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TREATMENT OF CELLULOSIC SHEET MATERIALS

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Fig. 1

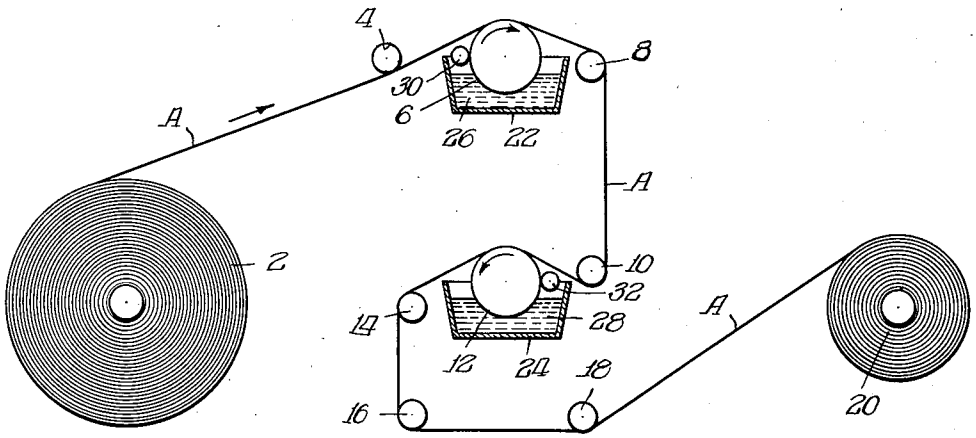
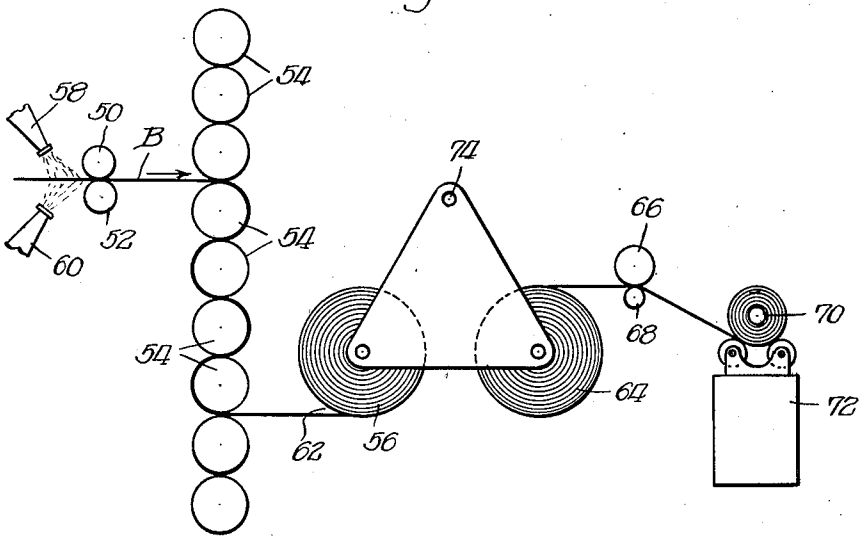


Fig. 2



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TREATMENT OF CELLULOSIC SHEET MATERIALS

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3 Claims. (Cl. 154—33.05)

This invention relates to an improved method of treating cellulosic materials and to a new and improved product obtained thereby. The invention particularly relates to a new and improved method of preparing the paper corrugating medium used to form the corrugated paper core of corrugated paper box board.

The expression "corrugating medium" is used herein to describe the paper sheet employed in making the paper core of corrugated paper board. In ordinary practice this material is an unsized paper usually made from straw, chestnut chip or kraft stock. The requirements of the corrugated board industry at the present time are that the paper used for this purpose be of such a nature that it will corrugate properly and give a rigid uniform corrugation.

Attempts to size the corrugating medium in order to obtain additional rigidity in the corrugation have been unsuccessful largely due to the face that papers sized by prior methods were rendered incapable of being corrugated properly at high speeds.

Since the most satisfactory corrugating mediums from the standpoint of operation on the corrugating machine are relatively soft, unsized papers, the resultant corrugated paper board is also relatively soft and does not possess the strength and stiffness that might be desired. Furthermore, due to the hydroscopic character of these types of papers, the corrugated paper board as made today tends to lose much of its original stiffness when subjected to high humidity conditions.

One of the objects of the present invention is to provide a new and improved method of treating corrugating media whereby they will give a more rigid corrugation which will substantially retain its stiffness under high humidity conditions and yet, which can be readily corrugated at high operating speeds. Another object of this invention is to provide a means of producing a superior type of corrugating medium utilizing as a base the cheaper grades of waste paper stock which are at present unsuitable for this purpose. Other objects will appear hereinafter.

It is characteristic of our invention that when unsized corrugated paper is treated by our method it is rendered stiffer and retains a substantial degree of its stiffness even when saturated with water. It furthermore has a higher wet tear strength and resistance to scuffing or puncture than the original untreated paper. Although the wet strength characteristics of the paper are increased by our method of treatment, the treated paper substantially retains the water permeability and rapidity of water absorption that distinguished the original untreated, unsized paper. In fact, the water absorption rate is often greater.

It is characteristic of our invention that when a rosin or otherwise sized corrugated paper is treated by our method the wet strength characteristics and scuff-resistance of the paper are improved without a detrimental effect in regard to such water-resistant characteristics as were present in the original sized but untreated paper.

In either case, the mullen test of the dry treated paper may or may not be higher than the original untreated paper depending upon the extent to which it was treated.

Our process is adaptable to treating the corrugated paper as it is being fabricated on the paper machine but also can be used to treat individual rolls of paper in the plant of the paper consumer. Our process, therefore, not only enables the paper manufacturer to treat his paper as it is being fabricated to obtain such desirable characteristics in the finished paper sheet as is outlined herein, but also enables the paper consumer to treat individual rolls of paper stock in his own corrugating plant in such cases wherein it is desired to obtain a paper sheet with such characteristics.

Generally speaking, our process consists of applying to the surface of the sheet, either by means of a spray or a kiss roll, a small amount of a mixture of urea and formaldehyde or a water-soluble urea-formaldehyde condensation product, and then by means of another spray or kiss roll applying, either to the same or the opposite side of the sheet, a small amount of acid or a mixture of acid and urea. The treated paper sheet is then immediately wound up into a tight roll before the applied materials have a chance to dry and the treated rolls of paper allowed to stand around for several days. During this period the liquid materials which were applied to the surface of the sheet gradually permeate into the paper and distribute themselves uniformly throughout the sheet. At the same time the water-soluble urea-formaldehyde condensation product reacts in the presence of the acid with the paper fibers, stiffening them and rendering them less capable of being softened or hydrated by water. As a result the sheet develops a high wet strength which is not merely a surface effect but which is distributed uniformly throughout the sheet, both sides of the

sheet showing the same degree of scuff-resistance.

By means of this method we overcome many of the disadvantages and high cost of treating paper with urea and formaldehyde compositions that were characteristic of prior art processes, and furthermore, we obtain a paper product which is quite different from that obtained by prior art processes and which is much more suitable for the purposes outlined herein.

Because of the unique procedure followed in our process we are able to obtain a very definite effect on the paper even when we use relatively small amounts of urea, formaldehyde and acid. Thus, by merely dampening the surface of the paper sheet with the urea-formaldehyde composition and acid solution, respectively, and immediately winding it into a tight roll and allowing it to stand for a period of time, we are able to obtain a uniform action on the paper fibers throughout the sheet without greatly increasing its moisture content and necessitating a drying operation. This feature makes the cost of treatment very low and enables the use of the paper product in fields where low cost is one of the primary factors.

According to our preferred method of practice, we dampen one side of the paper sheet with a solution of a water-soluble condensation product of formaldehyde and urea. The water-soluble condensation product is prepared by heating at about 200° F. a mixture of 100 parts of 38% formaldehyde with 25 parts of urea. The resultant soluble condensation product may or may not be diluted with water before application to the paper surface, depending upon the degree of effect desired. Subsequently, we dampen the opposite side of the paper sheet with a water solution comprising lactic acid and urea. The amount and proportion of urea and acid so applied are preferably so regulated that the amount of urea thus introduced onto the sheet will augment the amount of urea previously applied to the sheet in the form of a condensation product with formaldehyde to the extent that the final amount of urea in the sheet will be such that for each two moles of formaldehyde in the sheet at least one mole or slightly in excess of one mole of urea will be present. We then wind the treated paper into a tight roll and allow it to stand until the applied materials permeate throughout the paper structure and the reaction with the paper fibers is substantially complete. The amount of lactic acid applied is preferably the minimum amount that will accomplish the desired result, namely, the acceleration of the reaction between paper fibers and the formaldehyde-urea condensation product. The exact amount of acid used will depend upon the nature of the paper material being treated and the characteristics desired in the treated sheet.

If desired, the procedure of applying the formaldehyde-urea condensation product to the sheet and then applying the urea lactic acid solution to the sheet may be reversed without detriment to the final result. Furthermore, if a sheet with a somewhat one-sided effect is desired, both mixtures may be applied to the same side of the sheet instead of on opposite sides.

Although fair results may be obtained by using a mixture of urea, formaldehyde and lactic acid along with more or less water and applying it immediately to the paper sheet in one operation, we have found that a precipitate develops in such solutions on standing and a certain amount of their original effectiveness is lost. For this reason we prefer to apply the urea-formaldehyde solution and the acid solution to the paper in separate operations. Furthermore, we prefer to use a urea-formaldehyde solution or water-soluble condensation product thereof, wherein the proportion of formaldehyde is sufficiently in excess of two moles of formaldehyde to one mole of urea that a clear, stable, water-soluble condensation product is obtained. Other stable water-soluble, urea-formaldehyde condensation products prepared by other means are also suitable for our purpose.

Inasmuch as an excess of uncombined formaldehyde in the treated paper sheet would impart a disagreeable odor, we prefer to use a sufficient amount of urea in the acid solution so that when both solutions have been applied to the paper a sufficient or more than sufficient amount of urea is present to completely combine all of the formaldehyde present and render the finished sheet practically odorless. In such cases, of course, where odor in the finished sheet is not a detrimental factor, this step in the procedure is not essential.

For the most part we prefer to use lactic acid or similar organic acids as the catalyst to effect the reaction of the formaldehyde-urea condensation product with the paper fibers. Mineral acids and salts of an acid nature may also be used for this purpose but are not so desirable due to their detrimental effect on the strength of the paper fiber. We have found that if the paper fibers throughout the sheet are to be uniformly acted upon by the urea-formaldehyde condensation product it is essential that the acid catalyst chosen be one that has the property of readily penetrating into and distributing itself throughout the paper structure. Lactic, citric, tartaric, phosphoric and benzene sulfonic acids are examples of acids having this property to a satisfactory degree.

Although for most purposes it is desirable to produce a paper sheet wherein the paper fibers have been acted on throughout, it is possible that for some purposes a paper sheet is desired wherein only the paper fibers adjacent the surface of the sheet are to be acted upon. This can be readily accomplished by our method of treatment by using an alum solution instead of lactic acid as the catalytic agent and applying both acid and urea-formaldehyde solutions to the same side of the sheet. An alum solution is used as the catalytic agent in this instance because it does not have the property of readily penetrating into the paper structure and as a result only the paper fibers adjacent the surface of the paper are acted upon.

We have found that in those cases wherein the more highly rosin sized types of paper are to be treated with our process it is necessary in order to secure astisfactory penetration of the treating solutions into the sheet, to incorporate with each of the solutions a small amount of acetic acid or other acid adapted to cut the sizing material.

The invention will be further illustrated by the following description in conjunction with the accompanying drawing in which:

Figure 1 represents an apparatus suitable for treating a cellulosic sheet material in accordance with our invention where the cellulosic sheet has already been formed and wound up in a roll; and

Figure 2 illustrates another form of apparatus for incorporating materials into a cellulosic paper

sheet in accordance with our invention, said incorporation being effected while the paper sheet is still on the paper machine.

As shown in Figure 1, a paper sheet or other cellulosic sheet material in the form of a roll 2 is unwound and passed over and between a series of rolls 4, 6, 8, 10, 12, 14, 16 and 18 to a rewinding roll 20. Rolls 6 and 12 are coating rolls adapted to rotate respectively in vessels 22 and 24, said vessels being filled with liquids as illustrated by numerals 26 and 28. As shown in the drawing, these liquids are applied to opposite sides of the paper sheet A and in accordance with the invention these liquids may consist of a solution of a water-soluble urea-formaldehyde condensation product in one vessel and an acid solution or a mixture of acid and urea solution in the other. Doctor rolls 30 and 32 are provided to regulate the thickness of the film of liquid. As rolls 6 and 12 rotate in the direction of the arrows, any excess liquid is removed therefrom by said doctor rolls 30 and 32, thus providing for a uniform coating of the material to be applied.

The method of operation of the apparatus described in Figure 1 is as follows. The sheet of paper A is unwound from a roll 2, passed beneath guide roll 4 and over coating roll 6 where the underside of the paper is coated with either an acid solution, a mixture of urea-formaldehyde or a water-soluble condensation product of urea and formaldehyde. The coating operation is effected by direct contact between the roll 6 and paper sheet A at the upper surface of roll 6. The lower surface of roll 6 rotates in a bath of the material 26, held in vessel 22 and as the roll rotates about a central axis it picks up said material and carries a film thereof on its surface. The uniformity of this film is controlled by doctor roll 30. Roll 6 may be run at a rate equal to, faster, or slower than the rate of speed of the paper sheet A as it passes over the upper surface of said roll, depending upon the amount of material which it is desired to apply to the paper. Likewise, the distance between roll 6 and doctor roll 30 may be regulated as desired. After the paper sheet leaves roll 6 it passes over another guide roll 8 and thence around a third guide roll 10 to coating roll 12, where the previously uncoated top surface of the paper is coated with a material different from that applied from coating roll 6. Coating roll 12 rotates in a bath 28 of the material to be applied which is contained in vessel 24. The uniformity of the film carried on the surface of roll 12 is regulated by doctor roll 32. The speed of roll 12 may likewise be equal to, faster, or slower than the speed of paper sheet A, depending largely upon the amount of material which it is desired to apply. Regardless of whether the speeds of rolls 6 and 12 are the same or different it is preferable that their speeds be coordinated by a coordinating means of any type such as is well known to those skilled in the art and the same relative speeds of the two rolls be maintained.

As paper sheet A leaves coating roll 12 it is passed over a series of guide rolls 14, 16 and 18 and then rewound on roll 20. It is to be observed that when the roll is rewound the oppositely treated sides are brought into contact with each other, that is, the top side of the paper is brought into contact with the bottom side and vice versa, thus bringing together the acid reacting material and the urea-formaldehyde condensation product into relatively close relationship and thereby greatly facilitating a reaction adapted to increase the water-resistance of the paper. The speed of reaction may be increased somewhat by the tightness with which the roll 20 is wound. After the rewound roll has been allowed to stand for several days or for even a lesser period the paper is ready for use. Examination of the paper at this stage shows that its stiffness has been increased. Likewise its wet strength has been increased and it has greater resistance to scuff and puncture.

A corrugating medium treated in the manner above described may be directly corrugated from the paper roll with excellent results. An improved corrugated paper board assembly is thus obtained having a more rigid corrugated core which will not deteriorate under high humidity conditions.

Thus it will be seen that the present invention provides a new and improved method of making corrugated paper board assemblies wherein the paper corrugating medium is treated from opposite sides with an acid solution and a water soluble urea-formaldehyde reaction product, then wound into a roll, allowed to stand until the reaction is substantially complete within the fibers of the corrugating medium and is thereafter corrugated directly from said roll in any conventional manner. The method of corrugating the corrugating medium and of forming it into a corrugated paper board assembly by attaching a liner or liners thereto is known in the art per se and is shown, for example, in patents of Jordan V. Bauer, one of the joint inventors herein, U. S. 2,051,025 and U. S. 2,102,937.

Instead of carrying out our process as described with reference to Figure 1 in which we treat the paper when it is already in rolled form and after it has left the paper machine, we may also utilize our method to advantage in the direct treatment of paper before it has left the paper machine. This is accomplished by applying the acid solution and urea-formaldehyde condensation products to opposite sides of the paper sheet at some point in the paper making process, preferably at a stage where the paper sheet is completely formed and has most of the water removed therefrom. Thus, as shown in Figure 2, we may apply an acid solution and a urea-formaldehyde condensation product to opposite sides of the paper sheet just before it passes between the calender rolls on the paper machine. At this point the moisture content of the paper is between about 5% and 10% and the sheet is completely formed. The advantage of this method is the saving of a rewinding operation which is necessary in the method described in Figure 1.

As illustrated in Figure 2, the paper sheet B, which is coming from the drying rolls of the paper machine, passes between two guide rolls or pressing rolls 50 and 52 and thence through a series of calender rolls 54 where it changes direction several times, finally being wound onto a roll 56. Just prior to the time that the sheet passes through rolls 50 and 52 the acid solution or solution of acidic material and the urea-formaldehyde solutions are separately added to opposite sides of the paper sheet in any suitable manner, for example, by spraying, as illustrated, by means of nozzles 58 and 60 or by means of kiss rolls such as illustrated in Figure 1. If desired the spraying operation may be carried out between rolls 50, 52 and calender rolls 54, or the acid solution and urea-formaldehyde solution may be added to the paper sheet at the nip of

roll 56 upon which the paper is being wound, that is to say, at point 62. If this general method of adding the two solutions at the nip of a roll is employed, both liquids may be added from the same side since the opposite side automatically becomes coated with liquid as the paper is wound on the roll. This is another general method of applying our compositions to a cellulosic sheet and may be used in conjunction with a rewinding operation, as described in Figure 1, thereby avoiding the necessity of employing coating rolls.

The remainder of the apparatus shown in Figure 2 is conventional in paper making machines and consists of a rewinding means, including a roll of paper 64, guide rolls 66 and 68, rewinding roll 70 and means 72 for supporting rewinding roll 70. As soon as one roll is formed, another roll can be brought into place from the apex of the triangle 74.

In treating paper as previously described we prefer that the amount and concentration of the treating solutions added to the paper be such that not more than about 6% to 10% additional water will be added, thus making it unnecessary to dry the sheet after treatment for most purposes of usage.

Where urea is employed it may be replaced wholly or in part by its analogs or homologs including substantially water-soluble ureas and thio-urea. It will be understood, however, that urea itself is preferred. The formaldehyde used may be an ordinary grade of formaldehyde such as is sold in aqueous solution of about 30% to 40% concentration having a specific gravity of .75 to .81. Other aldehydes similar in reaction may also be employed, as, for example, acetaldol and paraformaldehyde. In general, compounds of this class may be referred to as formaldehyde forming compounds.

Methods of preparing stable condensation products of urea and formaldehyde which are miscible with water are well known in the art. These initial condensation products may be prepared under neutral conditions or in conjunction with various catalysts or agents designed to insure the stability of the condensation product. As previously indicated, we may also merely employ a mixture of urea and formaldehyde without bringing about any initial condensation therein.

It will be understood that the treating solutions and the method of treating cellulosic paper materials as above described may be varied considerably without departing from the essence of our invention. It will also be recognized that auxiliary materials may be used in conjunction with our method of treatment for various purposes, as, for example, plasticizers such as glycerine, ethylene glycol, lauryl sulphate, sodium lactate and/or mixtures of higher alcohol sulplates or sulphonated oils which have a wetting or dispersing action.

Having thus described the invention, what we claim as new and desire to secure by Letters Patent of the United States is:

1. In the art of making corrugated paper board assemblies, the steps which comprise treating opposite sides of a paper corrugating medium with an acid solution and a water-soluble urea-formaldehyde reaction product, the amount of said acid solution and said water-soluble urea-formaldehyde reaction product being sufficient to increase the water resistance of said paper corrugating medium without substantially decreasing its water permeability winding said corrugating medium in the form of a roll while it is still damp, allowing it to stand until reaction is substantially complete within the fibers of the corrugating medium and thereafter corrugating said medium directly from said roll.

2. In the art of making corrugated paper board assemblies, the steps which comprise, treating a paper corrugating medium with urea, formaldehyde and an acid material in the presence of water in concentrations such that the ratio of formaldehyde to urea is approximately 2 moles of formaldehyde to 1 mole of urea and the amount of water is not greater than about 10% by weight of the paper corrugating medium, the proportions of said materials being sufficient to merely dampen the paper corrugating medium and effective to increase the wet strength and the scuff-resistance without substantially decreasing the water absorptive capacity of the paper corrugating medium, allowing reaction to take place within the fibers of said corrugating medium, and thereafter corrugating said medium and incorporating it into a corrugated paper board assembly.

3. In the art of making corrugated paper board assemblies, the steps which comprise, treating a paper corrugating medium with urea, formaldehyde and an acid material selected from the group consisting of lactic acid, citric acid, tartaric acid, phosphoric acid and benzene sulfonic acids in the presence of water, the concentrations of said materials corresponding to approximately 2 moles of formaldehyde to 1 mole of urea with an amount of water not greater than about 10% based upon the weight of the corrugating medium, said materials being added to the corrugating medium in amounts merely sufficient to dampen said corrugating medium and effective to increase the wet strength and the scuff-resistance without substantially decreasing the water absorptive capacity of the corrugating medium.

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