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(54) Plasterboard

(57) A lining paper to be used in the manufacture of plasterboard is given a surface finish by printing the liner before it is used in plasterboard manufacture. The resulting plasterboard has the printed-on surface material on the whole of one face of the board, with a density of print sufficient that under optical examination at least 80% of the surface of the lining paper is covered by the applied print. The printed surface may be coloured to match the colour of a jointing material used to fill joints between adjoining boards after they have been secured in place.

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Description

[0001] This invention relates to the manufacture of plasterboard (also known in USA as gypsum wallboard). Plasterboard is well known for use in forming ceilings and interior wall surfaces in buildings. Generally the front face and side edge surface of the plasterboard have been provided by a multi-ply paper referred to as plasterboard liner, while the reverse face is surfaced with a second liner paper. Both of these liners are multi-ply papers.

[0002] One method for utilising plasterboard has been to fasten the plasterboard into position and then cover its exposed face and the joints between plasterboard sheets with a thin "skim coat" of wet plaster. After this has set, it requires decoration with paint or wallpaper.

[0003] Another method for utilising plasterboard has been widely used and dispenses with the "skim coat". The plasterboard is manufactured using a plasterboard liner paper which has a light colour. This is used to form the front surface and the side edge surfaces. The side edges of the boards are shaped to form a recess at their abutting edges. After the boards are fastened into position, their abutting edges are joined with tape and a jointing compound which is worked into the recess on top of the joining tape to create a continuous flat wall surface, with joints visible at regular intervals.

[0004] The wall is then decorated, either with wallpaper or with multiple coats of paint, which serves among other things to conceal the joints. If paint is used, the normal requirement is a first "mist coat" or primer, followed by two full further coats. This requires painters to come to the wall three times.

[0005] There have been a number of proposals for the manufacture of plasterboard with a decorative finish applied during manufacture, prior to fixing the boards in place. Examples of such proposals include US patents 3507684, 3694298 and 3984596.

[0006] US patent 4579610 proposed a process in which the surface of a plasterboard liner paper is gravure printed with a clear or tinted latex base coat. The gravure process applies this material as a pattern of dots, so that the applied material does not seal the paper. The base paper is then overprinted with a decorative design. Dimensions for the gravure pattern are not exemplified, but it is feasible that the dots of a gravure pattern might cover 50% or less of the total area to which the pattern is applied.

[0007] The subsequent application of a decorative design is not described in detail although it is said that a pattern of blotches is preferred.

[0008] The teaching which can be understood from this document is that the surface of the paper remains exposed between the gravure dots, in order to maintain the porosity of the paper. The pattern applied subsequently must be such as to retain the porosity.

[0009] Somewhat more recently, EP-A-521804 has described plasterboard manufactured using a liner paper with a coating applied to the liner paper before the boards are manufactured. The document recognises that this can avoid contrast between the colour of the board and the colour of material used to form joints between the boards. The proprietors of this document are marketing pre-decorated boards and a jointing compound of matching colour. In this document, as in earlier proposals for pre-decorated board, there is a recognition that the application of a decorative layer to the plasterboard liner could cause an unwanted reduction in the permeability of the liner paper and in this way impede the escape of steam during drying of the plaster.

[0010] We have now found that pre-decorated liner paper and plasterboard can be made by printing the liner paper before it is used in board manufacture, moreover it is not necessary to use a printing process which applies a pattern of spaced dots with gaps between them.

[0011] According to a first aspect of this invention there is provided a pre-decorated plasterboard having lining paper at its surfaces with material printed thereon over the whole of one face of the board, with a density of print on the lining paper sufficient that under optical examination at least 80% of the surface of the lining paper is covered by the applied print. The applied print may extend onto adjoining edges of the board.

[0012] The material which is applied by printing will generally include colour to match the colour of the board to the colour of a jointing compound to be used for joining board edges. The applied material may also include colourless or tinted lacquer, for example to increase the durability of the printed surface.

[0013] It would be within the scope of the invention to apply solely a colourless lacquer to improve durability, but it is preferred to include an application of colour.

[0014] The printed material may be a continuous layer of applied print. Alternatively it could be provided as gravure dots overlapping one another and between them covering 80% or more of the total surface area.

[0015] Determination of the extent of surface coverage is carried out by visual examination using a magnifying lens or microscope with magnification not greater than 100 times. We have discovered that areas of print which appear to be continuous at this magnification are not completely continuous when observed under an electron microscope operated to give something approaching the highest magnification achievable with such an instrument. These discontinuities which are observable only at such a high resolution of detail are believed to be pores through the ink (rather than unprinted areas) and are ignored when determining whether the printed material covers 80% or more of the

surface area.

[0016] In a second aspect of this invention, there is provided a method of making a pre-decorated plasterboard comprising steps of:-

printing onto one surface of a web of lining paper
introducing wet plaster between the opposite surface of the said web of lining paper and a second web of lining paper, shaping the edge portions of the first said web around the plaster to form board edges, cutting into lengths and heating to dry the plaster, thereby forming plasterboard with printing on one exposed face,

characterised in that the printing on the first web of lining paper extends over such a width that the whole face of the plasterboard has printing thereon, with a density of print sufficient that under optical examination at least 80% of the surface of the lining paper is covered by the applied print.

[0017] The steps of introducing wet plaster between two webs of lining paper, shaping edge portions, cutting into lengths and drying the boards will generally all be carried out in conventional manner on automated machinery.

[0018] The lining paper web which receives the print will generally have a width slightly greater than the width of the plasterboards which will be made, so that it can cover one face and two edges of the boards and also wrap around onto the margins of the reverse face where it will be overlapped by the second web.

[0019] Preferably the print is applied to the entire width of one surface of a web of lining paper and in consequence the resulting plasterboard has the printed colour completely covering the face of the board, two opposite edges of the board and the margins of the reverse face.

[0020] Alternatively, the edge portions of the web which form the edges of the board and wrap around onto the reverse face may be left unprinted. For the sake of good appearance it is preferred that the printed colour extends from the exposed face onto at least part of each edge.

[0021] It is intended that the pre-decorated boards can be used to form ceilings, interior partitions or the interior faces of wall by securing them to a supporting structure, e.g. by nailing or screwing them to studwork in conventional manner, or by using concealed fastenings.

[0022] The boards may be of conventional size. Boards for use in making walls and ceilings may have length exceeding 2 metres and width exceeding 70 cm, often exceeding 1 metre. Smaller boards may be utilised as ceiling tiles, supported by a grid structure which is itself suspended from above.

[0023] When the boards are fixed in place, for example by screwing or nailing to studwork, the joints between the boards may then be filled with a jointing compound and this will also be used to cover the heads of screws, nails or other exposed fixings.

[0024] Desirably the printed material on the boards should give them a colour which matches the colour of the jointing compound. As a result the joints in the wall or ceiling are much less apparent.

[0025] Accordingly the invention includes a combination of

i) pre-decorated boards as defined above; and
ii) jointing compound for filling joints between boards after fixing,

where the surface material printed onto the lining paper is matched to the colour of the jointing compound.

[0026] It is envisaged that the material which is printed on will be a uniform colour which matches the colour of the jointing compound. However, it would be within the scope of this invention to print a design on the boards or a random pattern, especially if this could be made such as to camouflage the joints between the boards.

[0027] The invention can be used to provide boards which will match the colour of the jointing compound, so that the finished wall will have a single colour (or conceivably a pattern) in which the joints blend into the wall and further decoration is not required.

[0028] Another possibility is to provide a wall which is painted after the plasterboards have been fastened in place and joined, but which requires fewer coats of paint.

[0029] Consequently, the invention includes a method of making a room surface by fixing plasterboards as specified above, filling joints between them with a mobile composition which is then allowed to set, and applying no more than two coats of paint as the only decorative treatment prior to occupation of the room. The invention also includes use of such plasterboards and a settable, mobile jointing composition in making such a room surface.

[0030] The printing of material can be done directly onto the paper liner before the liner is used in plasterboard manufacture. It is preferably applied by a printing process which applies a continuous layer of ink to the substrate which is being printed. A process which is particularly envisaged is by flexographic printing. The flexographic process is widely used for printing onto fibreboard for boxes, paper for paper sacks, and other packaging materials. In that application the print is applied to the paper or board from, for example, a "stereo" or a moulded printing roller which is formed using a polymeric material and is a mirror image of the design or wording which is being printed.

[0031] Continuous printing along a web (as contrasting with printing a repeating image) is a technique which is already available in the printing industry. For printing over substantially the whole width of a web, a normal flexographic printing machine can be used, but the roller which would normally carry a stereo is instead provided with a continuous surface of the polymer material or a printing roller with a smooth surface can be used.

[0032] Where the continuous surface is provided by a flexible sheet of polymeric material wrapped around a roller, edges of the sheet which extend along a circumference of the roller are butted against each other.

[0033] Suppliers of sleeves, stereos and moulded rollers for printing include Regal Rubber, Miller Graphics, Design and Stereo Services and Strachan & Henshaw machinery.

[0034] Printing could be carried out by another printing process, so long as the result is to apply print to over 80% of the surface to which print is applied. In order to control the colour of the printed liner paper it is desirable that coverage is even higher, such as at least 90% or at least 95% of the area.

[0035] Printing by a gravure process at more than one printing station would be a way to cover a high proportion of the total area: gravure dots applied at one printing station could largely fill the gaps between dots applied at another, although overlap of dots would also occur.

[0036] Whatever technique is employed it is likely that the weight of solids applied, including binder resin, will lie in a range from 7 to 30 gram/m^2.

[0037] Flexographic or other printing can be carried out using inks with an aqueous base or using inks with an organic solvent base in which pigment is dispersed. It is generally preferred to use an aqueous base and so avoid the use of flammable organic solvent. We have found that aqueous-based inks can be used for the present invention. A water-based ink suitable for use in the present invention is likely to contain pigment, water and binder materials. The binder materials are likely to be synthetic polymers such as acrylic resins.

[0038] Even with flexographic printing we prefer to print at more than one printing station in order to obtain a combination of properties.

[0039] The first print is desirably carried out using a coloured ink. This may well contain more than 40% by weight of pigment, as well as binder, water and minor ingredients. The pigment is likely to constitute more than 50% of the total solids in the ink.

[0040] A top layer of print may contain a much lower proportion of pigment or even none at all, e.g. 0 to 25% of the solids content, with a higher proportion of binder resin. Such a layer can serve as a lacquer, giving an improved resistance to marking during handling and to abrasion after wetting. The latter is valuable for giving a "wipe-clean" or washable surface.

[0041] It is normal practice for the manufacture of ink to be carried out by a specialist ink manufacturer who may well be working in close co-operation with a company having facility to manufacture and print paper. The formulation of ink to provide a required colour is part of the normal skill of the ink manufacturer.

[0042] A number of numerical scales for the definition of colour have been proposed. One which is commonly used is the CIE Lab colour space in which a parameter "L" denotes lightness, a parameter "a" denotes colour on a numerical scale extending from green to red and a third parameter "b" denotes colour on a scale extending from blue to yellow. A positive value for "a" is red, a positive value for "b" is yellow.

[0043] The lining paper onto which the printed colour is applied may be made in conventional manner using the normal machinery employed for making multi-ply paper and board by a wet-laid process. The fibres used in the manufacture of the plies of the lining paper may be new or recycled or a mixture of the two.

[0044] For the top ply it may be desirable to use fibres which have been bleached or incompletely bleached (so-called semi-bleached fibres) so that the top ply is a light colour before print is applied to it. Alternatively, it may be preferred to use a density of printed colour which is able to mask a darker colour of the liner paper. It may be preferred that the fibres of the top ply are predominantly chemical fibres and therefore lignin-free so as to avoid yellowing. However, we have found that when a coloured print is applied, the invention can be put into effect using a top ply formed with a predominance of semi-chemical and/or mechanical fibres which retain some or all of the natural lignin content of the original timber. Use of such fibres relies on the printed colour to stabilise the colour of the paper, both by reason of its own colour and by shielding the top ply from sunlight thereby preventing or retarding yellowing of the lignin-containing fibres in the top ply.

[0045] The top ply could be made from pulp - i.e. new fibres. However, for the sake of economy it will normally be made from recycled fibres, supplemented if necessary with new fibres.

[0046] Waste paper to provide the recycled fibres will generally be selected to give a light off-white, shade. Suitable sources include unprinted newspaper, lightly printed paper and so-called woody trimmings - i.e. offcuts from paper made using mechanical pulp.

[0047] Beneath the top ply there may, if desired, be a second ply also having a high proportion of bleached fibres and possibly of similar composition to the top ply. The remaining plies form the interior and the reverse face of the lining paper. It is normal for these to contain a high proportion of unbleached fibres which may be chemical fibres, because of their strength is greater than that of mechanical fibres

[0048] A suitable source of recycled fibre for these interior plies is recycled corrugated board from boxes and cartons.

[0049] Unsorted mixed waste paper - which is the residue after removing higher value light-coloured material - will generally contain a substantial proportion of unbleached chemical fibres from boxes and cartons. It may well be used as the source of recycled fibre for these interior plies.

[0050] A plasterboard lining paper conventionally has a weight in a range from 150 to 300 grams per square metre (gsm) and usually lies in a narrower range from 180 to 250 gsm. Paper within this range is suitable for use in this invention.

[0051] The porosity of plasterboard lining paper can be determined by the Gurley test of porosity laid down in the British Standard BS 6538: Part 3: 1987 entitled "Air Permeance of Paper and Board". This corresponds to ISO 5635/5 - 1986.

[0052] This test measures porosity as the time for a known volume (100 ml) of air to pass through a sample of predetermined area. The result is therefore expressed in seconds.

[0053] We have found that the application of a continuous printed colour can lead to a large reduction in porosity. Surprisingly, however, the manufacture of plasterboard using the printed paper can be carried out by entirely conventional steps. In a typical continuous production process these steps will be:

unreeling of lining paper onto a production line with the eventual outer face (in the case of the present invention the printed surface) at the underside;
delivery of wet plaster onto the web of lining paper;
shaping of the edges of the web to form edges of the eventual plasterboards;
application of a second web of lining paper to form the reverse face of the boards;
cutting of the resulting continuous material into individual sheets; and
passage of these cut sheets through a kiln to dry the plaster.

[0054] The accompanying drawing is an enlarged and diagrammatic cross-section through two plasterboards fixed in place with edges abutting.

[0055] As shown, each board has a front face 10 and a rear face 12. In the illustrated example, at each edge the board is tapered so that the edge consists of a bevel 14 as well as a narrow side edge 16. The plaster interior is indicated at 18.

[0056] The lining paper 20 on each front face covers each bevel 14 and side edge 16, before turning onto the margin of the rear face 12 where it is overlapped by the paper 22 on the rear face.

[0057] Printing in accordance with this invention extends over the whole of the front face 10 and at least part of the bevel 14. If convenient it covers the paper 20 around the side edge 16 to the extremity 24 of this paper.

[0058] After fixing the boards in the manner shown, they are joined with tape 28 which is adhered to the adjoining bevels 14, without extending onto the faces 10. A viscous, mobile jointing composition (not shown in the drawing) is then applied with a trowel to fill the cavity 26 and lie flush with the faces 10 as indicated by the chain-dotted line 30. This jointing compound is left to set hard. This jointing technique is conventional, but in accordance with this invention, the colour printed on the lining paper 20 is chosen to match the colour of the jointing compound.

[0059] The invention will now be described further by means of specific examples.

Example 1

[0060] Samples of a conventional plasterboard liner were printed in accordance with this invention before being used to make plasterboard. The properties of several samples of the lining paper, before printing, were measured and found to be :

Weight of single top ply	30 - 40 gsm	Total weight 220 gsm
Weight of three main plies	combined weight 180-190 gsm	
Air resistance (Gurley)	90 - 102 seconds	
CIE "L" value	78 to 80	
CIE "a" value	0.3 to 0.8	
CIE "b" value	4.4 to 5.1	

[0061] The paper was printed on the top ply which becomes the outer surface of plasterboard, at three stations of a multi-colour flexographic printing machine.

[0062] The flexographic inks and lacquers used were all water-based. At the first station the ink gave a "magnolia" colour. It contained 53% pigment, 15% aqueous acrylic resin, 27% water and a small balance made up of minor ingredients. This high content of pigment was intended to give high colour coverage.

[0063] The pigment was about 99% titanium dioxide and about 1% coloured pigment The aqueous acrylic resin contained approximately one third resin solids. These were styrene/acrylic copolymers of molecular weight 11,000 to 13,000. Thus the solids content of the ink was 53% pigment and 6.5% binder resin. This ink is referred to below as "ink 1".

[0064] The next printing station applied a less pigmented ink ("ink 2") containing 20% titanium dioxide pigment dispersed in an aqueous phase which also contained approximately 30% styrene/acrylic binder resin solids as above, partially in solution and partially as a dispersed liquid phase.

[0065] The third printing station applied a clear lacquer ("lacquer 1") with no pigment, consisting almost entirely of an aqueous continuous phase containing approximately 46% dispersed styrene/acrylic binder resin of molecular weight over 200,000.

[0066] At each of the three printing stations, application was 9.5 ml/m^2; the total volume applied was thus 28.5 ml/m^2. The total solids applied was 15g/m^2.

[0067] The porosity and ultra-violet resistance of several samples of the printed lining paper were measured. Air resistance (Gurley) was found to be approximately 240 seconds. The ultra-violet resistance of the paper was found to be very good.

[0068] The colour of the print on several samples was determined on the CIE Lab scale, and compared with the colour of the samples before printing.

[0069] It was found that before printing there was a difference of 4.12 between the highest and lowest "L" values, but this reduced to 1.10 after printing. There was a difference of 2.38 between the highest and lowest "b" values before printing. This reduced to a difference of 1.32 between the highest and lowest b values after printing.

[0070] Differences between the highest and lowest "a" values were less than 1.0, both before and after printing. Thus the effect of printing was to give greater uniformity of colour.

[0071] The L, a, b values for the printed liner were approximately 89, 0.1 and 5.2. It was thus somewhat lighter in colour than the unprinted liner with L value of about 80.

[0072] The printed surface of the paper was examined under a scanning electron microscope. At 250x magnification it was observed that the coating provided continuous colour but had a number of cracks. At high magnification individual particles of the printed pigment could be discerned and a pore structure could be seen.

[0073] The printing lining paper was used for making plasterboard on a conventional board-making line. The speed of the line, the time in the drying kiln and the temperatures in that kiln were conventional and indeed were the same as used for manufacture using unprinted liner.

Examples 2 to 7

[0074] The procedure of Example 1 was repeated using the same and additional inks and lacquers in various compositions.

[0075] "Ink 3" was an opaque white ink, similar in composition to Ink 1 except for the absence of any coloured pigment. "Lacquer 2" was a matt lacquer containing 5.8% of titanium dioxide pigment and 36% of styrene/acrylic binder resin solids.

[0076] The combinations of inks and lacquers are set out in the table below, together with the Gurley air resistance of the papers after printing (Example 1 above is included also). It can be seen that all the Gurley values lay between 200 and 400 seconds, while most lay between 240 and 400 seconds.

Example No	Printing stations			Gurley value (sec)
	First	Second	Third	
1	Ink 1	Ink 2	Lacquer 1	240
2	Ink 1	Ink 2	Lacquer 2	240
3	Ink 3	Ink 2	Lacquer 2	260
4	Ink 3	Ink 2	Lacquer 1	290
5	Ink 2	Ink 2	Lacquer 1	225
6	Ink 2	Ink 2	Lacquer 2	230
7	Ink 1	Ink 1	Lacquer 2	315

[0077] All of these preprinted liners were successfully converted into plasterboard on a normal production line without needing to depart from normal operating parameters of the production line.

Claims

1. A pre-decorated plasterboard having lining paper at its surfaces with a surface material printed thereon over the whole of one face of the board, with a density of print sufficient that under optical examination at least 80% of the surface of the lining paper is covered by the applied print.

2. Plasterboard according to claim 1 wherein the printed material extends onto adjoining edges of the board.

3. Plasterboard according to claim 1 or claim 2 wherein the printed material has a weight per unit area in a range from 7 to 30 g/m^2 dry weight.

4. Plasterboard according to any one of the preceding claims wherein the printed material includes printed colour.

5. A combination of

   i) pre-decorated plasterboards as defined in any one of the preceding claims and
   ii) settable, mobile jointing compound for filling joints between boards after fixing,

   where the printed material on the boards is matched to the colour of the set jointing compound.

6. A method of making pre-decorated plasterboard according to any one of claims 1 to 4 comprising steps of:-
   printing one surface of a web of lining paper, introducing wet plaster between the opposite surface of the said web of lining paper and a second web of lining paper, shaping the edge portions of the first said web around the plaster to form board edges, cutting into lengths and heating to dry the plaster, thereby forming plasterboard with printing on one exposed face,
   characterised in that the printing on the first web of lining paper extends over such a width that the whole face of the plasterboard has printing thereon, with a density of print sufficient that under optical examination at least 80% of the surface of the lining paper is covered by the applied print.

7. A method according to claim 6 wherein the printing step is carried out by flexographic printing.