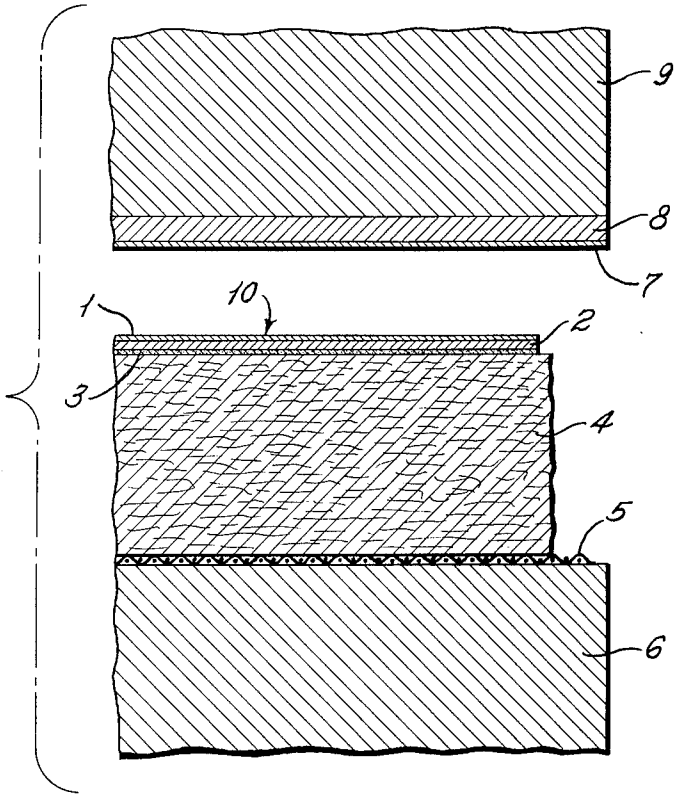
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PIGMENT COATED PAPER INCLUDING POLYVINYL ALCOHOL BINDER AS HARDBOARD OVERLAY

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PIGMENT COATED PAPER INCLUDING POLYVINYL ALCOHOL BINDER AS HARDBOARD OVERLAY

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This is a continuation-in-part of our copending U.S. application Serial No. 833,384, filed August 13, 1959, now abandoned.

This invention relates to a method of making a hardboard having a paper overlay on its surface and to the product of such method.

A hardboard having a paper overlay can be made by the method described in U.S. Patent No. 2,918,398 for an invention by Dorland et al. entitled Artificial Board to provide a hardboard having a sheet of paper integrally united with the surface of the hardboard. The resulting product, though far lighter than the base mat, has the disadvantage for some purposes of having a yellowish or beige colour particularly where a drying oil such as linseed oil has been used to supplement the bonding due to the lignins, hemicelluloses and other natural binding constituents of the pulp. The linseed oil makes the paper translucent with the consequence that bark specks and fiber bundles tend to show through. The yellow colour and show-through give an attractive appearance in the case of a plain unprinted overlay board and are not objectionable in darker patterns such as brown walnut or red-brown mahogany and in bold positive grains such as oak. However, where fine contrast or light colours are required such as light grey, sand or mauve, the yellow colour and show-through are undesirable.

One way of accomplishing an improvement with respect to colour and show-through is to provide a very thick highly bleached overlay, such as alpha resin impregnating stock. This is light in colour, overcomes show-through, and bonds well to the core. However, it has been found that such papers are weak internally, delaminate easily and have poor abrasion resistance. The latter can be improved by linseed oil but this gives rise to the undesirable yellow colour. Furthermore, such thick, refined papers are expensive.

Another approach is the use of paper loaded with light-coloured mineral opacifiers, added during the manufacture of the paper. However, it has been found that such papers bond poorly to the hardboard core, the filler apparently interfering with the natural bond which is characteristic of our invention.

The object of this invention is to provide a hardboard having a paper overlay surface which is uniform and opaque and coloured as desired, preferably white so as to permit the use of a wide variety of grains and colours.

A further object of this invention is to provide a paper overlay which can be laminated to a hardboard wet lap under practical conditions of mill use.

We have found, in accordance with this invention, that the foregoing objects can be achieved by applying to the hardboard wet lap, prior to the consolidation under heat and pressure, a sheet or paper superficially coated on the exterior surface and not on the interior surface with a coating comprising a pigment and a polyvinyl alcohol binder. Coating on the exterior side only has the advantage of giving good hiding power and at the same time maintaining the good natural bonding characteristics of an uncoated, unfilled, open fibrous surface and a high degree of absorbency of the interior surface to enable a firm bond to be achieved between the paper and the hardboard base.

In the accompanying drawing illustrating this invention the figure is a diagrammatic elevation view of a hardboard hot press section used in carrying out the process of the invention.

The hardboard is made by conventional techniques, including the defibration and refining of fibrous material such as wood chips followed by forming and dewatering of the wet lap on a Fourdrinier machine and consolidation under simultaneous heat and pressure to provide a hard, compact fibrous mass bound together by the hemicelluloses, lignins and other natural binding constituents of the wood. If desired, additional ingredients can be added such as wax or other sizes, and additional integral binding materials, such as synthetic resins, for example phenol formaldehyde resin. Preferably, a supplementary integral binder is used to augment the bond provided by the hemicelluloses, lignins and other natural binding constituents. Drying oils such as linseed oil or tung oil are particularly suitable as supplementary binders. U.S. Patent 2,918,398 may be referred to for additional details of the manner in which the hardboard is made.

The paper to which the coating is applied may vary widely. It may contain groundwood, sulphite, neutral sulphite semi-chemical, kraft, soda, singly or in admixtures. Preferably high groundwood content papers weighing from about 5 to 25 lbs./ M s.f. such as newsprint, directory, catalogue, rotonews, tissues are used. In the case of newsprint type papers it has been found that the coating is best applied to the wire side of the paper sheet with the top or felt side being used as the internal face against the board mat. This generally results in both better coating and also better overlay-to-board bond.

The paper to be applied to the board is treated on one side with a superficial layer of a formulation generally similar to those used in papercoating. These consist principally of an opacifying pigment which is generally white and a polyvinyl alcohol binder to bind the pigment particles to each other and to the paper. Minor amounts of other materials such as dispersants, defoamers may be present. Agents which will reduce the tendency of the coating to stick to hot press surfaces may be added by either integral or surface application. Examples of such agents are silicones, fatty acids or their salts such as ammonium, zinc or aluminium stearates, or oleic acid.

The untreated surface of the paper is applied to a wet lap having a solids content of 25–40% before the wet lap is transferred to the press in the same manner as that described in U.S. Patent 2,918,398, in connection with uncoated paper. Where lightweight tissue paper is used a lower solids content may be permissible. When heat and pressure are applied in the press, the natural binding constituents of the pulp together with any supplementary adhesive which may have been applied to the untreated surface of the paper, cause an integral bond to be created between the paper and the wet lap.

The preferred pigment, for maximum opacity, is titanium dioxide of the rutile crystal type which has a high refractive index of 2.76. However, other pigments may be used such as anatase titanium dioxide, zinc oxide and zinc sulphide. Pigments which do not have as high a refractive index as the foregoing may also be used but are less satisfactory from the point of view of providing opacity. Examples of such other pigments are barium sulphate, calcium sulphate, lithopone, calcium carbonate, talc, clay and diatomaceous earth. Mixtures of pigments may be used to reduce cost, adjust gloss, improve printability, reduce metal-marking, etc., as required by the particular circumstances. Coloured pigments may be used if desired to make a solid coloured overlay or to provide the desired background for a printed overlay.

It is desirable that the pigment particles be of small

particle size and the particles be well dispersed in the coating mixture. Sodium silicate, sodium hexametaphosphate, sodium pyrophosphate, sodium tetraphosphate, ammonium and sodium caseinates and various cationic wetting agents and many other similar substances may be used as dispersing agents. By way of example the particle size distribution of the titanium dioxide used in Example 1 when examined with an electron microscope in a resin dispersion was as follows:

	Percent
Less than 0.2 micron	30
0.2 to 0.3 micron	48
0.3 to 0.4 micron	13
0.4 to 0.5 micron	4
0.5 to 1.0 micron	5

The binder mixed with the pigment should be polyvinyl alcohol, preferably 5–10% by weight of the pigment. Above 10% the coating sticks to the caul plate while below 5% there is insufficient binder to tie the pigments firmly together. The solids to liquids ratio of the coating mixture may be varied to suit the weight of coating desired and the device used for applying the coating, but preferably the coating mixture is 25 to 30% solids for example 28%.

Polyvinyl alcohol, starch-latex and carboxy-methyl cellulose all gave the whiteness, opacity and printability desired in a printed decorative overlay product but only polyvinyl alcohol was actually practical in mill use because the other binders caused too much sticking and "caul transfer" in the hot press.

The accompanying figure which is a schematic sectional elevation view of the hot press will assist in the understanding of the term "caul transfer" and related phenomena. A hardboard wet lap of coarse fibrous pulp **4** bearing a sheet of coated paper **10** on its upper surface, is carried by a wire screen **5** between two fairly thick press hot plates **6** and **9**. The wet laps may for example be about 4 feet wide and 16 feet long and the press handles 20 wet laps at one time. The coated paper **10** bears adhesive **3** on the under surface facing the wet lap and coating **1** on the upper surface. The coating **1** is printed with a decorative design. The coating faces a relatively thin, polished, removable metal plate known as a caul plate **8**.

In operation the hot plates are pushed together with great pressure. A great deal of water is squeezed out or evaporated away. The heat, pressure and steam consolidate the wet lap and coated paper into a smooth, dense, printed overlaid hardboard. Since the upper decorative surface is pressed against the caul plate **8** it will be understood that imperfections in the caul plate can spoil the board.

The difficulties which can occur were demonstrated by experience with paper coating based on starch-latex binder, which was the first type to be tried in the mill. The combination of heat, pressure and moisture caused a small amount of the starch-latex coating (along with some printing ink) to stick or transfer to the caul plate. Hence, the term "caul transfer." As more and more boards were pressed, more and more coating was deposited on the caul plate. The deposit was uneven and the result was an undesirable variation in the gloss of the board surface. Also, the coating **7** began to transfer back from the caul plate to the printed hardboard **10**, thus blurring the printing. Sometimes the caul transfer was so thick that it produced depressions in the board. Finally, as pressing continued, the paper began to stick to the caul plate, particularly at the edges, and this caused the paper **2** to tear away from the board **4** when the hot press was opened. The only way of overcoming the resulting wastage was to interrupt production removing and cleaning all 20 caul plates at frequent intervals, a costly, impractical and inefficient method.

Experience with carboxy-methyl cellulose binder indicated that it too, like starch-latex, produced unsatisfactory caul transfer characteristics.

Of all the binders which were tried, only polyvinyl alcohol solves the caul transfer adequately. With it, 400 pressings in one opening can be made in the mill without cleaning the cauls, compared to 40 for startch-latex coating. Polyvinyl alcohol binder is therefore uniquely suited to the process of this invention. This is particularly surprising when it is recalled that polyvinyl alcohol is initially solbue in water and thus might be txpected to dissove, soften and stick under the conditions prevailing in the hot press.

The preferred vehicle for the coating is water, but other suitable vehicles may be used.

The weight of coating applied to the paper is preferably 0.2 to 7 dry lbs./M s.f. and preferably is in the range of 1 to 5 lbs./M s.f. As the weight of the coating is increased the opacity and therefore the hiding power increase.

Numerous methods of applying the coating to one surface of the groundwood paper are known, for example air-knife coating, printroll coating, roll coating, reverse roll coating, trailing blade coating, rotogravure coating, size press coating, brush coating. The water may be evaporated from the coated sheet on a conventional drier such as an air tunnel drier, a conventional paper drier or by using radiant heat or hot gases from the combustion of liquid or gaseous fuels. If it is desired that the overlay sheet be printed, the dried, coated sheet can be reeled to be printed on any suitable press such as, for example, a printing press of the web-fed variety. Alternatively the sheet can be cut into single sheets for printing on a sheet fed press. The coated surface of the sheet can be printed without supercalendering or it may be supercalendered or smoothed prior to printing, depending on the kind of pattern that is desired and the smoothness that is necessary for proper reproduction.

Various adhesives such as thermosetting resins, thermoplastic resins such as vinyls including polyvinyl alcohol, latices and polymerizable drying oils may be applied to the uncoated surface of the paper to provide a supplementary bond. Examples of suitable drying oils are linseed oil, soya bean oil, tall oil, tung oil. These drying oils may be blended with other adhesives such as petroleum polymers and synthetic resins such as phenolic resins, urea formaldehyde resins, vinyl resins, alkyd resins and butadiene-styrene latices. About 1 to 5 lbs./M s.f. of drying oil is preferred.

Various decorative and/or protective materials such as drying oils, alkyd resins, waxes may be applied to the top or coated surface of the overlay sheet prior to consolidation in the hot press.

The practice of this invention will be further apparent from the example which follows:

EXAMPLE 1

A coating formulation was prepared consisting of:

	Parts by wt.
Titanium dioxide (rutile crystal type)	200
Sodium hexametaphosphate (a dispersant)	½
Polyvinyl alcohol (5% solution)	240
Water	325

The pigment was thoroughly wetted down and dispersed by passing the slurry through a homogenizer or high speed mixer. A small amount of defoamer (consisting of a mixture of sulphonated castor and pine oils) was used to control foam and application uniformity.

This coating was applied by air-knife coater in the amount of 2.3 lbs. of solids per M s.f. to the wire side surface of newsprint paper weighing 13⅓ lb. per M s.f. and containing 80% groundwood and 20% sulphite. The sheet was then dried to set the coating.

A hardboard wet lap was prepared from a furnish of mixed hardwoods and soft woods in the manner described in U.S. Patent 2,918,398.

Tung oil in the amount of 3 lbs. per M s.f. was applied to the uncoated surface of the newsprint paper and the newsprint paper was then applied to a partially dewatered hardboard wet lap with the surface of the paper having the coating formulation facing outwardly and the tung oil treated surface facing inwardly.

The base mat with the coated paper overlay was then pressed at pressures up to 650 p.s.i. and at a temperature of 330° F. for 13 minutes. The resultant ¼" board was then baked at about 290° F. for 3½ hours and humidified to 5% moisture.

Hardboard having an overlay in accordance with this invention is characterized by its light opaque surface appearance which hides the darker colour and coarse bark and fibre pattern of the mat below. The overlay is however integrally bonded to the hardboard base as can be demonstrated by the comparison of the coated overlay applied by the method of the invention, as described in the example using oil as a supplementary binder; and applied to the board after it has been consolidated in the press, in a post-lamination procedure using ordinary mucilage and polyvinyl acetate separately as the overlay to core binders. The procedure used for testing can be the same as that described in U.S. Patent No. 2,918,398.

We claim:

1. The method of forming hardboard comprising the steps of applying to a wet lap of coarse fibrous wood pulp which has been partially dewatered to a solids content of 25 to 40%, a sheet of paper which has been coated on one surface with a coating comprising a pigment and a polyvinyl alcohol binder in the amount of about 5 to 10% by weight of the pigment, said sheet of paper having been applied to said partially dewatered wet lap with its surface which has not been coated with the pigment and the polyvinyl alcohol facing the partially dewatered wet lap, and consolidating the wet lap and the coated paper under simultaneous heat and pressure to form hardboard having said coated paper bonded to its surface.

2. The method of forming hardboard comprising the steps of applying to a wet lap of coarse fibrous wood pulp which has been partially dewatered to a solids content of 25 to 40%, a sheet of paper to one surface of which there has been applied a layer of adhesive comprising a polymerizable drying oil and to the other surface of which there has been applied a coating comprising a pigment and a polyvinyl alcohol binder in the amount of about 5 to 10% by weight of the pigment, said sheet of paper having been applied to said partially dewatered wet lap with said surface to which has been applied said adhesive facing the partially dewatered wet lap, consolidating the wet lap and the coated paper under simultaneous heat and pressure to form hardboard having said coated paper bonded to its surface, and baking said hardboard to harden said polymerizable drying oil to thereby provide a supplementary bond between said coated paper and said surface.

3. A process as in claim 2 in which the paper is a high groundwood content sheet weighing from about 5 to 25 lbs. per thousand square feet.

4. A process as in claim 1 in which the pigment comprises a substance selected from the group consisting of titanium dioxide, zinc oxide and zinc sulphide.

5. A process as in claim 1 in which the pigment comprises titanium dioxide of the rutile crystal type.

6. A process as in claim 1 in which the weight of coating applied to the paper is from about 1 to 5 lbs. per thousand square feet.

7. A process as in claim 2 in which the drying oil is linseed oil in the amount of 1 to 5 lbs. per thousand square feet.

8. A process as in claim 3 in which the drying oil is tung oil in the amount of 1 to 5 lbs. per thousand square feet.

9. A process as in claim 3 in which the pigment is titanium dioxide, in which the coating applied to the paper is in the amount of about 1 to 5 lbs. per thousand square feet and in which the drying oil is in the amount of 1 to 5 lbs. per thousand square feet.

10. A process as in claim 1 in which the coated surface of said paper is printed prior to the application of said paper to the wet lap.

11. A hardboard having an overlay on at least one surface thereof, said overlay consisting in a sheet of paper having an opaque coating comprising a pigment and a polyvinyl alcohol binder on its outer surface and said sheet of paper being integrally united with said surface of said hardboard by an adhesive comprising the natural binding constituents of the furnish for said hardboard.

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