Fiberboard (纖維板)

The term fiberboard includes hardboard, medium-density fiberboard (MDF), and insulation board.

Several things differentiate fiberboard from particleboard, most notably the physical configuration of the comminuted material.

Fibers can be made from many lignocellulosics and form the raw materials for many composites, most notably fiberboard. Fibers are typically produced by the refining process.

Fiberboards

- To make fibers for composites, bonds between the wood fibers must be broken.
- In its simplest form, this is accomplished by attrition milling (refiner).
Attrition milling, or refining as it is commonly called, can be augmented by water soaking, steam cooking, or chemical treatments. Steaming the lignocellulosic weakens the lignin bonds between the cellulosic fibers. As a result, the fibers are more readily separated and usually are less damaged than fibers processed by dry processing methods. Chemical treatments, usually alkali, are also used to weaken the lignin bonds. All of these treatments help increase fiber quality and reduce energy requirements, but they may reduce yield as well. Refiners are available with single- or double-rotating disks, as well as steam-pressurized and unpressurized configurations. Two types of pressurized refiners are being used and they shall be differentiated here as the single- and double-revolving disc which is the same classification as used to identify the atmospheric refiner. For MDF, steam-pressurized refining is typical.
Fiberboards

Pressurized refiner (Single-revolving-disk)

0.55-1.05 MPa (160-185°C)

Pressurized refiner (Double-revolving-disk)

Up to 1.05 MPa
Fiberboards

Pressurized refiner (Double-revolving-disk)

Figure 7.28. General view of refiners in a plant (Ruckel 1973).

Fiberboards

Dry-process fiberboard

- Fiberboard is normally classified by density and can be made by either dry or wet processes.
- Dry processes are applicable to boards with high density (hardboard) and medium density (MDF).
- Wet processes are applicable to both high-density hardboard and low-density insulation board.

Figure 10.16. Sketch of principal steps in wet and dry fiberboard processes (Schickard and Woodrow 1986).
Dry-process fiberboard is made in a similar fashion to particleboard.

- Resin (UF, PF) and other additives may be applied to the fibers by spraying in short-retention blenders.
- Introduced as the wet fibers are fed from the refiner into a blow line dryer.
- Add the resin in the refiner.

The adhesive-coated fibers are then air-laid into a mat for subsequent pressing, much the same as mat formation for particleboard.

Pressing procedures for dry-process fiberboard differ somewhat from particleboard procedures.

- After the fiber mat is formed, it is typically pre-pressed in a band press.
- The densified mat is then trimmed by disk cutters and transferred to caul plates for the hardboard pressing operation.
- For MDF, the trimmed mat is transferred directly to the press.
All dry-formed boards are pressed in multi-opening presses at approximately 140°C to 165°C for UF-bonded products and 190°C for PF-bonded products. Continuous pressing using large, high pressure band presses is also gaining in popularity. Board density is a basic property and an indicator of board quality. Since density is greatly influenced by moisture content, this is constantly monitored by moisture sensors using infrared light.

Wet-process hardboards differ from dry-process fiberboards in several significant ways. First, water is used as the distribution medium for forming the fibers into a mat. As such, this technology is really an extension of paper manufacturing technology.

Secondly, some wet-process boards are made without additional binders. If the lignocellulosic contains sufficient lignin and if lignin is retained during the refining operation, lignin can serve as the binder. Under heat and pressure, lignin will flow and act as a thermosetting adhesive, enhancing the naturally occurring hydrogen bonds.
Refining is an important step for developing strength in wet-process hardboards. The refining operation must also yield a fiber of high “freeness;” that is, it must be easy to remove water from the fibrous mat. Wet-process hardboards are pressed in multi-opening presses heated by steam. The press cycle consists of three phases and lasts 6 to 15 min.

The first phase is conducted at high pressure, and it removes most of the water while bringing the board to the desired thickness. The primary purpose of the second phase is to remove water vapor. The final phase is relatively short and results in the final cure.

A maximum pressure of about 5 MPa is used. A high temperature of up to 210°C is used to increase production by causing faster evaporation of the water.

Several treatments are used to increase the dimensional stability and mechanical performance of hardboard. Post-Treatment of Wet- and Dry-Process Hardboard

Heat treatment

- Heat treatment—exposure of pressed fiberboard to dry heat—improves dimensional stability and mechanical properties, reduces water adsorption, and improves interfiber bonding.
Tempering
- Tempering is the heat treatment of pressed boards, preceded by the addition of oil.
- Tempering improves board surface hardness and is sometimes done on various types of wet-formed hardboards.
- It also improves resistance to abrasion, scratching, scoring, and water. The most common oils used include linseed oil, tung oil, and tall oil.

Humidification
- Humidification is the addition of water to bring the board moisture content into equilibrium with the air.
- Air of high humidity is forced through the stacks where it provides water vapor to the boards.
- The entire process is controlled by a dry-bulb-wet-bulb controller.
- Another method involves spraying water on the back side of the board.

Insulation Board
- Like the manufacture of wet-process hardboard, insulation board manufacture is a modification of papermaking.
- Insulation boards typically do not use a binder, and they rely on hydrogen bonds to hold the board components together.
- Sizing agents are usually added to the furnish (about 1%) to provide the finished board with a modest degree of water resistance and dimensional stability.
- Sizing agents include rosin, starch, paraffin, resin, asphalt, and asphalt emulsions, etc.
**Fiberboards**

**Properties and Applications**

**Medium-Density Fiberboard**—Minimum property requirements, as specified by the American National Standard for MDF, A208.2

<table>
<thead>
<tr>
<th>Product class</th>
<th>Nominal thickness (mm)</th>
<th>MOR (MPa)</th>
<th>MOE (MPa)</th>
<th>Internal bond (MPa)</th>
<th>Screwholding (%)</th>
<th>Formaldehyde emission (ppm)</th>
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</thead>
<tbody>
<tr>
<td>Interior MDF</td>
<td>HD</td>
<td>34.5</td>
<td>3.450</td>
<td>1.555</td>
<td>1.335</td>
<td>0.30</td>
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<td></td>
<td>≥ 21</td>
<td>24.0</td>
<td>2.400</td>
<td>0.60</td>
<td>1.445</td>
<td>1.110</td>
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<tr>
<td></td>
<td>LD</td>
<td>14.0</td>
<td>1.400</td>
<td>0.30</td>
<td>0.780</td>
<td>0.670</td>
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<tr>
<td>Exterior MDF</td>
<td>MD — Exterior</td>
<td>34.5</td>
<td>3.450</td>
<td>1.445</td>
<td>1.110</td>
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<tr>
<td></td>
<td>≥ 21</td>
<td>31.0</td>
<td>3.100</td>
<td>0.70</td>
<td>1.335</td>
<td>1.090</td>
</tr>
</tbody>
</table>

*From NPA (1994). Metric property values shall be primary in determining product performance requirements.

This standard is typically updated every 5 years or less.

The furniture industry is by far the dominant MDF market.

Medium-density fiberboard is frequently used in place of solid wood, plywood, and particleboard in many furniture applications.

It is also used for interior door skins, moldings, and interior trim components (Youngquist and others 1997).

**Dry-process Fiberboard**

**Properties and Applications**

**Hardboard**—basic hardboard physical properties (ANSI/AHA A135.4)

<table>
<thead>
<tr>
<th>Product class</th>
<th>Water penetration (mm)</th>
<th>MOR (MPa)</th>
<th>MOE (MPa)</th>
<th>Parallial to surface</th>
<th>Perpendicular to surface</th>
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<td>9.3</td>
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<td>4.3</td>
<td>9.3</td>
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</tbody>
</table>

*Ask, refer
The uses for hardboard can generally be grouped as construction, furniture and furnishings, cabinet and store work, appliances, and automotive and rolling stock.

Typical hardboard products are prefinished paneling (ANSI/AHA A135.5), house siding (ANSI/AHA A135.6), floor underlayment, and concrete form board.

For application purposes, the AHA siding classifies into three basic types:

1. **Lap siding**—boards applied horizontally, with each board overlapping the board below it
2. **Square edge panels**—siding intended for vertical application in full sheets
3. **Shiplap edge panel siding**—siding intended for vertical application, with the long edges incorporating shiplap joints

Hardboard panels have a variety of uses.
Fiberboards

Properties and Applications

Insulation Board—Physical and mechanical properties of insulation board are published in the ASTM C208 standard specification for cellulosic fiber insulation board. Physical properties are also included in the ANSI standard for cellulosic fiberboard, ANSI/AHA A194.1

Examples of grade stamps: grade mark stamp for cellulosic fiberboard products conforming to ANSI/AHA A194.1 standard.

Fiberboards

Properties and Applications

Fiberboards can be divided into three categories: exterior, interior, and industrial.

Exterior products
- Sheathing—board used in exterior construction because of its insulation and noise control qualities, bracing strength, and low price
- Roof decking—three-in-one component that provides roof deck, insulation, and a finished interior ceiling surface; insulation board sheets are laminated together with waterproof adhesive
- Aluminum siding backer board—fabricated insulation board for improving insulation of aluminum-sided houses

Fiberboards

Properties and Applications

Interior products
- Building board—general purpose product for interior construction
- Ceiling tile—insulation board embossed and decorated for interior use; valued for acoustical qualities; also decorative, nonacoustical tiles
- Sound-deadening board—special product designed to control noise levels in buildings

Fiberboards

Properties and Applications

Industrial products
- Mobile home board
- Expansion joint strips
- Boards for automotive and furniture industries
Sizing agents, wax, and asphalt can be used to make composites resistant to moisture.

Sizing agents cover the surface of fibers, reduce surface energy, and render the fibers relatively hydrophobic.

Sizing agents can be applied in two ways.

In the first method, water is used as a medium to ensure thorough mixing of sizing and fiber.

In the second method, the sizing is applied directly to the fibers.
Fiberboards

- Rosin is a common sizing agent that is obtained from living pine trees, from pine stumps, and as a by-product of kraft pulping of pines.
- Rosin sizing is added in amounts of less than 3% solids based on dry fiber weight.
- Wax sizing is used in dry-process fiberboard production; for wet processes, wax is added in solid form or as an emulsion.
- Asphalt is also used to increase water resistance, especially in low-density wet-process insulation board.