(Rev.) 1677

INSULATION BOARD, WALLBOARD, AND HARDBOARD

Revised July 1950

No. 1677

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
FOREST PRODUCTS LABORATORY
Madison 5, Wisconsin
In Cooperation with the University of Wisconsin

INSULATING BOARD, WALLBOARD, AND HARDBOARD

Forest Products Laboratory,[1] Forest Service
U. S. Department of Agriculture

This report is intended as a reply to frequent requests received by the Forest Products Laboratory for information on the manufacture of insulating board, wallboard, and hardboard.

Definitions

Insulating board is a porous board composed of wood- or vegetable fiber material. It may consist of several laminated layers or be a single nonlaminated sheet of the required thickness. It is sized throughout.[2] Desirable properties are: low thermal conductivity, moisture resistance, fire resistance, vermin and insect resistance, permanency, and structural strength. None of the boards available possess all these properties to the most desirable degree, but all should meet certain strength and moisture-absorption requirements. Insulating board may be used for interior walls with either plain or decorative finishes, as an acoustic, or as a plaster base. It is also used as roof insulation and as a sheathing material. Although its insulating value increases with decrease in its density, strength requirements usually limit its density to not less than 16 pounds per cubic foot. Commercial sizes vary in nominal thicknesses from 1/2 to 1 inch.

Wallboard and fiberboard are often used as general terms to include all types of building board. More strictly, however, the word wallboard is used to denote a variety of boards composed of coarse fibers, wood pulp, waste paper, and the like, molded with binders or laminations cemented together. These boards may not be as thick and porous as insulating board, but are usually denser (up to 45 pounds per cubic foot), and stronger. Commercial sizes vary in nominal thicknesses from 3/16 to 3/8 inch.

Hardboard (or pressboard) may be composed of the same types of materials as insulating boards or wallboards. It is compressed to a relatively high density (60 pounds per cubic foot), has a hardened surface, and is generally quite tough. It is used for paneling, table tops, and the

---

[1] Maintained at Madison 5, Wis., in cooperation with the University of Wisconsin.

[2] The Dictionary of Paper. American Pulp and Paper Association, New York, N. Y. (1940).

like, and for a wide variety of special articles and purposes. Commercial sizes vary in nominal thicknesses from 1/8 to 1/4 inch.

Materials

The raw materials used in the manufacture of building boards[3] in the United States and Canada are jack pine, southern pines, Virginia pine (Jersey pine), Douglas-fir and other western firs, balsam fir, possibly some hemlock and spruce, aspen, cottonwood and other bottomland hardwoods, tupelo, extracted pine-stump waste and other wood waste, straw, hemp and flax wastes, bagasse, extracted licorice root, pulp-mill screenings, and waste paper. Cornstalks have also been used.

Production

As shown in table 1 the total annual production of building boards of all types has increased very rapidly during recent years. The production increased about 100,000 tons between 1935 and 1940. The subsequent increases of nearly 500,000 tons during 1941 and nearly 250,000 tons during 1942 were undoubtedly due to the war demand. By 1948 the production had reached a total of 1,270,348 tons. In recent years the proportion of insulating board produced has been about 70 percent of the total of building boards.

Manufacture

Several methods are employed commercially in the manufacture of insulating board, wallboard, and hardboard. These methods may be mechanical or combinations of chemical and mechanical processes.

One mechanical process consists of grinding short logs (2 to 4 feet long) in an ordinary pulpwood grinder. Coarse grit stones are used that have a much rougher grinding surface than that employed in the production of paper pulp. The energy consumption is from 35 to 50 horsepower-days per ton. A considerable amount of insulating-board stock is made in this way. Another strictly mechanical process consists of shredding the wood into a fine excelsiorlike product in a machine called a "Defiberizer." This process is adaptable to the use of wood waste in the form of slabs, edgings, and pieces about 2 feet in length. Very little of this type of fiber is used in insulating board at the present time; a small amount is used for the production of a molded hardboard. Another mechanical method that is still in a developmental stage, is the milling of water-softened chips in a disk attrition mill.

---

[3] This report does not include descriptions of those types of wallboard composed of cork, gypsum, or asbestos.

The combinations of chemical and mechanical processes consist of mild chemical or steam treatments of the material (in chip form, in the case of wood) in digesters or special retorts, followed by a mechanical fiberizing treatment. The fiberizing can be accomplished by blowing the contents of the retort against a target, as in the Mason process[4], by milling the softened material in disk-type attrition mills, or by hammer mills, rodmills, special-type jordans, and beaters. Often a combination of the several types of milling equipment is used. The Asplund process[5] is unique in that the steaming chamber and mill are integral parts of one machine, a combination that permits the fiberizing to be done at a temperature close to that of the steaming treatment. The Chemipulper[6] is a series of chambers in which the material can be continuously treated with hot water, steam, or chemical solutions. It can be operated independently of, or directly connected to, an attrition mill. The Mason process previously mentioned consists of heating the wood chips with high-pressure steam and "exploding" them by a sudden release of the pressure. Advantages in fiber characteristics and economies of operation are claimed for both methods of milling the treated material, that is, (a) in the presence of steam or in highly heated chemical solutions, or (b) after cooling and separation from the chemical solutions. The energy required to fiberize the material and to refine the fiber varies from 20 to 40 horsepower-days per ton.

The fiberized material is usually mixed in varying proportions with one or more of the following: repulped waste paper, hydrated pulp stock, and refined pulp-mill screenings. Moisture-, fire-, and vermin-retardant materials and sometimes bonding agents are added. Approximately 3,000 square feet of 1/2-inch insulating board can be made from 1 ton (oven-dry weight) of the mixture. The fibrous mixture used for hardboard is usually composed of finer or shorter fibers, and has freer drainage characteristics than that used for insulating board. Typical fiber-length ranges from those of insulating board to those of hardboard stocks, respectively, as determined by screen analyses are:[7]

---

[4] Paper Trade Journal 84 (No. 8) 131-136 (Feb. 24, 1927).

[5] U. S. Patent No. 2,008,892 (July 23, 1935) and Paper Trade Journal 113 (No. 11) 29-31 (Sept. 11, 1941).

[6] Paper Mill News 67 (No. 47) 14, 16, 18, 20 (Nov. 18, 1944) and 68 (No. 14) 14, 16 (April 7, 1945).

[7] From a description of wallboard manufacture in "Manufacture of Pulp and Paper," Volume 5, pages 289-300 (McGraw-Hill Book Co., New York, N. Y. 1939).

Screen	Percent
Over 14 mesh	30 to 45
Between 14 and 28 mesh	25 to 30
Between 28 and 48 mesh	7 to 10
Between 48 and 100 mesh	6 to 9
Between 100 and 200 mesh	2 to 5
Through 200 mesh	12 to 20

The method of molding and pressing single panels has been used to some extent, but it has been largely replaced with continuous-cylinder or Fourdrinier types of machines. The continuous sheet (8 to 12 feet in width), after passing between press rolls, is cut into lengths of 12 to 20 feet before being fed into the dryer. The drying of insulating board is accomplished in single- or multiple-deck continuous-tunnel dryers with suitable loading and unloading equipment, and in a few instances in multiple-deck hot presses. The material entering the dryer or press contains about 50 or 60 percent moisture. The drying temperature varies from 300° to 500° F. and is less (in the case of tunnel dryers) at the dry end than at the wet end. Hardboard is dried in multiple-platen hot presses, with the pressure at the maximum point of the schedule at about 400 pounds per square inch.

Properties of Boards

As previously mentioned, wallboard and hardboard should meet certain minimum requirements of moisture resistance and of strength. Test data obtained on several commercial boards, together with the Federal and A.S.T.M. specifications, are given in table 2.

Literature

In addition to the literature cited in the footnotes, the following articles and publications may be of interest.

A review of patent literature up to 1928 is given in articles by Joseph Rossman, "History of Laminated Wallboard Patents" and "Wallboard Patent History," in Paper Trade Journal 86 (Nos. 3 and 22) 21-23 and 50-53 (Jan. 19 and May 31, 1928), respectively. Patents since 1928 are listed in the annual issues of "Bibliography of Paper Making," by C. J. West (Technical Association of the Pulp and Paper Industry, New York, N. Y.).

References to articles on wallboard manufacture are also listed in the annual issues of the "Bibliography of Paper Making," as well as in the three compilations, 1900-1928, 1928-1935, and 1936-1945.

The National Bureau of Standards, Washington, D. C., has issued several bulletins and articles on commercial fiber building boards dealing especially with structural-strength, durability, insulating, and acoustical properties. Among these is the article, "Fiber Building Boards: Their Manufacture and Use," by Charles G. Weber, Industrial and Engineering Chemistry 27 (No. 8) 896-898 (August 1935).

"Wallboard Manufacture in Sweden According to the Defibrator System," Uno Lowgren, West Coast Lumberman 74 (No. 2) 85-91 (Feb. 1947).

"Manufacture of Insulating Board" and "Post War Development of the Insulating Board Industry," F. L. McConnel, Southern Pulp and Paper Journal 9 (No. 11) 54, 58, 62 (Oct. 31, 1946).

A.S.T.M. Emergency Specifications Designation DS-19 August 24, 1942. American Society for Testing Materials.

The following Federal specifications can be obtained from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C., for 5 cents in coin:

Federal Specification LLL-F-321b, December 17, 1942, Fiberboard: Insulation.
Federal Specification LLL-F-311, July 12, 1940, Fiberboard: Hard-Pressed, Structural.
Federal Specification UU-W-101a, July 3, 1935, Wallboard: Composition.

"An outline of the insulation board industry," by Carl G. Muench. Paper Trade Jour. 125 (No. 5) 48-50, July 31, 1947.

"Wallboard production and uses," Northeastern Wood Utilization Council, New Haven, Conn. Bul. 31, Jan. 1950.

"Hard facts on hardboard," by A. Elmendorf, Wood (Chicago, Ill.)
Part 1, Vol. 4, No. 12 (Dec. 1949)
Part 2, Vol. 5, No. 1 (Jan. 1950)

Table 1.--Production of building boards of all types 1935-1948[1]

Year	Wallboard	Insulating board	Other building board	Total
	Tons	Tons	Tons	Tons
1935	--	--	--	79,814
1937	--	--	--	110,005
1939	--	--	--	114,505
1940	40,748	112,004	24,691	179,443
1941	254,477	362,033	12,053	628,563
1942	260,057	608,705	7,816	876,578
1943	301,333	577,473	7,746	886,555
1944	273,065	636,659	7,976	917,690
1945	300,087	646,017	7,587	953,691
1946	--	--	--	975,653
1947	301,551	770,821	--	1,072,372
1948	364,562	905,786	--	1,270,348

[1] Source: Bureau of Census, U. S. Department of Commerce.

Table 2.--Some properties of commercial insulating and hardboards and specification requirements

	Insulating board							Hardboard			
	Thickness	Density	Breaking load	Deflection at 12 pounds	Tensile strength	Linear expansion	Water absorption	Thickness	Density	Modulus of rupture	Water absorption
	Inch	Lb. per cu.ft.	Lb.	Inch	Lb. per sq.in.	Per-cent	Percent by volume	Inch	Lb. per cu.ft.	Lb. per sq.in.	Percent by weight
Commercial boards:[1]											
A	0.510	19.2	16.6	0.31	266	0.10	5.0				
B	.510	22.0	15.7	.18	152	.08	6.0	0.140	60	5,310	11.0
C	.500	18.8	15.9	.34	238	.23	8.6				
D	.475	18.8	14.6	.31	229	.20	8.5				
E	.485	17.9	11.1		219	.15	11.1				
Specification requirements:											
Federal, insulating[2]	(3)		[4]12.0	2.85	[4]150	2.50	[5]7.0				
ASTM, insulating[6]			[4]12.0	2.85	[4]175	[5]2.50	[5]7.0				
Federal, hardboard[7]								(8)	[4]60	[4]6,000	[5]20.0

[1]Obtained from local lumber yards. Insulating boards tested according to A.S.T.M. Emergency Specifications. Hardboard tested according to Federal Specifications.

[2]Federal Specifications LLL-F-321b, December 17, 1942, Fiberboard: Insulating, Class A building board.

[3]Tolerance: Nominal thickness ± 0.0625 inch.

[4]Minimum.

[5]Maximum.

[6]A.S.T.M. Emergency Specifications, Designation DS-19, August 24, 1942, Class A building board.

[7]Federal Specifications LLL-F-311, Fiberboard: Hard pressed, structural, July 12, 1940, Class A, untreated.

[8]Tolerance: Nominal thickness ± 0.0156 inch.