897).

RAW MATERIALS AND SPECIES USED

The raw material consists of every conceivable fibrous substance mixed with mineral matter and then suitably coloured. The highest degree of chemically manufactured fibers occurs in wood pulp. Unbleached ground-wood pulp was formerly used almost exclusively in themanufacture of fiber building boards, and some of the well known brands of wall boards are still made wholly or principally from this material. A variety of crudely refined vegetable fibers from other sources are now utilized, particularly in the insulating types of boards. These fibers are obtained from extracted sugar cane, sawmill waste, straws, cornstalks, grasses, extracted licorice roots, tobacco stems, waste papers, bark, flax, cotton stalks, palmetto, asbestos, oat hulls, cottonseed hulls, rye straws, and other similar vegetable materials. This list of fibrous raw materials is comprised largely of farm crop and industrial wastes, the utilization of which is of great economic interest. The position of increasing importance assumed by waste crop materials is largely the result of recent researches on the utilization of farm wastes.

The manufacture of pulp chips for paper and fiber boards from sawmill wastes has become an established and important business in the Northwest. Pulpwood is now the major use of western hemlock and sitka spruce edgings, slabs, and trims. Some white fir and Douglas fir is also converted into pulp chips(8).

Several of the nationally sold fiber building boards are made from sawmill wastes. Thespecies mostly used include northern white pine, longleaf pine, southern gum, eastern spruce, balsam fir, and Douglas fir. There ispractically no restriction as to species usuable for fiber boards.

Economic and research trends and other factors in the pulp and paper and fiber board industries all point to an increasing use of sawmill waste for raw material. Some of these factors are statistics showing an upward trend in the per cent of sawmill wastes used for pulpwood; decreasing availibility of timber; the higher degree of waste utilization for pulp woods in Scandinavia; continued uses for paper and the development of new uses for fiber board; continued integration of thepulp and lumber industries; and research leading to methods for use of species not considered at present(8).

MANUFACTURING PROCEDURE

There are three important steps in the manufacture of the typical fiber building boards from a fibrous raw material. The raw material is pulped; a mat is formed from a water suspension of the pulp on a modified form of paper machine; and the mat is pressed and dried to form the finished board. There are two general types of boards made by different methods. One type is a laminated product consisting of several plies of thin pulp board pasted together with a suitable adhesive, usually sodium silicate; the other is a homogeneous product built up to thickness in the forming operation (9).

The manufacture of laminated boards consists essentially of making pulp board similar to ordinary box board on a conventional multicylinder paper-making machine; and pasting several (usually four) plies together to make up the finished board.

Ground-wood pulp, made by reducing wood to a coarse pulp by contact with a revolving abrasive stone and waste papers, pulped by beating in water, are the principal materials used in this class of boards. The pulps are refined in ordinary beaters. Water resistance is obtained by incorporating sodium resinate precipitated with alum, in the pulp board plies. Laminated products are pra practically all intended for uses as wall boards, the process of manufacture not being well adapted to making boards of the low density required for insulating purposes (9).

The homogeneous boards, now comprising the greater part of the total production, are made on modified cylinder or Fourdrinier paper-making machines. It is not necessary to have the pulp as finely divided for this type of board as for the laminated type, and for this reason the process lends itself more readily to the use of various crop plant materials and to the manufacture of loosely felted insulating boards. The pulping procedure varies greatly according to the raw material used. Crop materials such as bagasse, cornstalks, and straws are usually digested in dilute caustic or in water under pressure, and refined by mechanical means.

Waste wood from sawmills is pulped by exploding with steam, or by mechanical disintegration after softening by cooking in dilute or caustic acid. The pulps are refined in equipment of the kind used in the paper industry, such as Jordans, Clafine or Wiener refiners, attrition mills, rod mills, and beaters. Neither the pulping or refining of pulp is carried as far as in the preparation of paper stock, and all or a large part of the binding lignins and gums which are carefully removed in preparing paper stock, are left in to assist in sizing the board and to act as binders. Water resistance is aided by incorporating rosin size, waxes, gums, pitch, or emulsified asphalt in the fiber mat, and by impregnating the finished board with waterproofing materials. The board may be formed on a modified cylinder machine, and dried on rolls in tunnel driers or between heated press platens. Density and surface finish are controlled by pressure before and during the drying (9).

MANUFACTURING PROCESSES

The preparation and integration of the raw materials to produce suitable fibers may be accomplished in various ways. ground wood or chemical pulp may be formed into boards; wood may be exploded to separate the fibers, or it may be shredded and the excelsiorlike material adhesively united. In order to obtain a better understanding of the technological processes involved inthe manufacture of these materials, a discussion will be given of three types of fiber building boards: (1) Exploded wood fiber, (2) Chemically digested fiber, and (3) Mechanically shredded fiber(5,p.45).

EXPLODED WOOD FIBERS

Although the separation of wood fibers by the explosive force of hot water, steam, and compressed air was claimed in the early patant literatüre, it remained for a man by the name of W.H.Mason to carry it through the experimental stage to the present commercial production pf insulating board and other wood composition. Much credit is due Mr. Mason for his patient and exhaustive investigation to utilize waste wood for theproduction of a high grade synthetic product (5).

In this process any source of ligno-cellulose fibers may be used. At the present time it utilizes round wood, sawmill edgings, or sawmill waste consisting of slabs, shavings, bark, splinters, sawdust, etc,. The wood is first run through chippers which reduce it to chips approximately three-fourths of an inch long. The product of the chipper is next screened to a size three-eights to one inch in length , the fines being used for fuel and the coarse chips returned to chip crushers for rescreening. The chips are next fed into the explosion or "gun" which is 20 inches in diameter and five feet high, having a capacity of 10 cubic feet. It is provided with a manhole at the top for feeding,and quick acting hydraulic valve at the bottom for release. After filling, the gun is tightly closed and steam at 350 pounds pressure per square inch introduced, bringing the temperature to about 375 degrees F. which is maintained for 30 to 40 seconds, after which high pressure steam at 1,000 pounds per square inch is added and maintained for five seconds, reaching a temperature of 540 degrees F. (5).

The hydraulic valve is now opened and chips progressively

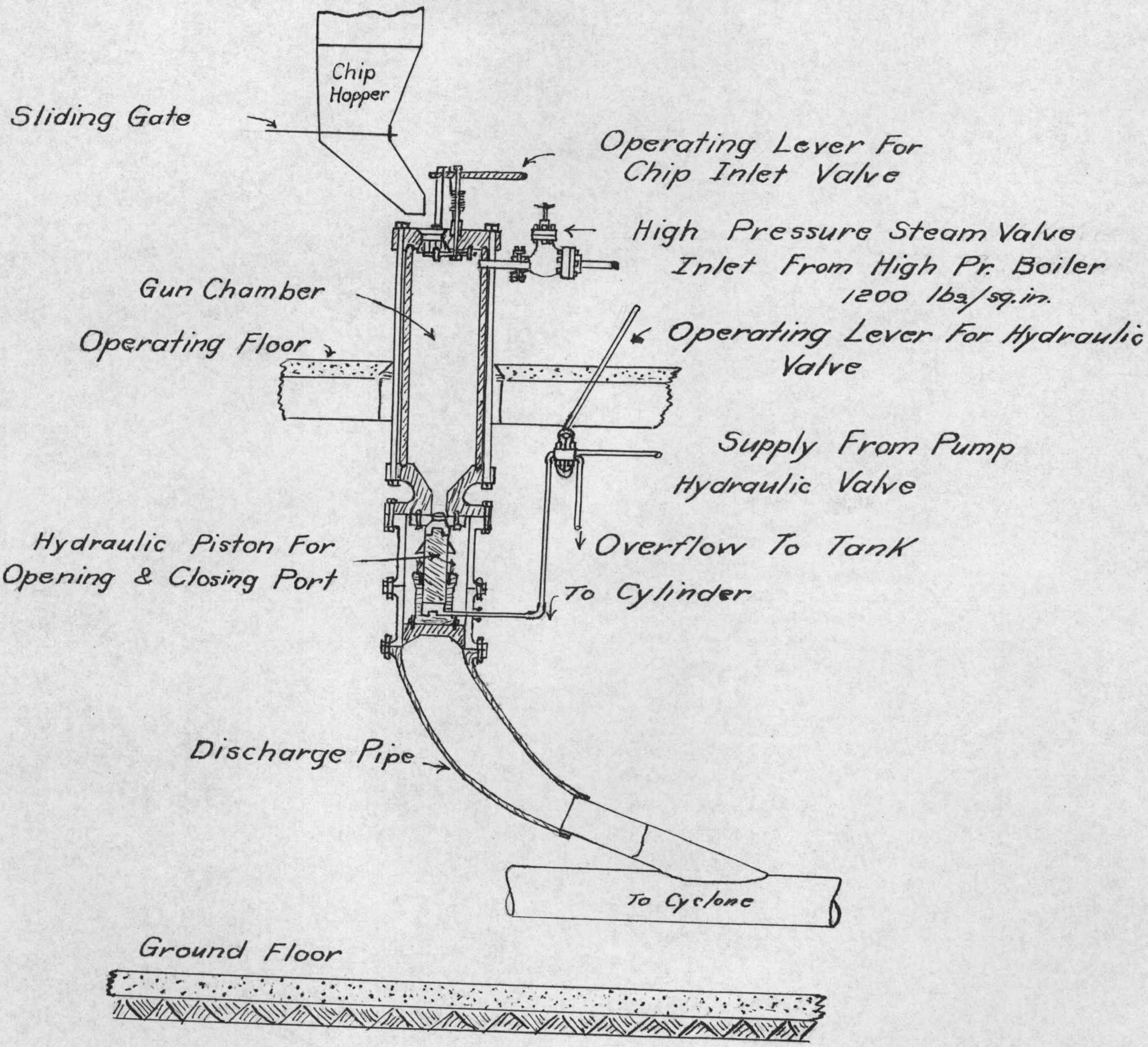


DIAGRAM OF MASON FIBER GUN

discharged through constructed openings, exploding immediately due to the high internal pressure. The complete rupture of the chips produces a mass of long fiber bundles and individual fibers. After separation of the steam in a cyclone, the "gun fiber" is dropped into water maintained at a temperature of 160 degrees F. and next passes through refiners and is screened to remove the fiber bundles which have not been sufficiently disintegrated. Petrolatum or paraffin is next added, and it is now ready to be felted into boards. The machines used for this puppose have been specially developed but operate similarly to the Fourdrinier machines of paper mills except that they produce a wet lap three-fourths of an inch thick rather than a thirty-second inch as on the paper machine. The endless wire is 57 inches wide and an automatic cut-off knife cuts the wet lap into 12½ foot lengths. These pass along until they reach a automatic tipple which feeds them into movable racks from which they are taken to the hydraulic presses. The procedure in thepresses determines the nature of the board to be made. Each press contains 21 steam heated platens. The wet sheets are drawn in between the platens or wire cloth, andthe press is closed. Each press is capable of exerting a pressure of 2,000 tons.

Masonite is the trade name adopted for products made from sawmill waste in this manner. Presdwood, the new commercial product, is a hard and durable board of great tensile strength. It is made by subject to pressure in thepress for a period of about 25 minutes. It is of any thickness from 1/8 to 5/16 inch, depending on how the press is handled. For insulatin board the time is 50 to 60 minutes and the thickness of the board is 7/16 inch. Each charge of a press produces approximately 1000 sq. ft. of board and when the press is discharged back into the empty rack the boards are finished except for cooling and trimming.

Preswood, the hardest board, has a specific gravity of 1.05 and the 1/8 inch thickness weighs 750 pounds to 2,000 pounds per thousand sq. ft. , and has a tensile strength of 3,500 pounds per square inch. One side is smooth and polished, while the other has a mesh surface. It can take any finish that can be applied to wood. Having no grain it is therefore equally strong in all directions. It has an extensive use in the automobile and speed-boat industries, but one of its chief uses is for concrete forms, yielding a smooth even surface not easily obtained otherwise. It is also used for desk tops,card tables, radio cabinets, wall board and paneling, and other specialized lines.

Insulating board has a tensile strength of 225 pounds per square inch, a specific gravity of 0.30, and weighs 700 pounds per 1,000 sq. ft. It is distinctly a structural insulating material useed to reduce noises or equalize temperatures. The annual production of products by this process is in excess of 100,000,000 square feet of board.

CHEMICALLY DIGESTED FIBERS

As representative of the manufacturing process involved a well known product, Fir-Tex, made from bark and waste wood of Douglas fir mills will be explained.

After passing through the usual chipper, the hogged material is screened and the portion consisting of pieces that are as nearly equal in size as possible, is transported to the digesters. Horizontal rotary digesters with a capacity of 12 units of hogged wood and bark are employed. A cookin liquor containing 350 lbs. of caustic coda and 1,500 lbs. of soda ash is added. The cook takes place at about 90 pounds pressure and at a temperature of 300 degrees F. The chips are cooked for 19½ hours during which time the digester revolves at the rate of about one revolution in five minutes. The temperature is maintained by adding live steam. After the cook is completed the contents of the digester are dumped into a conveyor and washed. It next passes through a hammer mill and is shredded. After washing and addition of water to proper consistency it is refined in Jordans and blended in stock chests, here paper makers' size and alum are added. It is formed into sheets on a Fourdrinier machine on 60-mesh wire screen and passed through rolls for the removal of excess water. The wet sheet passes over a table where it is sawed at right angles into desired lengths and passes through a kiln and is dried (5,p.50).

Cards, millboards, boxboards, carriage panels, and similar paper products are manufactured either on a single board machine by means of which single sheets of any required thickness can be obtained, or on a continuous board machine, which is capable of producing cards and plain or duplex boards of moderate thickness(1).

The process is as follows: the wood previously chipped into pieces one inch to 1½ inchs in length is boiled with caustic soda , the digestion being stopped before the wood pulp has been quite softened, and while the pulp is still to hard to be broken up into isolated fibers by simple agitation in water. The pulp after thorough washing is disintegrated by means of a edgerunner, or some form of breaking engine.

The wood can also be reduced by the sulphate process, in which case the chipped wood is boiled in a liquor to which about 25% of spent lye from a previous cooking is added.

The best results are obtained by attention to the cooking process to insure an under-cooked pulp, by careful isolation of the fibers in a kollergang or edgerunner, which machine is capable of separating the fibers without shortening them, and by proper manipulation on the board machine (1).

SINGLE BOARD MACHINE

In this process the beaten pulp , diluted with large quantities of water is pumped continuously into a large wooden vat of rectangular shape. Inside this vat revolves slowly a hollow cylindrical drum, the circumference of which is covered with wire gauze of fine mesh. The drum is not completely immersed in the mixture of pulp and water, so that as it revolves the water passes through the wire, while the pulp adheres to the surface. The water flows regularly into interior of drum and runs away through pipes fitted at each side of the vat near the axis of the drum, and the pulp is brought up out of the water until it comes into contact with a traveling felt. The thin moist sheets of pulp adheres to this felt, passes through squeezin rolls which remove part of the water, and is finally carried between two wooden or iron rollers of large diameter. The pulp adheres too, and is wound up on the upper roller, the felt being carried back by the lower roller to the vat. When the sheet on the upper roller has attained the desired thickness it is immediately cut off and transfered to a pileof similar sheets, a piece of coarse sacking or canvas being interspo sed between every wet board. The dimensions of the full sized board are determined by the diameter of the upper roller and its length. A roll 74 inches wide and 14 inches in diameter will ive a board 74 inches by 44 inches (1).

As soon as a sufficient number of wet boards has been obtained they are submitted to pressure in order to remove the excess of water and at the same time compress the material into dense heavy boards. The pieces pf sacking are then taken out andthe boards dried by exposure to air at the ordinary temperature or in a heated chamber.

The dried boards are finshed off by glazing rolls. These rolls compress the boards still further and impart a polished surface. The amount of "finish" may be varied by the pressure, number of rollings, temperature ofthe rolls, and by damping the surface of the dry boards just before they are glazed. The boards are cut into standard sizes before or after glazing.

DUPLEX BOARDS

If the single board machine is fitted with two vats instead of one it is possible to manufacture a board with different coloured surfaces. A board coloured red on one side and white on the other is manufactured by having one vat full of pulp coloured

red and the second vat full of white pulp. The thin moist sheets from the two vats are brought together and passed through the glazing rolls, which cause the moist sheets to adhere closely to one another, the double sheet of pulp so formed being wound up on the rollers at end of the machine. The board is then dried, glazed, and finished in the usual way (1).

CONTINUOUS BOARD MACHINE

The machine differs from the single board machine in that the finished board can be produced from the pulp at one operation. It is used principally for boards of moderate thickness which can be wound up in the form of a reel at the end of the machine;

The mixture of pulp and water is pumped into two or more vats and formed into a number of thin sheets, which are all brought together between squeezing rolls and passes through heavy press rolls which compress the several layers into a compact mass. The thick sheet obtained is dried over steam-heated cylinders which are placed at the end of the press rolls and calendered. The whole process resembles that of ordinary paper-making, the main difference being the method of producing the wet sheet or card (1).

Some machines are constructed with six or seven vats and forty or fifty drying cylinders, and are capable of turning out large quantity of finished material.

The board can be made of uniform quality and texture throughout or be finished off with high-grade paper on one or both sides. In the latter case the constituents of the "middle" part are waste papers and raw materials of inferior quality, the outer surfaces of wood pulp, white or coloured according to circumstances. The variety of boards which can be produce is due to the fact that the several vats of pulp are independent of one another and can be filled with any kind of paper stock. The combined sheets forming the ultimate board are dried on the ordinary cylinders, calendered, andreeled up at the end of the machine (1).

Another type of insulating material usually called a flexible blanket form utilizes the waste from sawmills cutting northern white pine. Slabs, edgings, and trimmings are disintegrated into chips and then cooked in a solution of sodium sulphite for six hours at 100 pounds pressure. After the digested wood is washed the cooked chips are reduced to fibers by means of attrition mills. Next, the pulp is dried and then disintegrated into a fluffy wool-like product, and then blown onto a moving apron. As the fibers are deposited on the latter, batteries of sprays coat the fibers with a sizing solution and adhesive. Any thickness is obtainable by regulating the speed of the screen on which the fibers are deposited. The composite mat is then dried and encased in asphalt-coated paper or other fabric. The paper liner is made plastic and pliable by creping the paper before it is applied to the fibers. The product reaches the trade in the form of rolls rather than boards (5,p.48).

The principal uses for the products made by this process are for heat andsound insulation. Various types are manufactured to make them suitable for insulation of houses, refrigerator cars, and electric refrigerators. Other forms are used for acoustical corrective purposes, some installations being made with material covered with open mesh cloth or screen.

MECHANICALLY SHREDDED FIBERS

The wood in this process of manufacture consists of tamarack or fir slabs from sawmills or else peeled logs of these species which are purchased. The clean wood is cut into 16-inch lengths, reduced to long, rather coarse excelsiorlike fibers, and conveyed to bins. The next step takes place in a mixer of a special design into which the fiber and cementing fluid are automatically fed and so brought into contact as to coat each fiber uniformly with the magnesia cement.

The cementing material is made from magnesite. In calcining the magnesite for the refractory trade, a fine flue duxt composed of magnesia, silica, and other matter was discharged into the atmosphere. This material is caught in dust precipatators and then treated with sulphuric acid and the resulting solution of magnesium sulphate is mixed with caustic magnesium oxide to form a gelatinous emulsion used as the binding material for the fiber building board. It sets and hardens similarly to the familar Sorel and oxychloride cements (5).

After the treatment with the magnesia cement the mass is then fed into a thin steel conveyor belt, 24 inches in width. This conveyor delivers it to a second conveyor so mounted as to form a space between the double belts which is exactly that of the thickness of the board desired. Its width is next reduced to 20 inches by means of narrow steel belts traveling vertically between the horizontal belts. In this manner the newly formed slab or board enters the setting oven which is the third step in the process. Hot flue gases from the furnace burning waste wood are blown into the setting oven, maintaining a temperature of 500 to 600 degrees F. The oven is four feet by five feet in section and 100 feet long. It travels through the oven in about fifteen minutes and is conveyed by thin, narrow belts totthe final drying oven which is three feet in diameter and about 30 feet long and heated with hot gases to complete the final set. The continuous slab is next sawed by an automatically controlled swinging saw, and a piling mechanism removes it and piles it squarely on the board that preceded it from the oven (5).

This fiber board is made in three thicknesses. The three inch boards are set up like hollow tile partitions. The two inch material is used for exterior construction and is coated with Portland cement stucco. The one inch is suitable for interior wall construction being finished by ordinary plastering.

It is specially adapted for insulating sheathing as a stucco base, insulating lath or plaster base, for fire proofing, and as an acoustical board. The mineralized surfaces of the wood largely protect it against decay and the attacks of termites. It lends itself particularly to the construction of the familar bungalow, and in audience chambers it has proved useful for both its acoustic and decorative effect(5).

OTHER PROCESSES AND METHODS OF FINISHING BOARDS

One recent process used in making hard fiber board is that of vulcanized fiber; fiber or pulp treated with zinc chloride in acid solution,or otherwise, for the manufacture of hard boards.

In this process the paper is passes as a contihuous sheet into a bath of strong zinc chloride of certain density (160-170), which causes the cellulose to swell up and partly gelatinise. A very large excess of strong zinc chloride is necessary and the process is only rendered commercially possible by a careful recovery of the zinc from the washing wastes, which are submitted to chemical treatment.

The vulcanized product is subsequently treated with nitric acid or with a mixture of nitric and sulphuric acids to render them waterproof. Dextrin is frequently employed to retard the chemical action to permit of the necessary manipulation of the material before it is finally washed. The complete removal of the excess of zinc and acid is a necessary feature of the whole operation.

There have been many processes patented on the manufacture of fiber board. There have also been many methods devised for testing strength properties , moisture vapor transmission, staining prevention, making good elasticity and water and fire resistance of boards.

It is now a common practice to give the finished boards special surface treatment to increase their resistance to moisture and improve their appearance. Moisture resistance is obtained by incorporating sodium resinate or by means of waterproof surface coatings. The treatments include decorations and sizing coatings with paints, oils, waxes, synthetic resins, etc,. On some boards a "liner" of paper is pasted to one or both sides to improve the appearance and reduce air permeability. Considerable attention has been recently given treatments to reduce the rate of burning of fiber boards, and surface coating with sodium silicate has been found quite effective; however such treatment impairs the acoustic properties of the boards. It is possible that fiber boards can be made slow-burning by impregnating with one or more of the salts used for flame-proofing textiles and and papers without seriously affecting the heat or sound insulation properties. It is also possible to reduce the susceptibility to molding to a point where the fiber board is less susceptible to mold growth than untreated wood by treating with solutions of zinc chloride, mercuric chloride, or other strong fungicides (9).

TYPES OF WALL AND INSULATING BOARDS

Wall board (of wood) has been defined by the National Committee on Wood Utilization as a " type of board composed of a number of layers of chips, binder ore pulp board molded or pasted together and generally "sized" either throughout or on the surface , it may also be non-laminated and homogeneous in nature." Of the principal commercial wall boards those which have wood fiber in the form of old paper as the principal component include Agasote, Vehisote, and Alton wall board. Others which are made from raw wood are Beaver-board, Compo-board, Cornell board, Fibelic, Upson board, Presdwood, and several others (2).

Wall board is important because it was the forerunner of a new wood product - insulating material.

At the present time there are 15 insulating boards, one or more flexible quilts and one fill-type of insulation made from wood.

Many of the insulating boards made from wood are manufactured by methods quite similar tothose in the pulp and paper industry. An example of this type of rigid insulation is Fir-Tex, one of the boards developed in recent years. As it mame signifies, Fir-Tex is made from Douglas fir, as previously mentioned (2).

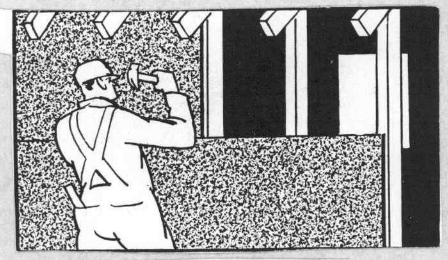
FIR-TEX

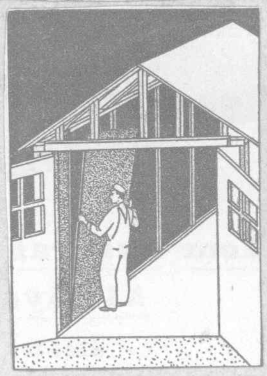
There are several types, sizes, and finishes of Fir-Tex made. Fir-Tex building board is made full ½ inch and 1 inch thicknesses, 4 ft. wide, and from 4 to 12 feet long. It is of a natural tan color, with a sanded or unsanded finish as desired. Fir-Tex "Ivrykote" building board comes in the same sizes only with a mottled ivory, glazed washable surface. The boards are wrapped in substantial packages, each containing six sheets. All packages are plainly marked as to number and size of contents.

Fir-Tex building board, by a special chemical treatment given the fir fibers, is highly water resisting, It is also a very slow burning material, and it chars rather than burns. It is vermin resisting- does not encourage fungus growth- and when given the same protection accorded to other building materials will outlast the life of the building in which it is used(10). Fir-Tex ½ inch building board has a tensile strength of over 250 pounds per square inch. During manufacturing processes these fir fibers are so skillfully laced and interlaced that great strength and rigidty in this board is the result (10).

Fir-Tex "Firkote" sheathing board is made to a standard thickness of 25/32 inches, 4 ft. wide, and from 7 to 12 feet long.

SHEATHING

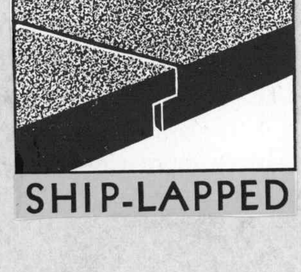




BETWEEN FLOORS

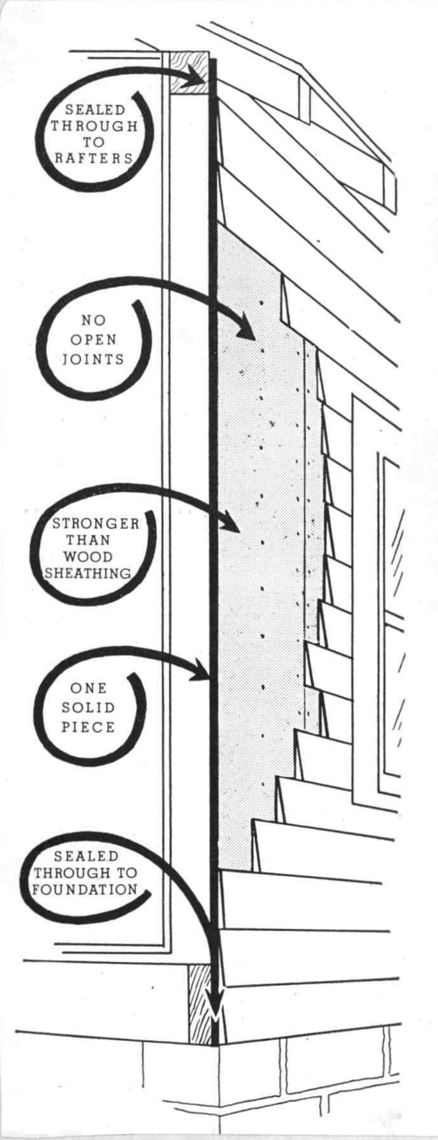
FINISH

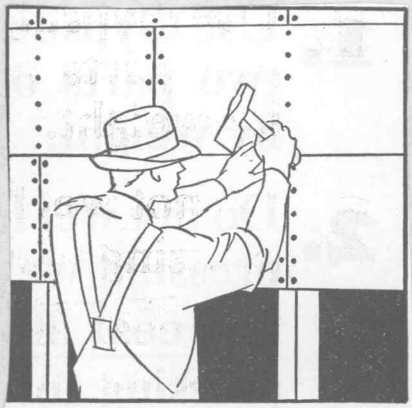
PLASTER BASE



SHIP-LAPPED

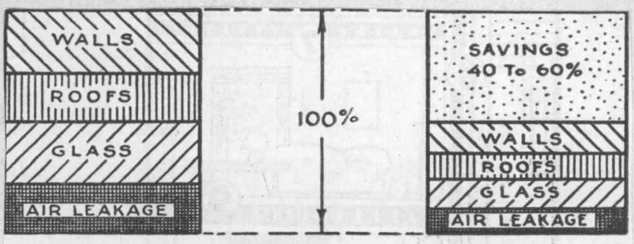
Applications of
Fir-Tex





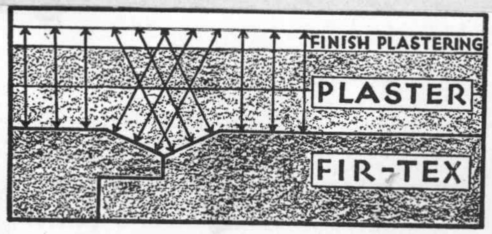
Long edges of lath must extend across framing making continuous horizontal joints.

Corners and angles to be reinforced.



Heat loss when walls and roofs are not insulated; and when storm sash and weather stripping are not used.

Heat loss when walls and roofs are well insulated; and when storm sash and weather stripping are applied to all outside openings.



Fir-Tex Insulating Plaster Lath as shown above contains the finished plaster. Note the reinforcement obtained from the bevel and the rigidness obtained from the shiplap.

Fir-Tex as Insulation

Fir-Tex as Plaster Lath

The finish is a glazed , waterproof surface. Firkote is all wood but the fibers are shredded and processed (without reducing to cellulose and impairing the natural strength of wood) and these fibers felted together so as to produce millions of dead air cells in each square foot of thematerial. These air cells provide a degree of insulation against heat, cold and sound that is three times more effective than wood, eight times more than plaster board, twelve times brick, fifteen times clay tile, and twenty-five times more effective than concrete.

Costs of Firkote sheathing are usually no greater and frequently less than lumber and building paper. Firkote lowers application costs because it is more easily and quickly applied, and no building paper is required. Costs saved are: building paper, costs of nails tohold paper in place, cost of application, and the length of time to build the home. Other plus advantages are: a stronger, more durable job, a degree of insulation far greater than from wood sheathing.

Fir-Tex finish plank is made withlong edges beveled and beaded. Standard thicknesses are ½ inch and 1 inch. Sizes are 6", 8", 10", 12", 16" wide by 6', 7', 8', 9', 10', 12', long. Colors are a natural tan or "Ivrykote".

Fir-Tex tile board comes in standard thicknesses of ½ inch, 3/4 inch and 1 inch. Sizes run from 6" to 24" by 6" to 48". Colors are a natural tan or "Ivrykote".

A Fir-Tex product, Economy Insulatin Plaster Base Lath is full 3/8 inches thick, 18 inches wide, and 48 inches long. Square cut sides and edges. It is put up in packages containing 15 pieces, or 90 square feet, or 10 sq. yds. Fir-Tex building lath is full ½" thick, 18" wide, 48" long, beveled four sides and shiplapped the long way. It is wrapped in Kraft paper packages, each containing 10 lath or 60 square feet per package.

Before the manufacture of Fir-Tex, most fibrous insulators over half an inch thick had to be bonded together in layers, with a resulting lowering of insulation efficiency. Today Fir-Tex is manufactured a full inch thick or thicker- not laminated- giving vastly increased protection from heat, cold and noise.

The significance of this new product in protecting American homes and American industries is summarized by government insulation experts: "From the point of view of insulation only, the most important question is the thickness of insulating material to be applied, rather than what material to select, provided the choice is restricted to the class of cellular or fibrous materials. No known material in a very thin layer can be expected to provide an appreciable amount of insulation. If a layer of insulating material is added to a wall, the insulating value ofthe wall will be increased by an amount equal to the insulating value of the material added. The thicker the layer, the greater will be the insulating value of the resulting wall".--- (Department of Commerce Bureau of Standards--Circular 227.) (10).

As also stated in Circul r No.227, fiber board contains more insulating and sound deadening values than even greater thicknesses of solid wood, plaster, brick or concrete. A one-half inch thickness of Fir-Tex buildin board would be the superior of one and 3/16 inches of solid wood, two inches of plaster, or four inches of brick or concrete.

Economy insulating board is made full 3/8 inch thickness, 4 feet wide, 6 to 12 feet long. It is wrapped is substantial bundles, each containing eight sheets -- all bundles plainly marked as to contents, sizes, etc,. Fir-Tex super insulation is manufacture up to 1½" thick without lamination. Standard sizes are 4 ft. wide and 6 to 12 ft. long, also 4' by 4' and 2' by 4'. It is made expecially for cold storage insulation, refrigerators, etc,. When used in house construction it will reduce fuel cost at least 40%. In the process of manufacturing , this Fir wood is thoroughly sterilized by excessive steam temperature and pressure to fully eliminate and assure that Fir-Tex super insulation does not contain any mold or fungus growth. The process of interlacing the Fir wood fibers is such that a very large number of air cells are formed, which air cells being sealed between the fibers produces superior insulation and sound-deadening values (10).

Fir-Tex roof insulation board is made in standard thicknesses of ½", 1", 1½", 2", and in sizes 22" by 47" and 24" by 48".

Fir-Tex refrigerator insulation blocks are made in standard thicknesses of 1", 1½", 2", 3", 4", The blocks are of low density, moisture-proof, waterproof, and vapor-proof. They are in rectangular shapes and are wrapped in vapor tight paper (10).

OTHER TYPES MANUFACTURED

Another pulpboard is Nu-wood, made of white pine. The J-M (Jones Mansville) board is one of the several made from pure spruce fiber (2).

Beaver-board or (Certain-teed) is also made from spruce, the chips being crushed, then mixed with diatomaceous earth and a little paper pulp. Weather is made from cottonwood fiber plus a small amount of willow (2).

There are several other insulating boards made from wood fiber, including Arborite, Birds-wood, Homosote, Insul-board, Temloc, Ten-Test, Ther-board, Thermo-sote, and Insulite.

Insulite is manufactured from the tough durable fibers of Northern woods. The wood is ground to fiber is such a manner as to retain the full strength of the fiber and also the natural, attractive, light color of the fresh wood. The fibers are subjected to a chemical treatment which renders the finished product moisture resistant. Then the fibers are felted into rigid, structural sheets in such a manner as to develop maximum strength and heat resistance. Insulite products are also treated during the process of manufacture to make them resistant to the attacks of termites or other vermin (2).

Among the flexible forms of insulation one of the most important of those made from wood is Balsam-wood which is manufactured from white pine, Norway pine, balsam fir and spruce (2).

PROPERTIES AND USES

The most important of the fiber building boards at present are those designed for heat and sound insulation. These fiber products owe their heat insulating properties to innumerable minute air spaces which they contain and to the infrequency of fibers parallel to the line of heat flow to act as conductors; hence, the insulating value of a board depends on its density and on the arrangement of its fibers. The results of heat transmission tests indicated that for ordinary vegetable fiber insulation, heat transfer through the fiber insulating materials is practically all by conduction in the fibers through the enclosed air. Other things being equal, boards having the greatest proportion of fibers parallel to the surfaces of the boards, and perpendicular to the line of heat flow, have the lowest conductivity. However present methods of manufacture tend to orient the fibers in this position, leaving density as the important factor. Above a minimum not attained in commercial products, the thermal conductivity of sheet insulating material has been found to increase with density at an approximately uniform rate (9).

A standard specification for fiber insulating board was adopted in 1932 by a general conference of producers, distributers, and users. The standard establishes definite criteria of the insulating value and other physical requirements that should be possessed by this material (6).

The standard is a minimum specification for two classes of fiber insulating board designated as "insulating building board" and "roof insulating board". The properties of insulating building board which is intended for such uses as sheathing partitions and plaster base, are governed by requirements of thermal insulation, water absorption, tensile strength, deflection, minimum thickness, plaster adhesion, and expansion with moisture absorption. The properties of roof insulating board which is used as the name implies are controlled by requirements of thermal insulation, water abosrption, tensile strength, and minimum thickness (6).

The following table gives the minimum commercial acceptance requirements for fiber insulating board.

Requirements	Insulating Building Board	Roof Insulation Board
Maximum allowable thermal conductivity per hr.,per sq.ft.,per deg.F.,per inch of thickness B t u.	0.36	0.36
Minimum thickness...............inch	13/32	13/32
Maximum allowable water absorption, based on initial volume per cent	5	10
Min. aver. tensile strength,lbs./sq.inch	175	100
Max. deflection of a 4 by 12 inch specimen, with 8 inch span, in center loading with 10 lb. weight, loaded for 30 seconds ....inches	0.1	
Min. plaster adhesion....lbs./sq.ft.	600	
Max. linear expansion........per cent	$\frac{1}{2}$	
Standard sizes:		
Boards..........inches	48 by 72,48 by 84 48 by 98,48 by 108 48 by 120,48 by 144	22 by 47 24 by 47 24 by 60 30 by 47
Lath............inches	16 by48,18 by48 24 by 48	

Few uses of insulating board requires that they contribute materially to the strength of the structure and sufficient strength for economic handling and erection appears to be all that is needed.

The boards are commonly made withthe lowest density consistent with sufficient resistance to flexural breaking for satisfactory handling. The essential properties for a typical insulating board follow:

Thickness,inch....................0.44
Density, gram/cc 0.26
Thermal conductivity b.t.u./sq.ft.
(hr) (inch) deg. F. 0.34
Flexural breaking strength (12-
inch span,3" wide)....lbs. 9.8

Some of the properties that make a fiber board effective as a heat insulator tend to make it sound-absorptive. The loose fiber arrangement and high porosity characteristics of boards of low density result in high absorption of sound and make the ordinary insulating boards valuable for sound insulation(9).

These boards are essentially heat insulating boards, an inch or more in thickness, usually made in small panels with beveled edges and often with special surface modifications im the way of regularly spaced holes or grooves to increase sound absorptions.

Common wall boardsare designed only for use as finish cover for interior walls and ceilings. They differ from insulating boards in that they are usually of much higher density, with greater strength per unit of thickness, and have a surface with decorated finish or designed for such finish.

The properties of a typical wall board are:

Thickness,inch.............. ..0.19
Density, gram/cc 0.55
Flexural breaking strength (12"
span,3" wide) lbs. 15.3

Fiber boards are subject to dimensional changes with changes in the relatively humidity of the surrounding stmosphere. However with modern methods of manufacture the dimensional changes are minimized, and many of the boards purchased by the Federal government are now required to show a lineal expansion of not over 0.5 per cent for a relatively humidity of from 50 to 60 per cent (9).

USES OF FIBER BOARD

Fiber board is used widely in home construction is walls, roofs, attic floors, and basement ceiling as heat insulation. It is also used in place of lath andplaster because of greater ease and speed of application. It does not, however, make a surface suitable for papering because expansion and contraction are often sufficient to crack the paper at the joints. Most pleasing effects are obtained in panel effects with a decorative surface. It is well adapted for use as sheathing under brick or stone veneer, and is used inplace of lath for inside plaster or outside stucco. If kept well painted it will give good service as outside sheathing for summer cottages and temporary construction. In factories and office buildings it is used extensively for roof insulation. The acoustic boards are being used increasingly as inside wall covering for theaters, auditoriums, hotels, restaurants, and churches for sound absorbing purposes. Ordinary wall boards find their chief applications as wall coverings in cottages, temporary buildin s and partitions and similar construction where low cost and ease of speed of application are the principal factors. However, boards designed for special finish as or with decorated finishes are used for interior finish covers in building construction ofthe better classes (9).

COMPETITION

In the advance in wood utilization the pulp industry has made by far the nost progress in industrial research, more progress, in fact, in fundamental research than the lumber and wood-using industries combined (8). Pulp products are now in extensive and increasing competition with sawn lumber and wood products in their natural form. Wood fiber boxes and containers of all kinds have been a familiar product for the last quarter century. But wood fiber boards for building and structural insulation are largely a development of the last few years.

Many of the fiber boards are widely advertised and have come into extensive use. Fiber building boards have already displaced over a billion and a half annually of ordinary lumber.

In comparison with other fibrous substances wood fiber makes the most efficient insulating boards at the lowest cost.

CONCLUSION

The advent of exploded wood and chemical processes of making fiber boards may have a far-reaching effect upon the forest utilization and the practice of forestry throughout the country. Forest waste may be utilized to the extent of its commercial value as pulp wood. This means a saving ofmany million feet of timber.

Another thing that can be expected of fiber board manufacturing processes is possible reduction of the forest rotation. Trees from 25 to 35 years old may be used. Thus, the value of cutover land, if immediately restocked, is increased materially (4).

It may open the door to a new and more rapid method of utilizing of waste in the making of paper. It characterizes the trend to closer utilization and conservation of the country's timber resources by progressive-minded people (4).

It is not beyond the bounds of possibilities that with the aid of diligent research economical methods will be devised to convert into wood pulp, and wood chemical products, the lower grades which now as board lumber are being laboriously sold in glutted markets, at unprofitable prices, to unenthusiastic consumers, or to bargain-hunting industries. In that event, wood pulp, and wood fiber products made from present non-utilized materials, and from the low grade portions of the log will become a familiar and eventually perhaps universal product of the best lumber manufacturing mills in America (3).

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