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PROCESS OF MAKING LIGNO-CELLULOSE FIBER PRODUCTS

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My invention relates to vegetable fiber products that are highly hard, strong water-resistant and dense, and process of making same.

My new process comprises the drying of a sheet or blank of ligno-cellulose fiber, which before drying is light and porous, to a state of practically complete freedom from moisture, followed by simultaneous application of high heat and high pressure to the previously dried sheet or blank.

The thorough preliminary drying may be accomplished in various ways, and in one or more steps or subdivisions. About the simplest mode of preparing the dried blank is to form the wet fiber into a sheet from a water bath, pass through squeeze rolls, and dry thoroughly in a hot air drier.

To obtain a final product of maximum density, it is desirable to prepare the dried blank so as to be itself of quite high density, and, when manufacturing flat products such as boards or sheets, such dense blanks may be formed as by drying the moist fiber sheet under heat and pressure in a multiple hot platen press or equivalent apparatus, having provision for escape of moisture during drying, such as a wire screen interposed between the fiber mass and a press platen. A blank of about 1 specific gravity and about 1/8'' thick can be made from a body of vegetable fiber containing say 60% of moisture before introduction into the press, and brought to approximately complete dryness in about 15 to 20 minutes under application of say a pressure of about 200 pounds per square inch and a temperature of about 300° F. With lower pressures, the density of the dried blank is, of course, also lower. If much higher pressures than those just stated are used on the initially moist fiber, surface defects, known as water spots, may appear.

Various other ways of making the dried blanks of vegetable fiber may be resorted to, and as stated, the making thereof may be subdivided into parts, as for example, the moisture in the fiber sheet may be reduced to a low percentage, say 5%, in an air drier without pressure, or in a press provided with distance stops, and the remainder of the moisture removed by hot pressing with provision for escape of moisture, the pressure being followed up as shrinkage takes place and until dry.

For the application of high heat and high pressure to the previously dried blank, secured in any of the above-described ways, I preferably make use of substantially the same sort of press as used for making press-dried blanks, but supplied with larger rams or otherwise constructed so as to be adapted to exert a higher pressure.

Due to the practically complete absence of moisture in the dried blank, and resulting absence of steam therein when heated, I do not need in practicing my new process to provide wire mesh or other means to permit escape of moisture during the application of the high heat and high pressure, and the hot press platens or other appliances for subjecting the dried blank to high heat and pressure can be smooth and polished continuous solid impervious bodies to directly engage and substantially seal the sheet on both faces, thus making each face of the finished sheet substantially the counterpart of a continuous imperforate pressing surface, and the platens can be maintained continuously at the desired high temperature, and the press opened when hot immediately after the pressing is completed, with no resulting injury to the product. A desirable arrangement is to provide the platens with chromium plated surface sheets on both faces.

In general, pressure and temperature and time are somewhat interchangeable in the step of applying high temperature and high pressure to the bone-dry sheet; for example, when making use of press dried blanks say about 1/8'' thick and about 1 specific gravity in order to secure a final product of maximum density, if the pressure applied ranges in the neighborhood of say 1,000 pounds per square inch, a temperature may be used, say as high as 500° F. and same applied for say three minutes to produce a final sheet product of about 1.2 specific gravity, whereas, if a higher pressure of say 2,000 pounds per square inch is made use of, burning may occur with such high temperatures used for too long a time, and a somewhat lower temperature of approximately 400° F. is more desirable and application of the temperature and pressure may be continued for a period of say four minutes, and the resulting board will be somewhat thinner and more dense, as about 1.3 specific gravity. These figures are, of coarse, illustrative only, and in practice there may be considerable variation therefrom, as in case of the use of fibers of various kinds, etc.

By using smooth platens or surface plates in the high pressure and temperature operation, both sides of the finished board or other product can be made substantially smooth and polished. This is so even in the case of using blanks made in a press with wire mesh interposed, the wire mesh marks on the blank being largely obliterated in the repressing against the smooth platen or surface plate and leaving only a slight texture effect of pleasing appearance, without objectionable roughness or irregularity. More than one sheet or board can be inserted between platens if desired and in case of two or more sheets, I preferably place a metal sheet between the blanks.

The ligno-cellulose fiber may be obtained from various sources such as hard woods, soft woods, wood forming grasses, such as bamboo, cane, straw or other fibrous vegetable material.

The preparation of the fiber can be accomplished in various ways; as for example, the fiber may be produced by explosion or by grinding, or in other mechanical fashion adapted to disintegrate the ligno-cellulose material and produce the fiber therefrom. A raw fiber such as mechanically prepared or exploded fiber is preferred, not only on account of greater yield and relatively lower cost, but because of self-bonding properties, high wet strength and high resistance to absorption of water, all of which are present to the greatest extent in the products made according to the present invention at temperatures over 400° F. applied to bone dry sheets of the raw ligno-cellulose fiber which contains the natural incrusting substances.

While binding agents are not needed with a raw ligno-cellulose fiber, they may be incorporated, if desired.

I preferably incorporate waterproofing size when increased resistance to water absorption is desired. In using hydrocarbon size, such as petrolatum, for example, the water bath or stock chest may be maintained at a temperature above the melting point of petrolatum, and molten petrolatum, to the extent of around 1% to 5% on the weight of the dry fiber, may be incorporated with the pulp in the water bath. Other waterproofing sizes, such as rosin and alum, for example, may be used, and instead of maintaining the water bath at a temperature above the melting point of the size, which is preferable with the use of petrolatum size, the waterproofing agent may be emulsified and introduced cold, if desired, or in yet other ways.

I am enabled by my process to produce very highly hard, dense and strong products, such as sheets, boards and other forms or shapes. In the case of using press-dried boards for example, made of the self-bonding ligno-cellulose fiber as blanks for subjecting in bone-dry state to high temperature and pressure in accordance with the present invention, the water absorption is reduced by practically one-half and the wet strength is tremendously increased. As an example, one such board pressed for fifteen minutes at a hydraulic pressure of 200 pounds per square inch and with steam in the press plates at 180 pounds per square inch had a modulus of rupture dry of 5250, and on soaking for 48 hours in water it had absorbed 26% of water and had a modulus of rupture wet of 2840; whereas the same board upon being repressed from the dry state for three minutes at 1000 pounds per square inch hydraulic pressure and with 500 pounds of steam—temperature of approximately 465° F.—in the press platens had a modulus of rupture dry of 8800 and on soaking for 48 hours in water it had absorbed only 14.25% of water, and such moisture as was absorbed had but little weakening or softening effect for the modulus of rupture wet was 6530.

When using press-formed blanks, for example, and repressing in the manner just described, one repressing press will take care of blanks formed in several blank forming presses, due to the much longer time required to dry the blanks than for repressing, and to the facility with which the self-sustaining blanks can be handled into the repressing press.

It is of great advantage to substantially completely remove the moisture without resorting to the application of the highest pressures and temperatures that are to be applied, and to later make the application of such high temperatures and pressures to the bone-dry blanks from which the water has been previously removed, making such application for a sufficient time to materially consolidate and densify the sheet and impart high dry strength and high wet strength to the sheet by activation of the bonding properties of the natural incrusting substances of the ligno-cellulose fiber.

Fiber sheets made of fiber refined sufficiently to give a smooth, even wetlap, i. e., thick, light and porous sheet of moist fiber, when formed from a water bath on a Fourdrinier screen which makes a felted fiber sheet continuously, and containing say 60% of moisture after passing through the squeeze rolls, if press-dried in the manners described in the fourth paragraph of this specification, with the exception that they are subjected in press-drying to a higher pressure and higher temperature than as stated in said fourth paragraph and sufficient to give a specific gravity higher than 1, would frequencly have defects known as water-spots, as already stated.

These defects can readily be avoided by drying such blanks at the comparatively low temperature and pressure and with the provision for moisture escape described in the said fourth paragraph. Then by using as blanks the bone-dry sheets thus prepared free from defects, preferably taking them bone-dry direct from the press or other device used for pressure drying of moist fiber sheets into a high duty repressing press, so as to avoid undue loss of heat and absorption of atmospheric moisture, and by there subjecting them without provision for moisture escape to the high temperatures over 400° F. and high pressures which activate the self-bonding properties of the ligno-cellulose fiber in bone-dry state, I am enabled to produce products of high density, hardness and strength, and at the same time avoid the water-spot defects that would be produced by subjecting moist fiber masses to such high temperatures and pressures with provision for moisture escape.

Various other effects in addition to those produced by the higher consolidation can also be secured in the final consolidated, self-bonded hot-pressed sheet products of the present invention, as for example, by forming of suitably engraved pressing surfaces, the sheets may be embossed in various ways and with various patterns, and coatings of material such as synthetic resins may be applied and hardened under heat and pressure.

I claim:

1. The process of making a hardboard product having high dry-and-wet strength from a light porous sheet of lignocellulose fiber containing the natural fiber incrustation, including the steps of drying the sheet to a bone-dry condition, and then applying pressure to the bone-dry sheet at a temperature of about 400 or 500° F. sufficient to materially consolidate and densify and impart high dry strength and high wet strength to the sheet by activation of the bonding properties of the incrusting substances.

2. The process according to claim 1, and in which during pressure application of each face of the sheet directly contacts and is consolidated against a continuous imperforate heated surface.

3. In the process of making a dense hardboard product of a light porous blank of ligno-cellulose fiber containing natural encrustants together with cellulose, the final step of applying pressure of about 1000 pounds per square inch or over to a bone-dry blank of the aforesaid material between continuous imperforate heated surfaces at a temperature of about 400°–500° F., the pressure and temperature being sufficient to consolidate, densify and reduce the thickness of the blank and bring its specific gravity to about 1 or higher and impart high dry-strength and high wet-strength to the product by activation of the self-bonding properties of the ligno-cellulose fiber material in bone-dry state.

4. The process of making a hard board product having high dry-and-wet strength from a light, porous sheet of ligno-cellulose fiber containing the natural fiber incrustation, including the steps of drying the sheet to a bone-dry condition and then applying pressure to the bone-dry sheet at a temperature of approximately 465° F. sufficient to materially consolidate and densify and impart high dry strength and high wet strength to the sheet by activation of the bonding properties of the incrusting substances.

5. The process of making a hot-pressed, self-bonded, consolidated, sheet product of ligno-cellulose fiber with each surface substantially the counterpart of a continuous imperforate pressing surface, and of high dry-and-wet strength, which consists in the steps of preparing, from ligno-cellulose material, disintegrated ligno-cellulose fiber containing the natural fiber encrustation, forming a pulp of such fiber in water, forming the fiber from water into a felted, light, porous, moisture-containing sheet, drying the sheet to a bone-dry condition, then applying high pressure to the bone-dry sheet with both faces thereof in direct contact with continuous imperforate pressing surfaces at a temperature over 400° F., but not high enough to cause material burning at the pressure used, for a time which is somewhat interchangeable with pressure and temperature, the time temperature and pressure used being sufficient to consolidate and densify the sheet and impart to it high dry strength and high wet strength by activation of the self-bonding properties of the ligno-cellulose fiber material, whereby, with the pressing surfaces in the heated state, the product sheet can be released without injury.

6. Process as in claim 5, and in which the temperature for the hot-pressing step is about 400–500° F.

7. Process as in claim 5, and in which the temperature for the hot-pressing step is approximately 465° F.

8. Process as in claim 5, and in which the pressure for the hot-pressing step is approximately 1000 lbs. per sq. in. or over and the sheet is consolidated to a specific gravity of about 1 or higher.

9. Process as in claim 5, and in which drying bone-dry is performed in a hot-air drier.

10. Process as in claim 5, and in which drying bone-dry is performed under pressure.

11. Process as in claim 5, and in which the drying of the sheet is subdivided into parts, the final part making the sheet bone-dry.

12. Process as in claim 5, and in which waterproofing size is incorporated with the pulp.

13. Process as in claim 5, and in which the disintegration to fiber is performed by explosion.

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