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COATED PAPER AND PROCESS FOR MAKING
SAME

Julian L. Azorlosa, Westbury, N. Y., and Donald
Paul Hug, Wilmington, Del., assignors to Her-
cules Powder Company, Wilmington, Del., a
corporation of Delaware

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1

This invention relates in general to a felted, fibrous material of improved properties and in particular to a high strength paper product and to the process for its preparation.

In the preparation of paper products, it is, for many purposes, highly desirable to prepare a paper having a relatively high wet and dry strength so that its performance under conditions of its actual use will be strikingly improved. It is the usual practice in the preparation of such a high strength product to add to the paper fibers, either prior to or after web formation, a material which in the final product improves the strength thereof, and for convenience of operation, it is necessary that this product be water-soluble and readily dilutable with water and that it be easily miscible with a paper stock or that it be easily applied to a moist paper web.

Now in accordance with the present invention, a felted, fibrous material of improved properties is prepared through the addition of a water-soluble carboxyalkyl hydroxyalkyl cellulose derivative such as, for example, a carboxymethyl hydroxyethyl cellulose salt. According to one embodiment of the invention, sodium carboxymethyl hydroxyethyl cellulose is applied to the paper fibers either before or after web formation and while it is the usual practice in the preparation of a high strength product to add to the paper fibers a strength-producing material in conjunction with an insolubilizing agent, such as alum, capable of precipitating that material on the fibers, it is a feature of this invention that water-soluble carboxymethyl hydroxyethyl cellulose derivatives may be applied to the paper after web formation in the total absence of precipitants and that notwithstanding the absence of these precipitants, the product is characterized by having an exceptionally high strength. In another embodiment of the invention, the aqueous solution is added to the fibers prior to web formation, and in this application it is desirable to insolubilize the cellulose derivative with alum or some other precipitant such as, for example, a chromic acid salt. In any event, whether the cellulose derivative, according to this invention, is applied before or after web formation, the product is characterized by having excellent performance, feel, texture, color, and the like.

The general nature of the invention having been set forth, the following examples are now presented in specific illustration but not in limitation of this invention.

Example 1

An aqueous solution containing 1% of the

2

sodium salt of 0.49-substituted carboxymethyl 0.375-substituted hydroxyethyl cellulose (prepared from a 2% solution having a viscosity of 37.5 cps.) was prepared and was applied to 100% rag paper having a basis weight of 37 lb./ream by immersing the paper in the solution. The saturated sheets were passed through a pair of squeeze rolls at low nip pressure (about 15 lbs./linear inch) to remove excess solution and to yield uniform pick-up of the cellulose derivative. The moist sheets were air dried at room temperature for one hour. The product containing the sodium carboxymethyl hydroxyethyl cellulose in an amount of .4% based on the weight of the paper was characterized by high strength as determined by the Mullen burst test of 116.5% of the strength of the untreated paper. The paper had excellent feel, texture, color, and general appearance and was a highly satisfactory, substantially unsized, high strength paper.

Example 2

Bleached sulfite paper having a basis weight of 37 lbs./ream and containing 0.15% size was immersed in a 1% aqueous solution of 0.73-substituted hydroxyethyl 0.33-substituted carboxymethyl cellulose (prepared from a 2% solution having a viscosity of 66.5 cps.) and the saturated sheets were passed through a pair of squeeze rolls and dried as in Example 1. The product containing the sodium carboxymethyl hydroxyethyl cellulose in an amount of .4% based on the weight of the paper had a strength as determined by the Mullen burst test of 128.5% of the untreated paper.

Example 3

Bleached sulfite paper as described in Example 2 was immersed in a 1% solution of 0.375-substituted hydroxyethyl 0.49-substituted carboxymethyl cellulose (prepared from a 2% solution having a viscosity of 37.5 cps.) and the saturated sheets were passed through a pair of squeeze rolls and dried as in Example 1. The product containing the sodium carboxymethyl hydroxyethyl cellulose in an amount of .28% based on the weight of the paper had a strength as determined by the Mullen burst test of 122.2% of the untreated paper.

Examples 4, 5 and 6

Three per cent rosin size and 3% sodium carboxymethyl hydroxyethyl cellulose (percentages being based on the dry pulp) were added to a well-agitated 2.5% bleached sulfite pulp slurry having a Schopper-Riegler freeness of 750 cc.

The sodium carboxymethyl hydroxyethyl cellulose was introduced as a 2% solution and after a few minutes additional agitation, the pH was reduced to 4.5 by the addition of 10% alum solution. Handsheets having a basis weight of 40 lbs./ream were prepared by the conventional method and dried for one hour at 105° C. Three samples of sodium carboxymethyl hydroxyethyl cellulose were investigated according to the method here outlined and all of these samples were prepared from an hydroxyethyl cellulose batch having an hydroxyethyl substitution of 0.60 hydroxyethyl groups per anhydroglucose unit, the samples differing only in their carboxymethyl content. The paper products had wet and dry tensile strengths by the Mullen burst test as shown in the following table:

TABLE I

Example	Carboxymethyl Substitution	Strength as percent of Control Containing 3% Rosin Size	
		Wet Tensile	Dry Tensile
4	0.15	176	156
5	0.2	187	157
6	0.25	191	156

In all of the above examples, the paper was characterized by having excellent feel, texture, color, and general appearance and was a highly satisfactory wet and dry strength paper.

The carboxyalkyl hydroxyalkyl cellulose derivatives employed in the preparation of the high strength composition according to the present invention are characterized by being soluble in and dilutable with water to yield somewhat viscous, dilute, aqueous solutions which can readily be applied to the paper in a convenient manner such as tub sizing, rolling, spraying, dipping, or the like. Among the water-soluble salts which are preferred are included those of sodium, potassium, and ammonium but obviously other water-soluble salts as well as water-soluble carboxymethyl hydroxyethyl cellulose derivatives are also operable. According to one embodiment of the invention, the material may be added to the paper fibers at any time after the formation of the web and although no precipitant is necessary in order to produce a high strength product, an even higher strength paper may be prepared by insolubilization of the carboxymethyl hydroxyethyl cellulose derivative with a precipitating agent such as glyoxal or related compounds.

In the surface application the viscosity of the cellulose derivative will determine the extent to which the paper is penetrated by the solution and, therefore, a product having predetermined properties may be obtained by regulating this viscosity, this regulation being accomplished by varying either the molecular weight of the cellulose derivative or the concentration of the solution. Where the maximum surface strength is desirable, a very viscous solution is used. Where exceptional internal strength is sought, the less-viscous more-penetrating solutions are employed. In any event, the treated paper is a highly satisfactory high strength paper having excellent feel, texture, color and general appearance.

According to another embodiment of the invention, the aqueous solution of the cellulose derivative is applied to the fibers before web formation and in this application the degree of substitution of the cellulose derivative is critical. In

order that the treatment be effective, a carboxymethyl hydroxyethyl cellulose having a carboxymethyl substitution range of from about 0.05 to 0.5 per anhydroglucose unit is necessary and a range of substitutions of from about 0.15 to 0.3 is preferred. The hydroxyethyl substitution of the cellulose derivative, on the other hand, is not critical in the hydroxyethyl substitution range of 0.2 to 0.7 so long as the cellulose derivative is water-soluble. In the beater application of the cellulose derivative according to this invention it is desirable to insolubilize the cellulose derivative and although alum is conventionally chosen for this purpose, other precipitants such as, for example, chromic acid salts may likewise be used. The product of this embodiment of the invention is a smooth, even-textured paper having excellent color and general appearance and a highly satisfactory wet and dry strength.

The felted, fibrous products produced according to this invention are particularly characterized by having unusually high strength, and this property is particularly set forth in the examples. It will be realized that means for producing high strength fibrous materials are extremely important to the art and particularly for economic reasons. For example, in the manufacturing of paper, it is known that certain strength properties such as tensile strength, bursting strength, fold resistance, and the like, may be increased by mechanical treatment of the pulp such as beating, but the increase of these properties is accompanied by correspondingly higher power costs. It is obvious, however, that this invention makes possible the preparation of new grades of paper having high strength, and at the same time accomplishes this highly desirable result with an actual saving of expense inasmuch as the improved properties are imparted without additional beating or working and in fact, in some instances, even with decreased beating and working.

What we claim and desire to protect by Letters Patent is:

1. A felted fibrous material of improved properties comprising cellulosic papermaking fibers and a water-soluble salt of a carboxyalkyl hydroxyalkyl cellulose, said salt being soluble in water to the extent of at least 1%, said carboxyalkyl hydroxyalkyl cellulose having a carboxyalkyl substitution of from 0.05 to 0.5 carboxyalkyl group and from 0.2 to 0.7 hydroxyalkyl group per anhydroglucose unit.

2. A felted fibrous material of improved properties comprising cellulosic papermaking fibers and a water-soluble salt of a carboxymethyl hydroxyethyl cellulose, said salt being soluble in water to the extent of at least 1%, said carboxymethyl hydroxyethyl cellulose having a carboxymethyl substitution of from 0.05 to 0.5 carboxymethyl group and from 0.2 to 0.7 hydroxyethyl group per anhydroglucose unit.

3. A felted fibrous material of improved properties comprising cellulosic papermaking fibers and a water-soluble sodium salt of a carboxymethyl hydroxyethyl cellulose, said sodium salt being soluble in water to the extent of at least 1%, said carboxymethyl hydroxyethyl cellulose having a carboxymethyl substitution of from 0.05 to 0.5 carboxymethyl group and from 0.2 to 0.7 hydroxyethyl group per anhydroglucose unit.

4. A felted fibrous material of improved properties comprising cellulosic papermaking fibers and a water-soluble ammonium salt of a carboxymethyl hydroxyethyl cellulose, said am-

5

monium salt being soluble in water to the extent of at least 1%, said carboxymethyl hydroxyethyl cellulose having a carboxymethyl substitution of from 0.05 to 0.5 carboxymethyl group and from 0.2 to 0.7 hydroxyethyl group per anhydroglucose unit.

5. A process for preparing a felted fibrous material of improved properties comprising treating a web of papermaking fibers after web formation with a water-soluble salt of a carboxymethyl hydroxyalkyl cellulose, said salt being soluble in water to the extent of at least 1%, said carboxymethyl hydroxyalkyl cellulose having a carboxymethyl substitution of from 0.05 to 0.5 carboxymethyl group and 0.2 to 0.7 hydroxyalkyl group per anhydroglucose unit.

6. A process for preparing a felted fibrous material of improved properties comprising treating a web of papermaking fibers after web formation with a water-soluble salt of a carboxymethyl hydroxyethyl cellulose, said salt being soluble in water to the extent of at least 1%, said carboxymethyl hydroxyethyl cellulose having a carboxymethyl substitution of from 0.05 to 0.5 carboxymethyl group and 0.2 to 0.7 hydroxyethyl group per anhydroglucose unit.

7. A process for preparing a felted fibrous material of improved properties comprising treating a web of papermaking fibers after web formation with a water-soluble sodium salt of a carboxymethyl hydroxyethyl cellulose, said sodium salt being soluble in water to the extent of at least 1%, said carboxymethyl hydroxyethyl cellulose having a carboxymethyl substitution of from 0.05 to 0.5 carboxymethyl group and from 0.2 to 0.7 hydroxyethyl group per anhydroglucose unit.

8. A process for preparing a felted fibrous material of improved properties comprising treating a web of papermaking fibers after web formation with a water-soluble ammonium salt of a carboxymethyl hydroxyethyl cellulose, said ammonium salt being soluble in water to the extent of at least 1%, said carboxymethyl hydroxyethyl cellulose having a carboxymethyl substitution of from 0.05 to 0.5 carboxymethyl group and from 0.2 to 0.7 hydroxyethyl group per anhydroglucose unit.

9. A process for preparing a felted fibrous material of improved properties comprising treating papermaking fibers before web formation with a water-soluble salt of a carboxyalkyl hydroxyalkyl cellulose and then forming a web from said treated papermaking fibers, said salt being soluble in water to the extent of at least 1%, said carboxyalkyl hydroxyalkyl cellulose having a carboxyalkyl substitution of from 0.05 to 0.5 carboxyalkyl group and from 0.2 to 0.7 hydroxyalkyl group per anhydroglucose unit.

10. A process for preparing a felted fibrous material of improved properties comprising treating papermaking fibers before web formation with a water-soluble salt of a carboxymethyl hy-

6

droxyethyl cellulose and then forming a web from said treated papermaking fibers, said salt being soluble in water to the extent of at least 1%, said carboxymethyl hydroxyethyl cellulose having a carboxymethyl substitution of from 0.05 to 0.5 carboxymethyl group and from 0.2 to 0.7 hydroxyethyl group per anhydroglucose unit.

11. A process for preparing a felted fibrous material of improved properties comprising treating papermaking fibers before web formation with a water-soluble sodium salt of a carboxymethyl hydroxyethyl cellulose, said sodium salt being soluble in water to the extent of at least 1%, said carboxymethyl hydroxyethyl cellulose having a carboxymethyl substitution of from 0.05 to 0.5 carboxymethyl group and from 0.2 to 0.7 hydroxyethyl group per anhydroglucose unit.

12. A process for preparing a felted fibrous material of improved properties comprising treating papermaking fibers before web formation with a water-soluble ammonium salt of a carboxymethyl hydroxyethyl cellulose, said ammonium salt being soluble in water to the extent of at least 1%, said carboxymethyl hydroxyethyl cellulose having a carboxymethyl substitution of from 0.05 to 0.5 carboxymethyl group and from 0.2 to 0.7 hydroxyethyl group per anhydroglucose unit.

13. A process for preparing a felted fibrous material of improved properties comprising treating a web of paper-making fibers after web formation with a water-soluble salt of carboxyalkyl hydroxyalkyl cellulose, contacting the treated web with glyoxal to precipitate the carboxyalkyl hydroxyalkyl cellulose on the fibers, said salt being soluble in water to the extent of at least 1%, said carboxyalkyl hydroxyalkyl cellulose having a carboxyalkyl substitution of from 0.05 to 0.5 carboxyalkyl group and 0.2 to 0.7 hydroxyalkyl group per anhydroglucose unit.

14. A process for preparing a felted fibrous material of improved properties comprising treating papermaking fibers before web formation with a water soluble salt of carboxyalkyl hydroxyalkyl cellulose and a material capable of precipitating the carboxyalkyl hydroxyalkyl cellulose on the fibers selected from the group consisting of alum and chromic acid salts, said salts being soluble in water to the extent of at least 1%, said carboxyalkyl hydroxyalkyl cellulose having a carboxyalkyl substitution of from 0.05 to 0.5 carboxyalkyl group and from 0.2 to 0.7 hydroxyalkyl group per anhydroglucose unit.

JULIAN L. AZORLOSA.
DONALD PAUL HUG.

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