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COATED PAPER AND METHOD OF MAKING
SAME

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9 Claims. (Cl. 117-62)

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This application is a continuation-in-part of my application Serial No. 616,146, filed September 13, 1945, now abandoned, for Coated paper and method of making same.

This invention relates to coated paper and a method of making the same wherein the filler or pigment is bound to the paper base with a binder which has hitherto not been employed for this purpose with new and improved results in the final product and which permits the use of a new and improved method of coating which is most simple and inexpensive and which has many other advantages over standard methods of coating paper.

One object of this invention is the production of a new and improved coated paper which is particularly adapted for printing.

Another object is to produce such a paper, the coating of which is highly resistant to rub and pick.

Another object is to produce such a paper with a coating that is highly flexible, free from bubbles, has a long life, and is water insoluble.

Another object is to produce such a paper with a continuous smooth surface which does not follow the surface contour of the paper base.

Another object is to produce such a paper with a coating which receives ink with an improved lay, free from spots and on which the ink dries more quickly than on ordinary coatings and is more firmly anchored.

Another object is to produce such a paper which is inexpensive and in which a minimum of binder is employed.

Another object is to provide a new and improved method of coating paper.

Another object is to provide a method of coating paper which is inexpensive and eliminates most of the standard drying equipment now used in coating paper.

Another object is to provide such a method in which penetration of the coating is kept at a minimum and in which the coating during the coating process takes such form that it may be easily given the desired finish on its surface, regardless of the surface contours of the paper base.

Another object is to provide a method in which the coating is precipitated on the base by an ion interchange.

Other objects of the invention will appear from the following description of the invention.

In carrying out the invention a suitable paper base is selected. This base will usually be of the type used in making book paper but it may be paperboard or the like and as used here the

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term "paper" is intended to cover all such bases.

The coating to be applied comprises any of the usual fillers such as clay, calcium carbonate, or other pigments which are used in coating paper, and a binder which is a hydroxy alkyl cellulose such as hydroxy ethyl cellulose or hydroxy propyl cellulose which is insoluble in water, but which is soluble in a water solution of sodium hydroxide. Hydroxy ethyl cellulose having the above properties is the preferred binder although results much better than those obtained with standard binders are obtained with the other hydroxy alkyl celluloses which have the above properties and lend themselves to the improved method of this invention and produce coated paper having the new properties of the paper of this invention. Although the hydroxy ethyl cellulose which is suitable is that which is insoluble in water but is soluble in a solution of sodium hydroxide in water, it is desirable to use hydroxy ethyl cellulose which is soluble in a five per cent sodium hydroxide solution, although it is economical to use hydroxy ethyl cellulose which is soluble in a water solution of sodium hydroxide ranging from three to twelve per cent. This hydroxy ethyl cellulose will have more than one and not more than four cellulose units to each ethylene oxide radical.

The ratio by weight of hydroxy ethyl cellulose to filler is preferably six to one hundred, although up to ten parts by weight of hydroxy ethyl cellulose will give most of the advantages of this invention, and even more or less hydroxy ethyl cellulose will give advantages over standard coatings both in the methods and in the final coated paper. Six parts by weight will give a paper with a coating which offers all necessary resistance to pick and rubbing and will not chalk off while providing the properties of receiving the ink well, setting it quickly, and giving excellent anchorage. Of course, the lower percentages of hydroxy ethyl cellulose offer advantages of low cost not obtained with higher percentages.

The filler and hydroxy alkyl cellulose are mixed together in a water solution of sodium hydroxide to form a viscous coating which is applied to the paper base by any suitable coating machine which will not be damaged by the sodium hydroxide. The machine may be a brush coater, a roll coater, a meniscous coater, an air brush coater, or a gravure or letter press type. A typical coating may be made as follows:

One hundred parts by weight of Georgia clay is dispersed in one hundred parts by weight of

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soft water containing five per cent by weight of sodium hydroxide. This slurry is dispersed with six parts by weight of water insoluble hydroxy ethyl cellulose dissolved in one hundred parts by weight of five per cent by weight water solution of hydroxide. The viscosity of this product may be varied to meet the needs of the coater employed by the addition of a five per cent aqueous solution of sodium hydroxide.

This coating is the one which is applied to the paper base by the above mentioned coaters in the desired thickness. The coating may vary from the preferred one above in varying the hydroxy ethyl cellulose content as above indicated or by varying the sodium hydroxide content to that needed for the dissolving of the particular hydroxy ethyl cellulose employed. It may also be varied by using other hydroxy alkyl celluloses such as hydroxy propyl cellulose.

Immediately after the coating is applied to the paper base, the sodium hydroxide is eliminated from the solution and its hydroxyl ion is converted into water. This is done by an ion interchange between the sodium hydroxide and a water-soluble compound, which has an ion which is reactive with the sodium ion of the sodium hydroxide to form a soluble sodium salt, and which also has an ion which is reactive with the hydroxyl ion of the sodium hydroxide, and which compound is selected from the group consisting of water-soluble acids, acid salts and ammonium salts. The ion which is reactive with the hydroxyl ion is thus a hydrogen ion which produces water directly, or an ammonium ion which eventually converts the hydroxyl ion to water, since the end products of the conversion are ammonia and water.

This step of the elimination of the sodium hydroxide from the solution and converting the hydroxyl ion to water is carried out by immediately contacting the coating with a water solution of the compound. This may be done by passing the coated web through or in contact with a bath of the water solution. It is done for best results immediately after the coating has been applied and before any appreciable drying of the coating or penetration thereof into the paper base. This prevents any appreciable deterioration of the paper base and keeps the coating up on the surface of the paper where it should be and keeps it from taking on a surface contour like that of the paper base and makes it possible at a late step in the process or method to more easily give the coating the desired surface.

When the coating is subjected to the solution of the compound which eliminates the sodium hydroxide, an ion interchange takes place. The sodium ion and the salt-forming ion of the compound react to form a sodium salt. The ion of the compound which is reactive with the hydroxyl ion reacts either to directly form water or to eventually form water as will be described later.

The elimination of the sodium hydroxide as such from the solution prevents any material deterioration of the paper which would result from the action of a caustic.

Suitable compounds for eliminating sodium hydroxide from the solution and converting its hydroxyl ion to water and which results in the precipitation of the hydroxy alkyl cellulose are water-soluble acid salts and water-soluble acids. Weak acids, and preferably weak organic acids, may be used. If weak acids are employed, they will not harm the paper. If stronger acids are employed extreme care should be taken that no

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acid residue is left after the elimination of the sodium hydroxide. In practical use of the process, such care may not be feasible. It is possible also to use ammonium salts which react with the sodium hydroxide to eliminate it from the solution and thus precipitate the hydroxy alkyl cellulose. These salts have an ion which reacts with the sodium ions in the solution to form a soluble sodium salt. The ammonium ion reacts with the hydroxyl ion and the hydroxyl ion is converted to water when the ammonia gas is eliminated from the coating. This will occur quite promptly at room temperature or may occur on standing or heating.

Suitable compounds falling within the above designation are monosodium phosphate, disodium phosphate, sodium bisulphate, and sodium bicarbonate. Suitable water-soluble, weak organic acids include: acetic acid, citric acid, lactic acid, tartaric acid, maleic acid, and oxalic acid. Strong acids, such as sulphuric acid, or hydrochloric acid, give a satisfactory product when care is taken to see that there is no acid residue left after the elimination of the sodium hydroxide from the solution and the precipitation of the hydroxy alkyl cellulose. Suitable ammonium compounds include ammonium sulphate, ammonium chloride, and ammonium carbonate. When these compounds are used the ammonium ion reacts with the hydroxyl ion of the sodium hydroxide, and the ammonia is thereafter eliminated, either by heating or by standing. Ammonium carbonate is not as practical as the other ammonium salts because of its property of disintegrating at room temperature to give off ammonia.

If the coated paper is to be employed for offset printing, and for some other uses in which the alkaline coating is not desired, a material which has an ion which reacts with the sodium ion to produce a non-alkaline sodium salt is preferred, since the alkaline coating would tend to emulsify most offset inks. Thus, the carbonates which produce a sodium carbonate residue would not be employed. However, if the paper is to be employed where some alkalinity in the coating is not undesirable, the carbonates are satisfactory and their use eliminates the caustic effect of sodium hydroxide.

All of the above substances may be used if the compound which reacts with and eliminates the sodium hydroxide from the solution is applied in a 30 per cent solution. A less concentrated solution can be employed and, of course, must be employed for substances having less than this much solubility. The web should be passed immediately to the solution and it may be desirable to heat the solution to 150° F. or 200° F. to speed up the reaction, although this step is not necessary.

When the hydroxy ethyl cellulose is precipitated by eliminating or destroying the sodium hydroxide as such, the hydroxy alkyl cellulose occludes the filler. It may be desirable to steam the paper at this point to speed up precipitation of the binder, and when ammonium salts are used, to dissipate the ammonia, although this step is not necessary for carrying out the invention. The web may next be given a hot water wash to remove excess sodium salts present in the coating. The excess surface water is then squeezed from the coating, which has no tackiness at all at this time. This step is not necessary, however, in most cases.

The hydroxy ethyl cellulose or other hydroxy alkyl cellulose at this stage of the method is

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swelled and it is possible by drying the coating in contact with a smooth roll, such as one with a high chrome polish, to impart to the surface of the coating a smoothness comparable to that of the roll and not conforming to the surface of the base. If desired other finishes can be applied to the surface of the coating by varying the surface of the drying roll.

It is not necessary in using the above process to resort to festooning, a hot air drying commonly used in making coated paper, and it is thus possible to avoid the dirt which may be deposited on the tacky coating while it is being dried. This process also avoids the bubbles and deterioration which attend high heating in festoon drying. The coating has less tendency to follow the surface contour of the paper base or to penetrate the base. It is possible to use a minimum amount of binder in the coating, which is flexible, continuous, resists chalking, rubbing and pick, and provides excellent ink lay and anchorage in a water-insoluble coating. The coating may likewise be non-alkaline, which makes it especially desirable for lithographic, offset or gravure printing. The coating has no odor, has excellent keeping qualities, is uniform and smooth. On this coating printing inks set much more quickly than when standard coated papers are used.

It should be noted that, as opposed to papers using a coating with a casein binder, the paper of this invention can be made more expeditiously, less expensively, with a smoother, glossier surface, better adapted to printing in ink lay, and anchorage and with the property of assisting in quickly setting printing ink. Less than half as much binder is needed as in cases using casein; the coating is not alkaline, keeps better and is more flexible and is water-insoluble. The color is better as well as the uniformity.

The coated paper of this invention is superior to paper using a starch binder in the coating because of the water solubility of starch and the lack of continuity in the coating. Even if urea-formaldehyde or melamine-formaldehyde reaction products are used with the starch to get water insolubility, the paper of this invention is superior in cost, flexibility, odor and resistance to rub and pick.

It is to be understood that widely different embodiments of this invention may be made without departing from the spirit and scope thereof, and that there is no intention to limit it to the specific embodiment thereof described above except as defined in the claims.

I claim:

1. The method of producing coated paper of the type having a base and a printing surface consisting of a continuous film of filler interspersed in binder by means of which the filler is retained on the base comprising completely covering the face of a paper with a continuous viscous coating consisting essentially of 100 parts by weight of filler dispersed in a solution in aqueous sodium hydroxide of from 6 to 10 parts by weight of binder consisting essentially of water-insoluble hydroxy ethyl cellulose and immediately after application of said viscous coating precipitating said hydroxy ethyl cellulose from solution to bind said filler to said base and to form on said base a continuous film of said filler interspersed in said hydroxy ethyl cellulose by ion interchange between the sodium hydroxide and ammonium sulphate in water solution by applying a water solution of ammonium sulphate

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to said viscous coating whereby said hydroxy ethyl cellulose is precipitated before substantial drying of said viscous coating and prior to substantial penetration of the base by said viscous coating and then drying the paper with the coating in contact with a smooth surface.

2. The method of producing coated paper of the type having a base and a printing surface consisting of a continuous film of filler interspersed in binder by means of which the filler is retained on the base comprising completely covering the face of a paper with a continuous viscous coating consisting essentially of 100 parts by weight of filler dispersed in a solution of from 6 to 10 parts by weight of binder consisting essentially of hydroxy ethyl cellulose soluble in aqueous sodium hydroxide but insoluble in water dissolved in aqueous sodium hydroxide and immediately after application of said viscous coating eliminating the sodium hydroxide from the solution and converting its hydroxyl ion to water by ion interchange and thereby precipitating said hydroxy ethyl cellulose from solution to bind said filler to said base and to form on said base a continuous film of said filler interspersed in said hydroxy ethyl cellulose by immediately contacting said coating with a water solution of a water-soluble compound having an ion reactive with the sodium ion of said sodium hydroxide to form a water-soluble sodium salt and an ion reactive with the hydroxyl ion of said sodium hydroxide, said compound being selected from the group consisting of water-soluble acids, alkali metal acid salts and ammonium salts, whereby said hydroxy ethyl cellulose is precipitated before substantial drying of said viscous coating and prior to substantial penetration of the base by said viscous coating and then drying the paper with the coating in contact with a smooth surface.

3. The method of producing coated paper of the type having a base and a printing surface consisting of a continuous film of filler interspersed in binder by means of which the filler is retained on the base comprising completely covering the face of a paper with a continuous viscous coating consisting essentially of 100 parts by weight of filler dispersed in a solution in aqueous sodium hydroxide of from 6 to 10 parts by weight of binder consisting essentially of water insoluble hydroxy ethyl cellulose and immediately after application of said viscous coating precipitating said hydroxy ethyl cellulose from solution to bind said filler to said base and to form on said base a continuous film of said filler interspersed in said hydroxy ethyl cellulose by ion interchange between the sodium hydroxide and ammonium sulphate in water solution by applying a water solution of ammonium sulphate to said viscous coating whereby said hydroxy ethyl cellulose is precipitated before substantial drying of said viscous coating and prior to substantial penetration of the base by said viscous coating and then drying the paper.

4. The method of producing coated paper of the type having a base and a printing surface consisting of a continuous film of filler interspersed in binder by means of which the filler is retained on the base comprising completely covering the face of a paper with a continuous viscous coating consisting essentially of 100 parts by weight of filler dispersed in a solution of from 6 to 10 parts by weight of binder consisting essentially of hydroxy ethyl cellulose soluble in aqueous sodium hydroxide but insoluble in water

dissolved in aqueous sodium hydroxide and immediately after application of said viscous coating eliminating the sodium hydroxide from the solution and converting its hydroxyl ion to water by ion interchange and thereby precipitating said hydroxy ethyl cellulose from solution to bind said filler to said base and to form on said base a continuous film of said filler interspersed in said hydroxy ethyl cellulose by immediately contacting said coating with a water solution of a water-soluble compound having an ion reactive with the sodium ion of said sodium hydroxide to form a water-soluble sodium salt and an ion reactive with the hydroxyl ion of said sodium hydroxide, said compound being selected from the group consisting of water-soluble acids, alkali metal acid salts, and ammonium salts, whereby said hydroxy ethyl cellulose is precipitated before substantial drying of said viscous coating and prior to substantial penetration of the base by said viscous coating and then drying the paper.

5. The method of producing coated paper of the type having a base and a printing surface consisting of a continuous film of filler interspersed in binder by means of which the filler is retained on the base comprising completely covering the face of a paper with a continuous viscous coating consisting essentially of 100 parts by weight of filler dispersed in a solution in aqueous sodium hydroxide of from 6 to 10 parts by weight of binder consisting essentially of water-insoluble hydroxy alkyl cellulose and immediately after application of said viscous coating precipitating said hydroxy alkyl cellulose from solution to bind said filler to said base and to form on said base a continuous film of said filler interspersed in said hydroxy alkyl cellulose by ion interchange between the sodium hydroxide and ammonium sulphate in water solution by applying a water solution of ammonium sulphate to said viscous coating whereby said hydroxy alkyl cellulose is precipitated before substantial drying of said viscous coating and prior to substantial penetration of the base by said viscous coating and then drying the paper with the coating in contact with a smooth surface.

6. The method of producing coated paper of the type having a base and a printing surface consisting of a continuous film of filler interspersed in binder by means of which the filler is retained on the base comprising completely covering the face of a paper with a continuous viscous coating consisting essentially of 100 parts by weight of filler dispersed in a solution of from 6 to 10 parts by weight of binder consisting essentially of hydroxy alkyl cellulose soluble in aqueous sodium hydroxide but insoluble in water dissolved in aqueous sodium hydroxide and immediately after application of said viscous coating eliminating the sodium hydroxide from the solution and converting its hydroxyl ion to water by ion interchange and thereby precipitating said hydroxy alkyl cellulose from solution to bind said filler to said base and to form on said base a continuous film of said filler interspersed in said hydroxy alkyl cellulose by immediately contacting said coating with a water solution of a water-

soluble compound having an ion reactive with the sodium ion of said sodium hydroxide to form a water-soluble sodium salt and an ion reactive with the hydroxyl ion of said sodium hydroxide, said compound being selected from the group consisting of water-soluble acids, alkali metal acid salts, and ammonium salts, whereby said hydroxy alkyl cellulose is precipitated before substantial drying of said viscous coating and prior to substantial penetration of the base by said viscous coating and then drying the paper.

7. A coated paper having a base and a printing surface consisting of a continuous flexible film adapted to receive printing overlying and completely covering the entire face of said base, said film consisting essentially of filler and binder in which said filler is interspersed and which binds said filler to said base, said binder consisting essentially of hydroxy ethyl cellulose which is soluble in aqueous sodium hydroxide but insoluble in water, and which is in the ratio of from 6 to 10 parts by weight to 100 parts by weight of the filler.

8. A coated paper having a base and a printing surface consisting of a continuous flexible film adapted to receive printing overlying and completely covering the entire face of said base, said film consisting essentially of filler and binder in which said filler is interspersed and which binds said filler to said base, said binder consisting essentially of hydroxy alkyl cellulose which is soluble in aqueous sodium hydroxide but insoluble in water, and which is in the ratio of from 6 to 10 parts by weight to 100 parts by weight of the filler.

9. A coated paper having a printing surface consisting of a continuous flexible film forming the outer surface of the paper and consisting essentially of a filler and a binder in which the filler is interspersed and by which the printing surface is held in place, said binder consisting essentially of hydroxy ethyl cellulose which is soluble in aqueous sodium hydroxide but insoluble in water, and which is in the ratio of from 6 to 10 parts by weight to 100 parts by weight of the filler, said printing surface being characterized by its property of accelerating the drying of ink.

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