(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 924 342 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
23.06.1999 Bulletin 1999/25

(51) Int Cl.6: **D21H 23/50**, D21H 21/14, D21H 19/36, D21H 27/10

(21) Application number: **98310335.9**

(22) Date of filing: **16.12.1998**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **19.12.1997 GB 9726921**

(71) Applicant: **ECC INTERNATIONAL LIMITED**
Theale, Reading, Berkshire RG7 4SA (GB)

(72) Inventor: **Preston, Janet Susan**
St. Austell, Cornwall PL25 3EH (GB)

(74) Representative: **McCormack, Derek James**
ECC International Ltd,
Patents Department,
John Keay House
St Austell, Cornwall PL25 4DJ (GB)

(54) **Packaging materials**

(57) A method of increasing the coefficient of static friction of a cellulosic sheet which method comprises the steps of preparing a sprayable aqueous coating composition comprising an aqueous suspension of a finely divided particulate inorganic material comprising material selected from the group consisting of kaolin clay, calcined kaolin, ground natural calcium carbonate, chemically precipitated calcium carbonate and zeolites, and, preferably from 4% to 60% by weight, based on the dry weight of the particulate inorganic material, of an adhesive, and spraying the coating composition on to the surface of a cellulosic sheet, in a quantity sufficient to give, after drying of the coating, a suitable coat weight per unit surface area, eg in the range of from $0.5g.m^{-2}$ to $3.0g.m^{-2}$. The static coefficient of friction of the coated sheet may be at least 0.5.

EP 0 924 342 A2

Description

[0001] This invention is concerned with packaging materials and in particular with a method for increasing the coefficient of friction of the surface of packaging materials made from cellulosic fibres, and especially the surface of paperboard products such as linerboards and of kraft paper for making paper sacks; it is also concerned with products produced thereby.

[0002] A large proportion of the finished products of industry are packed and despatched in boxes or cartons made from a sheet materials which is derived from a cellulosic fibrous material such as wood pulp or recycled waste paper. This sheet material is commonly referred to as cardboard or packaging board, but is most frequently known in the trade as linerboard. Linerboard generally consists of two or more layers of cellulosic sheet material laminated together. For example, a high quality linerboard may consist of a relatively thick base layer made from unbleached softwood kraft pulp to which is laminated a thinner layer called a "liner" which is generally made from a higher quality unbleached kraft pulp than that used to form the base layer. The two layers are separately manufactured on a conventional paper making machine, which may be, for example, of the Fourdrinier type. On this type of paper making machine, a dilute suspension of cellulosic fibres together with a mineral filler, if used, and chemical additives which may be used to improve the retention of the filler, is caused to flow in the form of a broad curtain on to the upper surface of a travelling wire mesh belt, through which water is withdrawn by gravity and by suction, to leave a felt-like web of cellulosic fibrous material on the surface of the wire mesh belt, which web is dried by radiation and/or convection to yield a sheet material. After the linerboard has been formed by laminating together two or more layers of cellulosic sheet material, the resultant laminated web is cut into sheets of appropriate size, and the sheets are creased and folded to make boxes or cartons for the product which is required to be packaged and transported.

[0003] Linerboard boxes filled with goods are generally handled in large numbers in warehouses, stores and in various means for conveying goods. A very common practice is to stack a number of such boxes, from two or three upwards to ten or more, on a pallet, and to move the pallet, complete with its stack of boxes, from one place to another on a particular site by means of a fork-lift truck. In such practice problems are caused if the coefficient of friction between the surface of two adjacent boxes is too low. In such a case, one box could easily slide over another while the stack of boxes was being handled and could become detached from the rest of the stack with results which would be very detrimental to efficient handling. The natural coefficient of friction of the sheet materials from which linerboards are generally made is relatively low, and it has been found recently that there is a tendency for linerboards to be produced with even lower coefficients of friction. This trend may be accounted for by the increasing use of greater proportions of cellulosic fibres derived from recycled waste paper in the stock used to form the sheet materials which are laminated together to form the linerboard. These cellulosic fibres tend to be shorter than those derived from virgin wood pulp, and recycled waste paper pulp tends to contain oily or waxy substances which have been added to, or picked up by, the paper which was recovered as waste. Both of these factors tend to decrease the coefficient of friction of a sheet material containing a high proportion of the waste paper pulp, and it has recently become more and more necessary to apply a layer of a friction-increasing coating to the outer surfaces of linerboards to decrease the tendency of the finished boxes to slide over one another.

[0004] A similar problem may occur when kraft paper sacks are used to contain particulate solid products during transport and storage. Typically such paper sacks are composed of two or more layers of kraft paper, and if the outermost layer has a relatively low coefficient of friction, there will be a tendency for the filled sacks to slide over one another during handling and transport.

[0005] In order easily to identify the contents of linerboard boxes and kraft paper sacks it is generally necessary to print some product identifying text on to the surface of the packaging material before it is made up into containers. The printing process most usually employed for this purpose is the flexographic process. It is a general requirement that any coating which is applied to enhance the coefficient of friction of the surface of the packaging material must not affect the visual appearance of the finished container. In fact it must be virtually invisible to the human eye. The coating must also not interfere with the printing of identifying text by the flexographic process.

[0006] Coating compositions which are at present being applied to cellulosic packaging materials such as paperboard and kraft paper to increase the coefficient of friction of its surface generally consist predominantly of either colloidal silica or alumina together with various organic additives. Such coatings meet the requirements of enhancing the coefficient of friction without impairing the visual appearance of the packaging material or adversely affecting the quality of printed text applied by the flexographic process. These coating compositions, however, suffer from the disadvantages that they are relatively expensive, and, in the case of compositions containing colloidal silica, may be considered to be hazardous to health, especially when dry.

[0007] US-A-2872094 (Leptien) describes a non-skid or anti-slipping composition for cellulosic paper container materials, including kraft bag stock and paperboard. The composition consists essentially of about 3 to 15% colloidal silica, about 3 to 15% finely divided extender material, which may be a finely divided clay, a non-ionic polyalkylene ether wetting agent and an emulsified dimethyl polysiloxane foam suppresser, the balance being water.

[0008] US-A-3689431 (Payne) describes a silica sol-containing coating composition for imparting antislip properties to a cellulosic sheet material which is said to have no detrimental effects on the printing and handling characteristics of the materials. The composition initially comprises from 30 to 65% by weight of a mixture of from 2 to 20, preferably from 4 to 6, parts by weight of colloidal silica to 1 part by weight of a silica powder having an average particle diameter within the range of from 4 to 120nm. The composition is diluted with water to from 0.5 to 1% by weight of silica, and applied as a coating at a rate of from 0.05 to 0.5 pound of silica per 1000 ft^2 of surface of the cellulosic sheet material ($0.24g.m^{-2}$ - $2.4g.m^{-2}$).

[0009] US-A-5569318 (Jarand) describes an anti-slip coating composition for the surface of a paper product, which coating composition is designed to overcome a problem which occurs when a conventional anti-slip composition containing colloidal silica is applied to the surface of a web of cellulosic sheet material by spraying. Under these conditions the sprayed coating composition will tend to settle, not only on the sheet material web, where it is required, but also on the surrounding work area, where it dries and flakes off eventually to form a fine dust, which is hazardous to health. The solution proposed to this problem is to use a coating composition comprising from 12 to 20% by weight of colloidal silica solids, from 5 to 16.5% by weight of glycerin and from 0.5 to 10% by weight of N,N-dimethyl acetoacetamide, the balance being water.

[0010] JP-A-04-327297 describes an anti-slip composition for cardboard boxes. Boxes treated with the composition are said to retain their anti-slip properties even after repeated shipments. The composition comprises calcium sulphate whiskers which have an average diameter in the range of from 1 to 5μm and an average length in the range of from 30 to 70μm. The calcium sulphate whiskers are combined with colloidal silica, an alumina sol, water glass, a resin emulsion or a water soluble resin.

[0011] It is an object of the present invention to provide a coating composition for cellulose sheet material such as linerboard or other packaging material which will increase the coefficient of friction of the surface of the material without impairing its visual appearance or adversely affecting the quality of printed text applied by the flexographic process, and which will avoid the disadvantages associated with the use of colloidal silica or alumina.

[0012] According to the present invention there is provided a method for increasing the coefficient of static friction of a cellulosic sheet packaging material, which method comprises the steps of:

(a) preparing an aqueous coating composition by preparing a suspension in water of a finely divided particulate mineral comprising material selected from the group consisting of kaolin clay, calcined kaolin, ground natural calcium carbonate, chemically precipitated calcium carbonate and zeolites and an adhesive, and
(b) spraying the coating composition on to the surface of a cellulosic sheet material to produce a coating of the coating composition thereon.

[0013] The coating may have, eg after drying of the coating, a coat weight per unit surface area coated in the range of from $0.5g.m^{-2}$ to $3.0g.m^{-2}$.

[0014] The adhesive may form at least 4% by weight, eg from 10% to 60% by weight, based on the dry weight of the particulate inorganic material.

[0015] The cellulosic sheet material may be packaging material. For example, it may comprise a kraft paper material of the type which is used, often in two or more layers or "plies", to form paper sacks, or it may be a board material formed by laminating together two or more cellulosic sheets to form a packaging material of the type known variously as paper board, cardboard or linerboard. The cellulosic sheet material generally has at least one surface which is capable of receiving a good quality print impression in a printing process, which may be, for example, of the flexographic type. The flexographic printing process is a process of the relief type. In other words it makes use of raised characters to form the print image. In the specific case of flexographic printing, the printing plate is of a flexible material such as rubber, and a very fluid ink, comprising a pigment dissolved in a water or alcohol medium, is used with minimal print pressure.

[0016] The invention unexpectedly and beneficially allows anti-slip (anti-skid) coatings to be applied to cellulosic sheet materials such as packaging materials effectively and more cheaply than in the prior art.

[0017] In step (a) of the method according to the invention, the particulate mineral material preferably has a particle size distribution such that at least 20% by weight consists of particles having an equivalent spherical diameter smaller than 2μm. In this specification it is to be understood that particle size distribution is as measured by the well known technique of sedimentation in a fully dispersed condition in a dilute aqueous suspension using a SEDIGRAPH™ 5100 machine supplied by Micromeritics Corporation, USA. Most preferably the particulate inorganic material comprises calcium carbonate, ie is either a ground natural calcium carbonate, such as ground chalk or marble, and/or a chemically precipitated calcium carbonate.

[0018] The adhesive may comprise a hydrophilic substance of the carbohydrate type, for example a starch, a cellulose derivative, such as sodium carboxymethyl cellulose or hydroxyethyl cellulose, or a saccharide such as arabinogalactan. Alternatively the adhesive may comprise a hydrophilic substance of the polymer latex type, for example a latex of a copolymer of two or three monomers selected from the group consisting of styrene, butadiene, acrylonitrile and acrylic acid, a polyvinyl acetate latex, a polyvinyl alcohol latex or an ethylene vinyl acetate latex. The adhesive may be a mixture of two or more of the foregoing.

[0019] A lubricant, in an amount of up to 80% by weight of the binder, eg glycerol forming up to 50% of the binder, may be included in an adhesive or binder composition.

[0020] In step (b) the aqueous coating composition prepared in step (a) is preferably diluted, if necessary, before spraying to a total solids content in the range of from about 10% to about 20% by weight. In any case, the water content of the sprayable composition employed in step (b) preferably is in the range 80% to 92% by weight.

[0021] The sprayable composition may include one or more further additives to improve properties before, during or after spraying of the composition.

[0022] For example, a surfactant may be included to improve spraying of the composition and to prevent coalescence of the particles in the droplets. The surfactant may comprise a non-ionic surfactant. Examples of suitable non-ionic surfactants include one or more compounds selected from primary, secondary and tertiary alcohol ethoxylates, alkyl phenols, ethoxylated dialkyl phenols, block copolymers comprising alkylene oxides, alkylphenoxypolyethoxylalkanols and polyoxyethylated acetylenic glycols. Alcohol ethoxylates are preferred for use as the surfactant. Preferably, the surfactant if non-ionic has a hydrophile/lipophile balance (HLB) in the range 5 to 14, eg in the range 8 to 11. Examples of suitable commercially available non-ionic surfactants are the products sold respectively under the trade names TRITON X-100, DOBANOL 91-6 and NEODOL 91-6.

[0023] The surfactant may form, based on the dry weight of the particulate inorganic material, up to 5% preferably from 0.1% to 2%, by weight.

[0024] A dye or colouring material may be added to the composition to match the colour of the deposited composition to that of the cellulosic sheet material. The cellulosic sheet may comprise yellow or brown packaging or board material and the composition may include one or more additives giving a yellow or brown colouration. A suitable additive for brown sheet coating comprises a brown dye optionally together with a black pigment, eg carbon black. An example of a suitable brown dye is BASAZOL™ Brown 43L. The sprayable composition is preferably one in which substantial sedimentation of the solid components does not occur over a period of time, eg at least one hour.

[0025] Preferably, the coefficient of friction of the sheet material treated by the method of the invention is raised by an increment of at least 0.1 in some cases by from 0.2 or more, eg to a value of 0.50 or more, in some cases 0.58 or more.

[0026] Preferably, the means employed to spray the sprayable composition provides a spray of droplets having an average size not greater than lmm, in many cases not greater than 0.5mm. The sprayed droplets are thereby fine droplets of the coating composition which may suitably form a uniform coating on the surface of the cellulosic sheet material.

[0027] Embodiments of the present invention will now be described by way of example only with reference to the following Examples.

EXAMPLE 1

[0028] Five anti-slip coating compositions for liner board were prepared. Compositions 1 to 4 were in accordance with an embodiment of the present invention and each contained 100 parts by weight of dry calcium carbonate pigment and 50 parts by weight of a starch binder. The calcium carbonate pigments were either produced by grinding a natural calcium carbonate or by chemical precipitation and had varying particle size distributions, which were characterised by the percentage by weight of particles which had an equivalent spherical diameter smaller than 2μm and 1μm, respectively. Details of the calcium carbonate pigments are given in Table 1 below.

Table 1

Composition	Type of calcium carbonate	% by wt smaller than	
		2μm	1μm
1	Ground natural	99	91
2	Ground natural	88	63
3	Ground natural	22	13
4	Chemically precipitated	99	97

[0029] Composition 5 was a control composition representing a prior art formulation and consisting of 31.5% by weight of a colloidal silica having a mean particle diameter of 91nm, 13.5% by weight of an organic carbohydrate binding agent and 55% by weight of water.

[0030] Compositions 1 to 4 were diluted with water to about 10% by weight of dry solids and Composition 5 was diluted to about 7% of dry solids, a value which is given as being appropriate in many prior published patent specifications relating to the use of anti-slip coating compositions containing colloidal silica. Each diluted suspension was sprayed on to the surface of a sample of a linerboard of substance weight 42 lb. per 1000 ft^2 ($205g.m^{-2}$) to give a coating of dry weight in the range of from about 0.5 to about $2.5g.m^{-2}$.

[0031] The coatings were allowed to dry and the samples of coated linerboard were then tested for static coefficient of friction and for brightness or percentage reflectance to light of wavelength 457nm.

[0032] The static coefficient of friction was measured by means of a "Tensometric™ Micro 350" tensometer by attaching a sample of coated linerboard to the highly polished surface of a weighted stainless steel block which is drawn across a second sample of the coated linerboard which is attached to a glass bed plate which in turn is securely located on the bed plate of the tensometer. The stainless steel block is drawn across the surface of the second coated linerboard sample by means of a flexible steel wire which passes around a substantially frictionless pulley and is connected at its further end to the cross head of the tensometer. The dimensions of the block are 60mm x 45mm x 6mm and the weight of the block and the wire together is 128 grams. The block is also loaded with a 2kg weight placed on top of the block. The cross head ascends at a constant rate of $100mm.min^{-1}$ and the loaded block is drawn across the surface of the linerboard sample at the same speed. A load cell mounted in the cross head gives a continuous read-out of the tension in the wire in Newtons. A second digital read-out displays the distance travelled by the block. The tension in the wire is measured continuously during the movement of the block and the data is automatically saved using a personal computer. The static coefficient of friction is a measure of the frictional force which must be overcome to initiate movement, and this is the coefficient of friction which is most often quoted in the paperboard industry. The kinetic coefficient of friction is derived by averaging over a set time period the forces required to pull the already moving block. The set time period is conveniently from 10 to 40 seconds, measured from the instant of initiation of movement, since during this period the frictional forces are relatively constant. From the average value obtained the coefficient of friction of the surface of the coated linerboard is calculated by means of the formula

$$\mu = F/Mg$$

where

μ is the coefficient of friction
F is the tension in the wire
M is the total load on the coated linerboard (2.128 kg), and
g is the acceleration due to gravity ($9.81m.s^{-2}$)

[0033] Technicians in the paperboard industry often express the frictional properties of a paperboard surface in terms of a "slide angle", q, which is related to the static coefficient of friction by the expression

static coefficient of friction = tan q

[0034] For each sample of coated linerboard the static coefficient of friction was first measured when the sample had been freshly coated and dried. Then in order to investigate whether the coefficient of friction would be maintained after repeated sliding of one coated linerboard surface over another, the friction testing procedure was performed a further two times, and the static coefficient of friction measured for the third slide was also recorded.

[0035] The brightness was measured by the procedure laid down in International Standard No ISO 2470. This test gave an indication as to the visual appearance of the surface after the anti-slip coating had been applied, and revealed whether the appearance had been significantly changed by the application of the coating.

[0036] The results are set forth in Table 2 below. For comparison, corresponding results for the uncoated base linerboard are also given in Table 2.

Table 2

Composition	Coat weight ($g.m^{-2}$)	Static coefficient of friction on		% reflectance to light of wavelength 457 nm
		1st slide	3rd slide	
1 (invention)	0.76	0.433	0.309	14.3
1 (invention)	0.97	0.679	0.277	14.6

Table 2 (continued)

Composition	Coat weight (g. m^{-2})	Static coefficient of friction on		% reflectance to light of wavelength 457 nm
		1st slide	3rd slide	
1 (invention)	1.45	0.673	0.449	14.2
1 (invention)	1.83	0.741	0.556	14.4
2 (invention)	1.61	0.571	0.356	14.6
2 (invention)	1.79	0.643	0.443	14.8
2 (invention)	2.32	0.727	0.529	14.5
3 (invention)	0.90	0.608	0.588	15.3
3 (invention)	1.65	0.603	0.591	15.0
3 (invention)	1.88	0.601	0.611	15.4
3 (invention)	2.05	0.578	0.563	14.6
4 (invention)	1.30	0.611	0.446	14.3
4 (invention)	1.64	0.555	0.365	14.5
4 (invention)	1.81	0.644	0.369	14.4
4 (invention)	1.97	0.597	-	14.5
5 (comparison)	0.80	0.569	-	14.4
5 (comparison)	1.24	0.441	0.338	14.2
5 (comparison)	1.40	0.666	-	14.6
5 (comparison)	1.83	0.671	-	14.6
Uncoated	0	0.445	0.320	14.5

[0037] These results show that Composition 1, which contains a very finely ground natural calcium carbonate, provides an anti-skid effect which is as good as, if not slightly better than that provided by the prior art Composition 5. The anti-skid effect provided by the other composition in accordance with an embodiment of the invention is at least comparable with that provided by the prior art composition.
With the exception of Composition 3, which appeared to give a small, but significant, increase in the reflectance to light of wavelength 457nm, none of the compositions had an appreciable effect on the visual appearance of the coated linerboard.
[0038] Samples of the same base linerboard, coated with each of the five compositions by the procedure described above, were subjected to a flexographic printing test using a "DYNAQUA"™ black water based ink on an "IGT"™ F1 Flexographic Printer. The ink was diluted before use with 10 parts by volume of water added to 100 parts by volume of ink. The printer was run with a load of 50 N on the engraved cylinder and 100 N on the impression roller and a printing speed on 0.5m.s^{-1}. A solid black area was printed on each sample and the optical density of the printed and unprinted areas were measured for each sample.
[0039] The results are set forth in Table 3 below. Again, a sample of the uncoated base linerboard was subjected to the same printing test, and the results are also shown in Table 3.

Table 3

Composition	Coat weight (g.m^{-2})	Optical density	
		Printed	Unprinted
1 (invention)	0.89	1.26	0.54
2 (invention)	1.32	1.25	0.53
3 (invention)	1.37	1.26	0.53

Table 3 (continued)

Composition	Coat weight (g.m^{-2})	Optical density	
		Printed	Unprinted
4 (invention)	1.95	1.26	0.54
5 (comparison)	1.26	1.25	0.54
Uncoated	0	1.26	0.54

[0040] These results show that none of the coating compositions has an appreciable effect on the quality of a print image applied by the flexographic technique.

EXAMPLE 2

[0041] Four anti-slip coating compositions for liner board were prepared. Compositions 1 to 3 were in accordance with an embodiment of the present invention and each contained 100 parts by weight of dry mineral pigment and 50 parts by weight of a binder composition consisting of 60% by weight of starch and 40% by weight of glycerol. The mineral pigments had the following properties:

Composition 6: A mixture consisting of 50% by weight of a calcined clay having a particle size distribution such that 90% by weight consisted of particles having an equivalent spherical diameter smaller than 2µm and 50% by weight of a hydrous kaolin clay having a particle size distribution such that 96% by weight consisted of particles having an equivalent spherical diameter smaller than 2µm.

Composition 7: A ground marble having a particle size distribution such that 88% by weight consisted of particles having an equivalent spherical diameter smaller than 2µm.

Composition 8: A ground marble having a particle size distribution such that 80% by weight consisted of particles having an equivalent spherical diameter smaller than 2µm.

[0042] Each aqueous coating composition was diluted with water to a solids content in the range of from 16.5 to 19.0% by weight and was sprayed on to a sample of a test linerboard to give coat weights in the range of from about 0.5 to about 4.5g.m^{-2}. Test linerboard is so called because the product was historically designed to meet a specific test value. It consists of a base layer of high quality waste paper pulp and a thin top layer comprising virgin unbleached kraft pulp.

[0043] Composition 9 was a control composition similar to Composition 5 in Example 1 above and consisted of 31.5% by weight of a colloidal silica having a mean particle diameter of 91nm, 13.5% by weight of an organic carbohydrate binding agent and 55% by weight of water. This composition was diluted to about 7% of dry solids before spraying.

[0044] Each sample of coated linerboard was allowed to dry and was then tested for static coefficient of friction when the sample was freshly coated and dried, ie on the first slide, and for percentage reflectance to light of wavelength 457nm. by the procedures described in Example 1 above.

[0045] The results are set forth in Table 4 below. For comparison, corresponding results for the uncoated base linerboard are also given in Table 4.

Table 4

Composition	Coat weight (g. m^{-2})	Static coefficient of friction on 1st slide	% reflectance to light of 457nm wavelength
6 (invention)	1.47	0.609	19.7
6 (invention)	2.36	0.650	22.0
6 (invention)	2.99	0.723	27.5
6 (invention)	4.41	0.736	32.4
7 (invention)	0.88	0.565	15.4
7 (invention)	1.22	0.624	15.6
7 (invention)	1.55	0.632	16.6
7 (invention)	3.01	0.742	18.0
8 (invention)	0.92	0.548	15.6

Table 4 (continued)

Composition	Coat weight (g. m^{-2})	Static coefficient of friction on 1st slide	% reflectance to light of 457nm wavelength
8 (invention)	2.02	0.824	17.5
8 (invention)	3.01	0.844	19.2
8 (invention)	4.05	0.922	20.5
9 (comparison)	1.77	0.726	14.9
9 (comparison)	2.07	0.720	15.0
9 (comparison)	2.82	0.720	15.0
9 (comparison)	4.59	0.692	15.4
Uncoated	0	0.434	15.0

[0046] These results show that the two compositions which contain calcium carbonate pigments, Compositions 7 and 8 give a good increase in the coefficient of friction of the surface of the linerboard, provided that the coat weight is in excess of about 1.5 to 2.0g.m^{-2}. The increase in reflectance to light of wavelength 457nm with these two compositions is only slight and insufficient to cause a noticeable change in the visual appearance of the coated linerboard. Composition 6, which contains a pigment which is a mixture of calcined and uncalcined kaolin clays, also gives a useful increase in coefficient of friction, but in this case there is a greater increase in reflectance to light of wavelength 457nm from the coated surface, and this results in a detectable difference in the visual appearance of the coated linerboard.

EXAMPLE 3

[0047] Five anti-slip coating compositions for liner board were prepared. Compositions 10 to 13 were in accordance with an embodiment of the present invention and each contained 100 parts by weight of a dry mineral pigment which was a ground natural marble having a particle size distribution such that 88% by weight consisted of particles having an equivalent spherical diameter smaller than 2µm and 63% by weight consisted of particles having an equivalent spherical diameter smaller than 1µm. Each composition used a different adhesive system details of which are as follows:
Composition 10: 20 parts by weight of a soft rotogravure grade, alkali swellable acrylic latex, which is available from BASF under the trade name "ACRONAL S553V".
Composition 11: 50 parts by weight of a hot water starch adhesive which is sold under the trade name "EMOX TSC"
Composition 12: 50 parts by weight of a sodium carboxymethyl cellulose adhesive.
Composition 13: 50 parts by weight of a polyacrylamide adhesive, which is available from the Calgon Corporation under the trade name "TRP-1044".

[0048] Each aqueous coating composition was diluted with water to a solids content in the range of from 10 to 12% by weight and was sprayed on to a sample of a linerboard having a dry substance weight of 42 pounds per 1000 ft^2 (205g.m^{-2}) to give coat weights in the range of from about 0.3 to about 2.0g.m^{-2}.

[0049] Composition 14 was a control composition similar to Compositions 5 and 9 in Examples 1 and 2 above and consisted of 31.5% by weight of a colloidal silica having a mean particle diameter of 91nm, 13.5% by weight of an organic carbohydrate binding agent and 55% by weight of water. This composition was diluted to about 7% of dry solids before spraying.

[0050] Each sample of coated linerboard was allowed to dry and the coefficient of friction of the coated surface was first measured by the procedure described in Example 1 above when the sample was freshly coated and dried. Then the friction testing procedure was performed a further two times, and the coefficient of friction measured for the third slide was also recorded. The percentage reflectance to light of wavelength 457nm. was also measured by the procedure laid down in International Standard No ISO 2470.

[0051] The results are set forth in Table 5 below. For comparison, corresponding results for the uncoated base linerboard are also given in Table 5.

Table 5

Composition	Coat weight (g. m^{-2})	Static coefficient of friction on		% reflectance to light of wavelength 457 nm
		1st slide	3rd slide	
10 (invention)	0.57	0.622	0.534	14.7
10 (invention)	0.88	0.554	0.489	16.0
10 (invention)	1.03	0.552	0.503	15.8
10 (invention)	1.68	0.732	0.555	16.8
11 (invention)	0.87	0.673	0.525	14.8
11 (invention)	1.05	0.632	0.478	14.8
11 (invention)	1.48	0.762	0.561	14.6
11 (invention)	1.95	0.613	0.484	14.7
12 (invention)	0.88	0.571	0.503	14.6
12 (invention)	0.98	0.554	0.469	14.5
12 (invention)	1.18	0.520	0.417	14.6
12 (invention)	1.45	0.613	0.472	14.6
13 (invention)	1.00	0.605	0.450	15.0
13 (invention)	1.13	0.523	0.442	14.5
13 (invention)	1.30	0.606	0.462	15.0
13 (invention)	1.46	0.619	0.496	15.3
14 (comparison)	0.41	0.461	0.486	14.5
14 (comparison)	0.62	0.621	0.585	14.7
14 (comparison)	0.71	0.694	0.643	14.4
14 (comparison)	0.98	0.640	0.552	14.5
Uncoated	0	0.433	0.355	14.8

[0052] These results show that coating compositions containing a fine ground natural calcium carbonate as the particulate mineral and either a latex or starch adhesive, will provide a good increase in the coefficient of friction of the coated linerboard surface, and the level of the coefficient of fiction will be well retained after the third slide, provided that the coat weight of these composition applied is at least about 1.5g.m^{-2}. These compositions have an insignificant effect on the reflectance to light of 457nm wavelength, and therefore on the visual appearance of the surface.

EXAMPLE 4

[0053] Three anti-slip coating compositions for liner board were prepared. Compositions 15 and 16 were in accordance with an embodiment of the present invention and each contained 100 parts by weight of a dry mineral pigment and 20 parts by weight of a soft styrene/butadiene latex adhesive, which is often used in paper coating compositions for preparing coated paper for use in rotogravure printing, and is marketed by GenCorp under the trade name "GENFLO 5170". The mineral pigments used in the two compositions were:

Composition 15: a ground natural marble having a particle size distribution such that 88% by weight consisted of particles having an equivalent spherical diameter smaller than 2μm and 63% by weight consisted of particles having an equivalent spherical diameter smaller than 1μm

Composition 16: a ground natural marble having a particle size distribution such that 61% by weight consisted of particles having an equivalent spherical diameter smaller than 2μm and 40% by weight consisted of particles having an equivalent spherical diameter smaller than 1μm.

[0054] Each aqueous coating composition was diluted with water to a solids content of about 10% by weight and was sprayed on to a sample of a linerboard which was formed from virgin pulp alone and which had a dry substance weight of 33 pounds per 1000 ft^2 ($161g.m^{-2}$) to give coat weights in the range of from about 0.2 to about $1.5g.m^{-2}$.

[0055] Composition 17 was a control composition similar to Compositions 5, 9 and 14 in Examples 1 to 3 above and consisted of 31.5% by weight of a colloidal silica having a mean particle diameter of 91nm, 13.5% by weight of an organic carbohydrate binding agent and 55% by weight of water. This composition was diluted to about 7% of dry solids before spraying.

[0056] Each sample of coated linerboard was allowed to dry and the coefficient of friction of the coated surface was measured by the procedure described in Example 1 above when the sample was freshly coated and dried. The percentage reflectance to light of wavelength 457nm. was also measured by the procedure laid down in International Standard No ISO 2470.

[0057] The results are set forth in Table 6 below. For comparison, corresponding results for the uncoated base linerboard are also given in Table 6.

Table 6

Composition	Coat weight ($g.m^{-2}$)	Static coefficient of friction	% reflectance to light of wavelength 457nm
15 (invention)	0.28	0.660	16.6
15 (invention)	0.79	0.710	16.9
15 (invention)	0.89	0.724	17.0
15 (invention)	1.41	0.740	18.6
16 (invention)	0.42	0.603	16.6
16 (invention)	0.75	0.638	16.8
16 (invention)	1.02	0.643	17.7
16 (invention)	1.11	0.713	17.6
17 (comparison)	0.44	0.726	16.2
17 (comparison)	0.58	0.706	16.2
17 (comparison)	0.66	0.733	16.0
17 (comparison)	0.79	0.744	16.1
Uncoated	0	0.502	16.3

[0058] These results show that the coating compositions which contained a finer ground natural calcium carbonate mineral (Composition 15) provided a better increase in the coefficient of friction of the coated linerboard surface than the composition containing a less fine calcium carbonate mineral (Composition 16). These compositions had an insignificant effect on the reflectance to light of 457nm wavelength, and therefore on the visual appearance of the surface.

EXAMPLE 5

[0059] Three anti-slip coating compositions for liner board were prepared. Compositions 18 to 20 were in accordance with the present invention and each contained 100 parts by weight of the same fine ground natural calcium carbonate mineral as was described in connection with Composition 16 in Example 4 above and different quantities of the same latex adhesive as was described in Example 4. The amounts of the latex adhesive used in each of the compositions were:

Composition 18:	20 parts by weight
Composition 19:	35 parts by weight
Composition 20:	50 parts by weight

[0060] Each aqueous coating composition was diluted with water to a solids content of about 10% by weight and was sprayed on to a sample of the same linerboard as was described in Example 4 to give dry coatings having weights in the range of from 0.35 to $1.3g.m^{-2}$.

[0061] Each sample of coated linerboard was allowed to dry and the coefficient of friction of the coated surface was measured by the procedure described in Example 1 above when the sample was freshly coated and dried. The percentage reflectance to light of wavelength 457nm. was also measured by the procedure laid down in International Standard No ISO 2470.

[0062] The results are set forth in Table 7 below. For comparison, corresponding results for control Composition 17 from Example 4 and for the uncoated base linerboard are also given in Table 7.

Table 7

Composition	Coat weight (g. m^{-2})	Static coefficient of friction	% reflectance to light of wavelength 457nm
18 (invention)	0.42	0.603	16.6
18 (invention)	0.75	0.638	16.8
18 (invention)	1.02	0.643	17.7
18 (invention)	1.11	0.713	17.6
19 (invention)	0.38	0.577	16.4
19 (invention)	0.92	0.618	16.6
19 (invention)	1.15	0.647	16.7
19 (invention)	1.28	0.677	16.9
20 (invention)	0.87	0.620	16.5
20 (invention)	0.92	0.621	16.3
20 (invention)	1.12	0.666	16.6
20 (invention)	1.18	0.706	16.7
17 (comparison)	0.44	0.726	16.2
17 (comparison)	0.58	0.706	16.2
17 (comparison)	0.66	0.733	16.0
17 (comparison)	0.79	0.744	16.1
Uncoated	0	0.502	16.3

[0063] These results show that the increase in the coefficient of friction provided by the coating compositions in accordance with an embodiment of the invention is not greatly affected by the proportion of latex adhesive used in the coating composition, provided that this proportion is within the range of from 10 to 60% by weight, based on the weight of dry calcium carbonate mineral.

EXAMPLE 6

[0064] Two anti-slip coating compositions for liner board were prepared. Compositions 21 and 22 were in accordance with an embodiment of the present invention and each contained 100 parts by weight of the same fine ground natural calcium carbonate mineral as was described in connection with Composition 16 in Example 4 above and different quantities of an adhesive which was supplied by Larex Inc. and comprised an arabinogalactan sugar derived from wood gum. The amounts of the arabinogalactan adhesive used in each of the compositions were:

Composition 21: 28 parts by weight
Composition 22: 50 parts by weight

[0065] Each aqueous coating composition was diluted with water to a solids content of about 10% by weight and was sprayed on to a sample of the same linerboard as was described in Example 4 to give dry coatings having weights in the range of from 0.6 to 1.6g.m^{-2}.

[0066] Each sample of coated linerboard was allowed to dry and the coefficient of friction of the coated surface was measured by the procedure described in Example 1 above when the sample was freshly coated and dried. The percentage reflectance to light of wavelength 457nm. was also measured by the procedure laid down in International Standard No ISO 2470.

[0067] The results are set forth in Table 8 below. For comparison, corresponding results for control Composition 17 from Example 4 and for the uncoated base linerboard are also given in Table 8.

Table 8

Composition	Coat weight (g. m^{-2})	Static coefficient of friction	% reflectance to light of wavelength 457nm
21 (invention)	0.87	0.734	16.4
21 (invention)	0.91	0.764	16.7
21 (invention)	1.07	0.765	16.8
21 (invention)	1.43	0.780	16.8
22 (invention)	0.67	0.704	16.5
22 (invention)	0.98	0.753	16.4
22 (invention)	1.22	0.767	16.4
22 (invention)	1.60	0.803	16.1
17 (comparison)	0.44	0.726	16.2
17 (comparison)	0.58	0.706	16.2
17 (comparison)	0.66	0.733	16.0
17(comparison)	0.79	0.744	16.1
Uncoated	0	0.502	16.3

[0068] These results show that again the increase in the coefficient of friction provided by the coating compositions in accordance with an embodiment of the invention is not greatly affected by the proportion of the adhesive used in the coating composition, provided that this proportion is within the range of from 10 to 60% by weight, based on the weight of dry calcium carbonate mineral. The arabinogalactan adhesive used in these experiments was found to have a dispersing, or deflocculating, effect on the particles of the calcium carbonate mineral, and, as a result, the compositions containing this adhesive showed a lesser tendency to gel or increase in viscosity on storage. Also, because the arabinogalactan adhesive was brown in colour, the coating compositions containing it, when dry, had a reduced whitening effect on the linerboard, with the result that the coating was even less detectable by the naked eye.

EXAMPLE 7

[0069] An anti-slip coating compositions for liner board, Composition 23, in accordance with the an embodiment of present invention, contained 80 parts by weight of the same fine ground natural calcium carbonate mineral as was described in connection with Composition 16 in Example 4 above, 20 parts by weight of the calcined clay which was described under Composition 6 in Example 2 above and 50 parts by weight of the arabinogalactan adhesive which was used in Example 6 above.

[0070] This coating composition was diluted with water to a solids content of about 10% by weight and was sprayed on to a sample of the same linerboard as was described in Example 4 to give dry coatings having weights in the range of from 0.8 to 1.0g.m^{-2}.

[0071] Each sample of coated linerboard was allowed to dry and the coefficient of friction of the coated surface was first measured by the procedure described in Example 1 above when the sample was freshly coated and dried. Then the friction testing procedure was performed a further two times, and the coefficient of friction measured for the third slide was also recorded. The percentage reflectance to light of wavelength 457nm. was also measured by the procedure laid down in International Standard No ISO 2470.

[0072] The results are set forth in Table 9 below. For comparison, corresponding results for the uncoated base linerboard are also given in Table 9.

Table 9

Composition	Coat weight (g. m^{-2})	Static coefficient of friction on		% reflectance to light of wavelength 457nm
		1st slide	3rd slide	
23 (invention)	0.84	0.757	0.642	16.7
23 (invention)	0.91	0.760	0.662	16.6
23 (invention)	0.94	0.736	0.656	16.4
23 (invention)	0.95	0.773	0.689	16.6
17 (comparison)	0.44	0.726	0.707	16.2
17 (comparison)	0.58	0.706	0.708	16.2
17 (comparison)	0.66	0.733	0.730	16.0
17 (comparison)	0.79	0.744	0.740	16.1
Uncoated	0	0.502	0.450	16.3

[0073] These results show that the increase in the coefficient of friction provided by the coating composition in accordance with an embodiment of the invention is comparable with that provided by the prior art composition even at low coat weights. The level of the coefficient of friction was also well retained after the third slide.

EXAMPLE 8

[0074] Because of the relatively high cost of adhesives of the latex type, an attempt was made to provide anti-slip coating compositions for liner board which had greatly reduced quantities of a latex-type adhesive, or which made use of an alternative, and less costly, type of adhesive. Compositions 24 and 25 were each in accordance with an embodiment of the present invention and each contained 100 parts by weight of the same fine ground natural calcium carbonate as was described in connection with Composition 15 in Example 4 above. The formulations of the two compositions are given in Table 10 below:

Table 10

Ingredient	Parts by weight	
	Composition 24	Composition 25
Calcium carbonate	100	100
Latex adhesive	10	0
Arabinogalactan	2	4
Lignosulphonate (brown colourant)	3	3

[0075] The latex adhesive was the same as that described in Example 4, ie that marketed by GenCorp under the trade name "GENFLO 5170". The arabinogalactan adhesive was the same as that described in Example 6. The lignosulphonate was of the cross linked type.

[0076] Each coating composition was diluted with water to a solids content of about 10% by weight and was sprayed on to samples of the same linerboard as was described in Example 1 to give dry coatings having weights in the range of from 0.2 to 0.7 g.m^{-2}.

[0077] Each sample of coated linerboard was allowed to dry and the coefficient of friction of the coated surface was first measured by the procedure described in Example 1 above when the sample was freshly coated and dried. Then the friction testing procedure was performed a further two times, and the coefficient of friction measured for the second and third slides were also recorded. The average coefficient of friction for the three slides was then calculated. The percentage reflectance to light of wavelength 457 nm. was also measured by the procedure laid down in International Standard No ISO 2470.

[0078] The results are set forth in Table 11 below. For comparison, corresponding results for the uncoated base linerboard are also given in Table 11

Table 11

Composition	Coat weight (g. m^{-2})	Static coefficient of friction (average of 3 slides)	% reflectance to light of wavelength 457 nm
24 (invention)	0.45	0.509	15.7
24 (invention)	0.54	0.602	16.2
24 (invention)	0.57	0.596	15.8
24 (invention)	0.62	0.641	15.8
25 (invention)	0.34	0.571	15.2
25 (invention)	0.40	0.592	15.8
25 (invention)	0.58	0.627	15.7
25 (invention)	0.65	0.632	16.0
Uncoated	0	0.385	14.8

[0079] These results show that the proportion of adhesive in the coating composition can be reduced, with consequent saving in the cost of the composition, without unduly impairing the increase in the coefficient of friction obtainable over that of the uncoated liner board. The increase in brightness, or lightening of colour, of the treated liner board is also kept to a value such that the dried coating is virtually invisible to the naked eye.

EXAMPLE 9

[0080] During a trial at a commercial paper mill it was discovered that, if apparatus capable of applying the coating composition to a web of liner board in the form of a spray of fine droplets was not available at the mill, but the coating composition was applied as larger droplets, eg greater than lmm in size, the coated liner board assumed a mottled appearance after drying with areas of lighter colour appearing where individual droplets of coating composition had dried. In order to solve this problem, compositions in accordance with an embodiment of the present invention were prepared which contained (i) a surfactant, or (ii) a combination of a surfactant and a dark coloured pigment. Compositions 26 and 27 each contained 100 parts by weight of the same fine ground natural calcium carbonate as was described in connection with Composition 15 in Example 4 above. The formulations of the two compositions are given in Table 12 below:

Table 12

Ingredient	Parts by weight	
	Composition 26	Composition 27
Calcium carbonate	100	100
Arabinogalactan	4	4
Lignosulphonate	3	3
Surfactant	1	2.1
Brown dye	0	1.1
Carbon black	0	0.7

[0081] The arabinogalactan adhesive was the same as that described in Example 6. The lignosulphonate was of the cross linked type and was first dissolved in warm water to form a 20% by weight aqueous solution before being added to the coating composition. The surfactant was a non-ionic alcohol ethoxylate of the general formula $R(OCH_2CH_2)_8OH$, where R is a hydrocarbon radical having from 9 to 11 carbon atoms, and having an HLB number of 13.7. It was used in the form in which it is made available in commerce. The carbon black, which consisted of particles having an average diameter about 20nm, and which is marketed by Columbian Chemicals under the trade name "ACTION A5 PFE", was added to the coating composition in the form of a 20% by weight aqueous slurry. The brown dye was "BASAZOL Brown 43L" and was used in the form in which it is made available in commerce.

[0082] Each coating composition was diluted with water to a solids content of about 10% by weight and was sprayed on to samples of the same linerboard as was described in Example 1 to give dry coatings having weights in the range of from 0.1 to 0.9 $g.m^{-2}$. A further sample of Composition 25 was prepared as described in Example 8, and this was also diluted with water to a solids content of about 10% by weight and sprayed on to samples of the liner board in the same way.

[0083] Each sample of coated linerboard was allowed to dry and the coefficient of friction of the coated surface was first measured by the procedure described in Example 1 above when the sample was freshly coated and dried. Then the friction testing procedure was performed a further two times, and the coefficient of friction measured for the second and third slides were also recorded. The average coefficient of friction for the three slides was then calculated. The percentage reflectance to light of wavelength 457 nm. was also measured by the procedure laid down in International Standard No ISO 2470.

[0084] The results are set forth in Table 13 below. For comparison, corresponding results for the uncoated base linerboard are also given in Table 13.

Table 13

Composition	Coat weight ($g.m^{-2}$)	Static coefficient of friction (average of 3 slides)	% reflectance to light of wavelength 457 nm
25 (invention)	0.227	0.585	15.2
25 (invention)	0.477	0.615	16.1
25 (invention)	0.617	0.637	16.1
25 (invention)	0.852	0.646	16.5
26 (invention)	0.102	0.633	15.9
26 (invention)	0.257	0.640	16.0
26 (invention)	0.612	0.680	17.4
26 (invention)	0.807	0.683	18.0
27 (invention)	0.197	0.587	14.9
27 (invention)	0.222	0.611	15.0
27 (invention)	0.382	0.656	15.5
27 (invention)	0.422	0.630	15.7
Uncoated	0	0.469	14.8

[0085] These results show that the addition of a surfactant to the coating composition (Composition 26), while it made it possible to spray the composition more evenly over the surface of the liner board, did not have a significant effect on the increase in the coefficient of friction. On the other hand, with this composition, a small but significant increase in the brightness of the coated liner board was observed. When a dark coloured pigment mixture was also added to the coating composition (Composition 27), the brightness of the coated liner board was reduced to a level which was closer to that of the uncoated board.

Claims

1. A method of increasing the coefficient of static friction of a cellulosic sheet which method comprises the steps of preparing a sprayable aqueous coating composition comprising an aqueous suspension of a finely divided particulate inorganic material comprising material selected from the group consisting of kaolin clay, calcined kaolin, ground natural calcium carbonate, chemically precipitated calcium carbonate and zeolites, and an adhesive, and spraying the coating composition on to the surface of a cellulosic sheet, to produce a coating of the coating composition thereon.

2. A method according to claim 1 and wherein the weight per unit surface area of the coating is in the range of from $0.5g.m^{-2}$ to $3.0g.m^{-2}$.

3. A method according to claim 1 or claim 2 and wherein the adhesive constitutes at least 4% by weight based on

the dry weight of the particulate inorganic material.

4. A method as claimed in claim 1, claim 2 or claim 3 and wherein the particulate inorganic material has a particle size distribution such that at least 20% by weight consists of particles having an equivalent diameter smaller than 2μm.

5. A method as claimed in claim 1, claim 2, claim 3 or claim 4 and wherein the particulate inorganic material comprises a ground natural calcium carbonate or a material containing a chemically precipitated calcium carbonate.

6. A method as claimed in any one of the preceding claims and wherein the adhesive comprises a hydrophilic substance selected from one or more of the following types:
starches, cellulose derivatives, saccharides, and polymer latices.

7. A method as claimed in any one of the preceding claims and wherein the binder includes a lubricant forming up to 80% by weight of the binder.

8. A method as claimed in any one of the preceding claims and wherein the lubricant comprises glycerol present in an amount of up to 50% by weight of the binder.

9. A method as claimed in any one of the preceding claims and wherein the water content of the sprayable composition is in the range 80% to 92% by weight.

10. A method as claimed in any one of the preceding claims and wherein the ratio by dry weight of the mineral material to the adhesive including any optional lubricant is in the range 30:1 to 1.5:1.

11. A method according to any one of the preceding claims and wherein the sprayable composition includes a surfactant.

12. A method according to claim 11 and wherein the surfactant comprises a non-ionic surfactant and forms from 0.1% to 5% by weight based on the dry weight of the particulate inorganic material.

13. A method according to any one of the preceding claims and wherein the sprayable composition includes a colouring additive.

14. A method according to claim 13 and wherein the colouring additive comprises a brown dye, optionally together with a black pigment.

15. A method according to any one of the preceding claims and wherein in the spraying step the composition sprayed is in the form of fine droplets having an average droplet size of not greater than 1mm.

16. A method according to any one of the preceding claims and wherein the static coefficient of friction of the cellulosic sheet coated is at least 0.5.

17. A method as claimed in any one of the preceding claims and wherein the coated packaging material is allowed to dry following the spraying step.

18. A method as claimed in any one of the preceding claims and wherein the packaging material comprises liner board.

19. A coated cellulose sheet packaging material which is the product of the method claimed in any one of claims 1 to 18.