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3,362,845

METHOD AND COMPOSITIONS FOR DOUBLE COATING A TRAVELING WEB

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ABSTRACT OF THE DISCLOSURE

Process of double coating a traveling web wherein coarse pigment materials having an average particle size of at least about 1.6 microns are employed in the base or top coats to reduce and prevent streaking when the top coat is applied by a blade or knife coater.

Cross-reference to related application

This is a continuation-in-part of U.S. patent application Ser. 332,292, filed Dec. 20, 1963, and now abandoned.

Brief summary of the invention

This invention relates to the coating of web material. In general, the coating of web material, such as paper, paperboard, and the like, may be performed by the use of roll coaters, air knife coaters, or blade coaters. Each type of coater has advantages and disadvantages peculiar to its own type. For example, blade coaters have a distinct advantage of providing a very smooth surface even at low coat weights because of a leveling or filling action which is accomplished by the blade. Blade coaters find great utility, therefore, in the coating of paper and paperboard which is subsequently subjected to a printing operation, since the latter operation is enhanced if the medium to be printed has a smooth surface.

In the coating of paper and paperboard, it is sometimes desirable to apply two layers of coating to a traveling web in order to obtain a coated surface with maximum smoothness and improved ink holdout. This invention concerns such a double coating process. A first layer of coating, comprising an aqueous dispersion of mineral pigment and an adhesive, is applied to a traveling web by one of the above mentioned coating apparatuses, and the coated web is dried. Then a second layer of coating, comprising an aqueous dispersion of mineral pigment and an adhesive, is applied, and the web is again dried. According to this invention, the apparatus used to apply the first coating layer, or base coat, is not important. In the preferred method, the base coat is applied by a blade coater. Regardless of how the base coat is applied, the second coating layer, or top coat, is applied by a blade coater in order to produce a final coated sheet of highest quality.

A web of paper or paperboard has an inherent roughness or unevenness which is attributable to its formation on a paper machine. A first layer of coating over the paper or paperboard fills in the roughness of the web to a great extent and tends to seal the fibers in the web. The second layer of coating enhances the filling of the roughness of the web and improves the continuity of the final coated surface, since it is applied over a relatively smoother surface than is the first layer of coating.

With the increased use of blade coaters in the industry to obtain maximum quality has come the problem of scratching or streaking which becomes more pronounced when the top coat is applied by a blade coater over the previously coated web. The base coat fills in low areas of the web and reduces the inherent roughness of the web. Oftentimes, when the top coat is applied by blade coater,

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scratches or streaks occur in the top coat as it is being smoothed by the blade. Such paper is a reject product primarily because of appearance. The streaks are caused by hard particles in the coating which become lodged in the nip between the blade and the traveling web, and as the web travels under and past the blade, the absence of coating on the web, caused by the lodged particle, takes the form of a streak or scratch on the web. The streaking continues until either the particle becomes dislodged and passes under the blade or the particle is abraded away.

The hard particles which cause the streaking may be dried adhesive or dried coating from the coating supply system, or they may be foreign materials which have not been removed from the coating system. It was believed that increased screening of the coating by use of finer screens would eliminate the problem. It is common in the industry to screen coatings with screens having mesh sizes in the range of 80 to 150. Use of screens with mesh sizes above 150 is not commercially feasible, but in an attempt to eliminate the scratching problem, coatings were passed through 325 mesh screens with the result that while a slight improvement in scratching was noted, the problem was far from solved.

Through much experimentation, it has been found by the inventor that, surprisingly, the rougher the web is when it is presented for the second coating application, the less the amount of scratching that occurs in the top coat. It has been found that when the web is somewhat smoothed by a first layer of coating, scratch-producing particles in the coating for the top coat have a more difficult time passing under the blade of a blade coater. This situation occurs, it is believed, because there are relatively few low areas in the web which can accommodate the lodged particles and carry them through the nip formed by the web and the blade. When the first layer of coating is applied, a particle which lodges under the blade soon becomes dislodged, either by finding a low area in the web or by being abraded away by the inherent roughness of the web until such time as the particle becomes of a size to successfully pass under the blade. But due to the filling of the low areas of the web by the base coat, the web is in a relatively smooth condition such that its roughness, and hence its abrasive effect on a lodged particle in the top coat, is reduced. A particle in the top coat which lodges under the blade is thus not removed by the web and may lodge indefinitely.

It has been found that the advantages of a double coating operation, such as higher coat weights, increased opacity, printing smoothness, and uniformity of ink holdout, can be obtained and yet scratching can be drastically and significantly reduced by applying a base coat which has what may be termed as a built-in, preselected roughness. Contrary to normal procedure, it has been found that an increase in the roughness of the base coat reduces the amount of scratching that occurs when the top coat is applied by a blade coater. Base coats containing such pigments as coarse calcium carbonate, ground marble, and sand as replacements for part or all of the regular coating pigments have been found to produce the properties desired in the base coat for the reduction or elimination of scratching in the top coat. This substitution of coarse materials in the base coat provides a means for controlling the base coat roughness by selection of the particle size of the coarse materials, which particle size may be varied to obtain the roughness necessary to eliminate scratching in the top coat. By building in a roughness in the base coat, scratch-producing particles in the top coat which become lodged under the blade during the smoothing of the top coat are carried away from the blade by the web or the roughness of the base coat abrades away the lodged particles until they successfully pass under the blade.

Replacements in the base coat of coarse pigment materials having an average particle size of at least about 1.6 microns for from 10 to 100% of the regular coating pigments, such as regular coating clay or precipitated chalk, have been found to be effective in the reduction of scratching when the top coat is applied over the base coat by a blade coater. The invention is not limited to the use of a particular coarse pigment.

As one skilled in the art of paper coating will readily appreciate, the invention is not limited to the use of a particular adhesive. The adhesive or binder used to bind the pigment in the coatings to the traveling web can be any of the conventional water-dispersible adhesives used in aqueous paper coatings. Such adhesives are starches, casein, and other proteins such as alpha and soybean protein, polyvinyl alcohol, resin emulsions, resin latices, and combinations of adhesives such as starch-latex or soya protein-acrylic resin mixtures, all of which may be referred to as film-formers. The invention is not limited to the use of a particular starch as any of the usual starches, such as dextrans, oxidized starches, cationic, acid modified, pearl, and ethylated starches can be used.

Detailed description

The invention will be better understood by reference to the following illustrative examples.

EXAMPLES 1-4

In Examples 1-4, a standard base coating of the following formulation was employed:

Columbia clay (a standard grade coating clay) -----	100	Parts
Acrylic resin (Rhoplex B-15), 16% based on the pigment -----	16	
Protein (soya), 4% based on the pigment -----	4	

A standard top coating of the following formulation was employed:

Lustra clay (a premium grade clay) -----	80	Parts
Columbia clay -----	20	
Rhoplex B-15, 18% based on the pigment -----	18	
Protein (soya), 3½% based on the pigment -----	3½	

In all the data given throughout this specification, unless otherwise noted, the solids content of the base coatings ranged from 52.1 to 53.0%, and the solids content of the top coatings ranged from 57.8 to 59.6%, after reduction with water to form aqueous dispersions of coating. Coat

weights are expressed as pounds per 3300 square feet of coated web materials.

Fourteen point board was double coated with the above base and top coat formulations by inverted blade coaters, such coaters being known in the art, as for example the coater described in my U.S. Patent 3,149,005. A first coating layer was applied to the traveling web of board in known manner, as by an applicator roll; the coating was smoothed with a doctor blade in known manner; the first layer of coating was substantially set by passing the traveling web into a drying zone, as for example a zone comprised of heated drier drums; a second layer of coating was applied over the first coating layer; the second layer of coating was smoothed with a doctor blade; and the resultant double coated web was substantially dried. A length of the so-coated board, 100 feet, chosen at random, was examined for scratches which were evaluated as short (3 inches and less in length), medium (between 3 inches and 12 inches in length), and long (more than 12 inches in length). The following data was gathered:

STANDARD RUNS—TOP COATS SCREENED THROUGH A 100 MESH SCREEN

Example	Coat	Coat Weight	Scratches on 100' of Web			
			Long	Medium	Short	Total
1-----	{Base.... Top....}	{3.1 3.5}	16	12	8	36
2-----	{Base.... Top....}	{4.5 3.4}	25	25	0	50
3-----	{Base.... Top....}	{5.2 2.8}	24	21	9	54

STANDARD RUN—TOP COAT SCREENED THROUGH A 200 MESH SCREEN

4-----	{Base.... Top....}	{2.6 4.2}	3	2	4	9
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EXAMPLES 5-13

Fourteen point board was doubled coated with the base and top coat formulations of Examples 1-4, in the same manner as above, except that replacements for the coating clay in the base coat of Examples 1-4 were made with coarse calcium carbonate, ground limestone, and sand. The data for these runs was as follows:

TOP COATS SCREENED THROUGH A 100 MESH SCREEN

Example	Coat	Coat Weight	Percent Replacement of Clay	Material	Scratches on 100' of Web			
					Long	Medium	Short	Total
5-----	{Base.... Top....}	{2.6 3.0}	50	Sand-----	0	0	2	2
6-----	{Base.... Top....}	{4.1 3.9}	50	Gamaco-T-----	0	0	0	0
7-----	{Base.... Top....}	{4.1 4.4}	10	do-----	14	10	5	29
8-----	{Base.... Top....}	{3.5 4.2}	10	Ground Marble---	15	6	3	24
9-----	{Base.... Top....}	{3.3 3.9}	25	do-----	3	5	3	11

TOP COATS SCREENED THROUGH A 200 MESH SCREEN

10-----	{Base.... Top....}	{1.4 5.1}	100	do-----	0	0	0	0
11-----	{Base.... Top....}	{2.1 3.7}	50	do-----	0	1	1	2
12-----	{Base.... Top....}	{3.1 2.9}	100	Gamaco-T-----	0	1	2	3
13-----	{Base.... Top....}	{4.8 1.2}	100	do-----	0	0	1	1

Comparing Examples 5-13 with Examples 1-4, it can be seen from the data that the amount of scratching in the top coats was greatly reduced by use of the substituted materials for regular coating clay in the base coats, when compared to the amount of scratching that occurred when the standard base coat formulation was employed. It can also be seen that as greater substitutions for clay were made, the level of scratching decreased. There is an improvement with only a 10% substitution in the base coat; the preferred range is from 25 to 100% substitution.

The Gamaco-T is a material marketed by the Georgia Marble Company and is prepared by crushing stone of high calcium carbonate content, to yield a product which typically has a calcium carbonate content of 98%. Ninety percent of the particle size range is finer than 10 microns, with 80% below 6.5 microns, 58% below 3 microns, 40% below 2.2 microns; the average particle size is approximately 2.5 microns.

It has been found that Atomite, marketed by Thompson, Weinman & Co., which is also a material prepared by grinding stone of high calcium carbonate content to yield a product which typically has a calcium carbonate content of 98.2%, can also be used successfully. The particle size range for Atomite is from 0.5 to 10 microns, with an average particle size of approximately 2.5 microns.

The ground marble used is known as Georgia Marble Co. 5-25 and has the following particle size characteristics: 75% between 5 and 25 microns, with 90% below 25 microns; average particle size of 12 microns.

The sand used above was 15 micron Minusil which is white, crystalline silica of angular shape, and two dimensional, primarily as slivers or flakes, marketed by the Pennsylvania Glass Sand Corporation. This silica has the following particles size characteristics: 99.7% below 20 microns; 98.2% below 15 microns; 90% below 10 microns; 60% below 5 microns; 40% below 3 microns; 28.5% below 2 microns; average particle size of 2 microns. 10 micron Minusil has also been employed suc-

cessfully. This material is white, crystalline silica with the following particle size characteristics: 99.7% below 12 microns; 98.7% below 10 microns; 80% below 5 microns; 40% below 2 microns; average particle size of 1.6 microns.

In comparison with the coarse materials used in the base coats of this invention, standard coating clays have an average particle size of approximately 0.8 micron, and premium coating clays have an average particle size of approximately 0.4 micron.

EXAMPLE 14

Precipitated materials used in the base coat rather than ground materials have been found to be ineffective in reducing scratching the top coat, as the following data illustrates:

Run	Coat	Coat Weight	Percent Replacement of Clay	Material	Scratches on 100' of Web, Total
1195	{Base Top}	{3.9 4.5}	70	Purecal O	40

The top coat was screened through a 100 mesh screen. The base coat has a solids content of 57% and the top

coat had a solids content of 58%. It can be seen that the scratch level is in the same range as the standard formulations, and that substitution of the Purecal O for regular coating clay in the base coat was ineffective in reducing scratching in the top coat. Purecal O, a well known precipitated calcium carbonate, has an average particle size of approximately 0.25 micron.

While the great utility of the ground and coarse materials is not fully understood, it is known that ground calcium carbonates are generally larger in particle size than precipitated calcium carbonates, and it is believed that particle size, along with the abrasive nature of the ground materials, is responsible for the improvements in scratching shown throughout this specification. Thus, it is preferred to use in the base coat of a double coating process a coarse pigment material which has an average particle size of at least 1.6 microns, and the preferred coarse pigment materials are calcium carbonate and silica, and their equivalents.

EXAMPLES 15-16

It has been found that replacements of at least 20% of the coating clay in the top coat with the coarse materials herein disclosed will also reduce scratching in the top coat. If more than a 20% replacement is made in the top coat, printability of the final coated web may be adversely affected, but more than a 20% replacement may be utilized. The following data is illustrative of a 20% replacement of Gamaco-T or 10 micron Minusil for the coating clay in the top coat. The base coat was a standard formulation of 100 parts regular coating clay (Columbia clay), with 20% binder (16% acrylic resin and 4% protein) based on the clay content; solids content of 52.7%. The top coat formulation was 80 parts premium clay, 20 parts of either Gamaco-T or 10 micron Minusil, with 21½% binder (18% acrylic resin and 3½% protein) based on the clay content; solids content of 58% in both instances. The top coats were screened through a 100 mesh screen before application.

TOP COATS SCREENED THROUGH A 100 MESH SCREEN

Example	Coat	Coat Weight	Percent Replacement of Clay	Material	Scratches on 100' of Web			
					Long	Medium	Short	Total
15	{Base Top}	{4.5 2.2}	20	Gamaco-T	0	3	4	7
16	{Base Top}	{4.5 2.4}	20	10 Micron Minusil	2	4	1	7

Comparing the results of Examples 15 and 16 with Examples 1, 2, and 3 above where the standard formulations were used, it is seen that an effective reduction in the amount of scratching in the top coat was achieved by using the coarse materials in the top coat. The reason for improvements in scratching when using the coarse materials in the top coat is not fully understood, but it is believed that a lodged particle is abraded away by the coarse particles in the second coating layer as the coarse particles flow past the lodged particle.

EXAMPLE 17

As previously stated, any of the usual paper coating adhesives can be employed in practicing the methods of this invention. In this instance, the base coating used in Example 6 above, containing as pigment equal parts of clay and Gamaco-T, was employed again, except that the acrylic-resin-protein adhesive was replaced by 17 parts by weight of alpha protein. The base coating was applied at a coat weight of about 4 pounds, and the coated paper was dried. Then about 4 pounds of the standard top coating from Examples 1-4 was applied over the dried base coat, and the scratch level of the so-coated paper was substantially the same in excellence as that exhibited in Example 6.

Additional runs have shown that the resin-protein adhesives set forth in the base and top coats of Examples 1-4 can be replaced by other conventional paper coating adhesives. For example, in one run, Example 6 was repeated, except that the resin-protein adhesive in the top coat was replaced by 16 parts by weight of alpha protein. The scratch level was substantially the same as in Example 6. Further, when the coarse pigments are used in the top coats, as in Examples 15 and 16, any of the conventional adhesives can be used in the top coat to bind the coarse pigments to the paper. In one run, Example 15 was repeated except that the resin-protein adhesive in the top coat was replaced by 18 parts by weight of an ethylated starch, and the resultant scratch level of the final coated paper was substantially the same as that of Example 15.

The base stock to be coated in the manner of this invention may be subjected to a conventional surface size treatment, and if so, the size treatment is not considered to be one of the layers of coating according to this invention. However, the coarse materials employed in this invention may be applied at the size press, in which case, the sizing is considered to be the base coating.

While ground calcium carbonate and silica have been disclosed as materials to be incorporated in the base or top coats of a double coating process, other coarse particles, having an average particle size of at least about 1.6 microns, may also be used and combined in coating formulations with the usual coating clays which range in particle size from about 0.4 to 0.8 micron, to reduce scratching or streaking in the top coat. Therefore, various ingredients may be substituted for the coarse materials set forth herein without departing from the spirit of this invention or the scope of the appended claims.

I claim:

1. In the method of coating a traveling web of paper, paperboard, and the like which involves the steps of (a) applying to the traveling web a first layer of coating comprising an aqueous dispersion of mineral pigment having an average particle size up to about 0.8 micron and film-forming binder, (b) substantially setting the first coating layer, (c) applying over the first coating layer a second layer of coating comprising an aqueous dispersion of mineral pigment having an average particle size up to about 0.8 micron and film-forming binder, (d) smoothing the second layer of coating with a doctor blade, and (e) substantially drying the resultant coated web, the improvement for the reduction of scratching in the second coating layer which comprises applying as the first coating layer a coating wherein the mineral pigment comprises at least about 10% of a coarse pigment material which has an average particle size of at least about 1.6 microns.

2. The method of claim 1 in which the coarse pigment material is selected from the group consisting of ground calcium carbonate and silica.

3. The method of claim 2 wherein the coarse pigment material comprises from about 10 to 100% of the mineral pigment in the first coating layer.

4. The method of claim 2 wherein the coarse pigment material comprises from about 25 to 100% of the mineral pigment in the first coating layer.

5. The method of claim 1 wherein the binders in the coatings employed in steps (a) and (c) are water-dispersible.

6. The method of claim 5 wherein the binders include water-dispersible resins.

7. In the method of coating a traveling web of paper,

paperboard, and the like which involves steps of (a) applying to the traveling web a first layer of coating comprising an aqueous dispersion of mineral pigment having an average particle size of up to about 0.8 micron and film-forming binder, (b) substantially setting the first coating layer, (c) applying over the first coating layer a second layer of coating comprising an aqueous dispersion of mineral pigment having an average particle size of up to about 0.8 micron and film-forming binder, (d) smoothing the second layer of coating with a doctor blade, and (e) substantially drying the resultant coated web, the improvement for the reduction of scratching in the second coating layer which comprises building a roughness in the first coating layer applied in step (a) above by replacing at least about 10% of the mineral pigment with a coarse pigment material which has an average particle size of at least about 1.6 microns.

8. The method of claim 7 in which the coarse pigment material is selected from the group consisting of ground calcium carbonate and silica.

9. The method of claim 7 wherein the binders in the coatings employed in steps (a) and (c) are water-dispersible.

10. In the method of coating a traveling web of paper, paperboard, and the like which involves steps of (a) applying to the traveling web a first layer of coating comprising an aqueous dispersion of mineral pigment having an average particle size up to about 0.8 micron and film-forming binder, (b) substantially setting the first coating layer, (c) applying over the first coating layer a second layer of coating comprising an aqueous dispersion of mineral pigment having an average particle size up to about 0.8 micron and film-forming binder, (d) smoothing the second layer of coating with a doctor blade, and (e) substantially drying the resultant coated web, the improvement for the reduction of scratching in the second coating layer which comprises applying as the second coating layer a coating wherein the mineral pigment comprises at least about 20% of a coarse pigment material which has an average particle of at least about 1.6 microns.

11. The method of claim 10 in which the coarse pigment material is selected from the group consisting of ground calcium carbonate and silica.

12. The method of claim 10 wherein the binders in the coatings employed in steps (a) and (c) are water-dispersible.

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**UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION**

Patent No. 3,362,845

January 9, 1968

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It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, line 22, after "Ser." insert -- No. --; column 5, line 2, for "or" read -- of --; line 65, after "scratching" insert -- in --; line 75, for "has" read -- had --; column 7, line 40, for "micro" read -- micron --; column 8, line 40, after "particle" insert -- size --.

Signed and sealed this 11th day of February 1969.

(SEAL)

Attest:

Edward M. Fletcher, Jr.

Attesting Officer

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