PROCESS OF IMPROVING PAPER FORMATION

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This invention relates to a process of improving the sheet formation characteristic of cellulose fiber paper containing a positively charged filler. The process comprises incorporating in the paper furnish a chemical component that reverses the sign of the electrical charge on the filler so that it becomes negatively charged and repels the negatively charged cellulose fibers, thereby lessening the tendency for agglomeration of the cellulose fibers and filler particles. This results in improved sheet formation due to better distribution of the fiber and filler components.

This application is a continuation-in-part of the co-pending application of Robert M. Levy and Milton O. Schur, Serial Number 181,920 filed August 28, 1950.

The paper may be any type of paper containing a positively charged filler and will generally be of a high quality type of paper wherein "formation" or appearance is one of the important characteristics. Also, the formation problem is particularly significant in the lightweight, waterleaf, types of paper and accordingly this invention is especially adaptable to those types of papers. Illustrative examples are text paper, such as Bible paper, carbonizing papers, wrapping papers for drinking straws and other miscellaneous articles, and cigarette papers. These papers fall in the class of high quality, lightweight papers, having weights within the range of about 8 to 80 grams per square meter. Comparable weights and filler contents of these papers are as follows:

Cigarette papers:
- Weights 12—19 grams/sq. meter
- Percent filler 5—20%
- Weights 20—30 grams/sq. meter
- Percent filler 20—35%

Text papers:
- Weights 20—80 grams/sq. meter
- Percent filler 15—40%

Carbonizing papers:
- Weights 8—20 grams/sq. meter
- Percent filler 3—10%

Sipping-straw wrap and misc. wrap: Same as heavy weight cigarette papers.

Regarding the cellulose fiber component of the paper, it may consist of any of the common paper fibers, including cotton fibers, wood fibers and bast fibers, such as flax fibers and manila fibers.

As to the filler component of the paper, it may consist of any of the common positively charged mineral loading materials or fillers, such as calcium carbonate, magnesium carbonate, and the reaction products of carbon dioxide with dolomitic lime, etc. The filler content of the paper may vary within a range of about 3 to 40%.

The sign reversing chemicals comprise soluble polyphosphates such as, for example, tetrasodium pyrophosphate, sodium hexametaphosphate, sodium tetra-

phosphate, sodium tripolyphosphate. Disodium or tetrasodium ethylenediamine tetra-acetate, glue, and ammonium caseinate can also be utilized. When one or more of these compounds is incorporated in the carbonate fiber or in the paper furnish containing both the carbonate filler and the cellulose fibers, a substantial improvement in the dispersion or defloculation of the stock is immediately apparent. The cellulose pulp fibers and carbonate filler no longer tend to flocculate in the head box or on the paper-forming wire of the paper machine, or have a greatly reduced tendency to flocculate, and the paper sheeted from this stock and dried in conventional manner on the paper machine present a nice, uniform formation and watermark and is a distinct improvement over the relatively "wild" formation which ordinarily characterizes wood fiber cigarette paper. The amount of charge-reversing agent that may be used in accordance with our invention is about 0.1% to 1% based on the weight of the filler. The percentage varies with different furnish, with manufacturing conditions and equipment, and with the degree of deflocculation required. In actual practice we have found that the use of more than 1% is of no advantage, and, accordingly, the 1% is an economically desirable upper limit.

For illustrative purposes but without limitation there- to, the process of this invention will be described hereafter with particular reference to cigarette papers. Cigarette paper normally contains negatively charged cellulose fibers, such as flax fibers or wood fibers, and a positively charged mineral filler, such as, calcium carbonate. In the furnish or aqueous suspension of these oppositely charged components, they tend to produce a clotting or flocculating of fiber and filler which results in a cigarette paper sheet of "wild" or mottled, non-uniform appearance. This effect is especially noticeable in the so-called "combustible" type of cigarette paper that contains about 20% to 35% calcium carbonate filler, and to a lesser extent in the non-combustible type of cigarette paper that contains about 5% to 20% filler.

In addition to the substantial and important improvement in formation and watermark characteristics of the cigarette paper obtained by the use of a sign-reversing agent as described above, these characteristics of the final cigarette paper sheet may be further improved, if desired, by the incorporation in the paper furnish of a suitable gum, such as deacetylated karaya gum or other polyole gum. Although there is no apparent interrelation between the gum and the charge-reversing agent above described, there is an interdependent relationship which is demonstrated by the fact that if the charge- reversing agent were not used and the gum were added to the pulp, the furnish would clot badly and would result in a paper of exceedingly "wild" formation. In fact, the clotting of the furnish is in some instances so pronounced as to clog the screens at the head of the paper machine.

On the other hand, when a charge-reversing agent, such as, for example, tetrasodium pyrophosphate, is used, it prevents the filler from agglomerating with the cellulose fibers and the addition of the gum no longer clots the furnish, but, on the contrary, aids in effecting the improved distribution of the filler and fiber particles and in the production of a final cigarette paper sheet having good formation and watermark characteristics. In this manner, the addition of a gum to the furnish may be employed to augment the improvement which is obtained by reversing the charge on the filler.

Typical but non-limiting examples of the process are as follows:

Example 1

A beater was charged in the usual way with a bleached kraft wood pulp comprised of spruce, balsam fir and jack.
pine fibers. It was beaten at a consistency of about 6% for about four hours to a high degree of fibrillation and to a weight of one millimeter and to a Schoeller-Riegler freeness of about 100 cc. as measured by the Tappi Standard Method. It was then slurred to a machine chest, from which it was pumped through the usual papermaking screen to the head box of the paper machine. On the way to the screen, the stock was diluted in the usual way with white water recirculated from the paper machine, and to the stock thus diluted was added calcium carbonate filler to which 1% of tetrasodium pyrophosphate had been added, based on the dry weight of the filler. As the stock entered the screen, there was added to it a 1% aqueous solution of partially decayed karya gum. The rate of addition of the gum solution was equivalent to 0.1% karya gum based on the weight of the paper being made, both on a dry basis. The cigarette paper as it came off the dry end of the machine weighed 20 grams per square meter and contained 26% calcium carbonate filler, based on the dry weight of the paper. It was excellent in all its properties, including clarity of the watermark and uniformity of formation.

**Example II**

For purposes of comparison, the pulp was run over the paper machine without the addition of decayed karya gum to the filler, and a sheet weighing 20 grams per square meter and containing 26% filler was produced. The strength and porosity characteristics of the paper were practically identical with those of the previous run, but the watermark was relatively blotchy in appearance and the formation distinctly mottled.

**Example III**

In another example, the wood pulp was run over the paper machine without the addition of decayed karya gum, but the filler was treated with tetrasodium pyrophosphate as in the first example of procedure. In comparison with the second run, an improved watermark and a markedly improved formation were realized. However, the watermark and formation were not quite as good as in the case of the first run.

**Example IV**

In another series of runs, a 12-gram sheet was made containing 19% filler. In this case, the fiber was shortened to an appreciably lower freeness, since such modifications are necessary when the paper is exceedingly light in weight. In this case, the use of tetrasodium pyrophosphate alone improved the watermark and formation to an important extent.

When flax fibers or other cellulosic fibers are substituted for wood pulp, the foregoing examples will apply in all respects except for the substitution of the fibrous material. When papers other than cigarette paper are involved, the percentages of sign-reversing chemical compound remain the same, based on the filler and fiber constituents, and the only variation will be in the basis weight and filler contents. These differences in basis weight and filler contents are illustrated by the weights and percentages given heretofore.

The use of the polyphosphates or other sign-reversing reagents is usually associated with a lesser retention of filler on the paper machine. Ordinarily, the filler retention may run about 75%. In the case of the runs described above, the normal retention in the presence of soluble polyphosphate would be nearer 68%. This loss is compensated for by the addition of extra filler.

Regarding the gum which may be used, such as, for example, the decayed karya gum, we have found that under some conditions an amount as small as 0.01% based on the total weight of paper gives appreciable improvement, and that as high as 1% to 2% of the gum may be used for obtaining the desired improvement in fiber distribution, and the percentage will depend largely upon the place and condition under which the gum is incorporated. The gum is very sensitive to agitation and if it is added to the furnish, for example, in the machine chest and then is subjected to the pump refining operations normally carried out between the machine chest and the head box of the paper machine, a considerably larger amount of gum is required, such as 1% to 2%. For this reason, it is usually desirable to add the gum after these refining operations, that is, at the head box of the paper machine where a substantially small amount, such as, for example, 0.1%, is sufficient to give the added improvement above described.

Various modifications and changes may be made in the above-described process and materials within the scope of the invention as defined in the appended claims.

We claim:

1. A process of improving the sheet formation characteristics of a high quality, light weight, water-leaf cellulosic fiber paper having a weight of approximately 8 grams to 80 grams per square meter containing approximately 3% to 40% of a positively charged carbonate filler, comprising incorporating in the paper furnish approximately 0.1% to 1%, based on the weight of the filler, of a sign-reversing chemical selected from the group consisting of tetrasodium pyrophosphate, sodium hexametaphosphate, sodium tetrasilicate, sodium tripolyphosphate, that reverses the sign of the electrical charge on the filler so that it becomes negatively charged and repels the negatively charged cellulosic fibers, thereby lessening the tendency for agglomeration of the cellulosic fibers and filler particles and resulting in improved sheet formation due to better distribution of the fiber and filler components, and thereafter forming paper therefrom.

2. A process of improving the sheet formation characteristics of a high quality, light weight, water-leaf cellulosic fiber paper having a weight of approximately 8 grams to 80 grams per square meter containing approximately 3% to 40% of a positively charged carbonate filler, comprising incorporating in the paper furnish approximately 0.1% to 1%, based on the weight of the filler, of a sign-reversing soluble polyphosphate that reverses the sign of the electrical charge on the filler so that it becomes negatively charged and repels the negatively charged cellulosic fibers, thereby lessening the tendency for agglomeration of the cellulosic fibers and filler particles and resulting in improved sheet formation due to better distribution of the fiber and filler components, and thereafter forming paper therefrom.

3. A process of improving the sheet formation characteristics of a high quality, light weight, water-leaf cellulosic fiber paper having a weight of approximately 8 grams to 80 grams per square meter containing approximately 3% to 40% of a positively charged carbonate filler, comprising incorporating in the paper furnish approximately 0.1% to 1%, based on the weight of the filler, of a sign-reversing chemical selected from the group consisting of tetrasodium pyrophosphate, sodium hexametaphosphate, sodium tetrasilicate, sodium tripolyphosphate, that reverses the sign of the electrical charge on the filler so that it becomes negatively charged and repels the negatively charged cellulosic fibers, and incorporating approximately 0.01% to 2%, based on the total weight of paper, of a polyole gum, thereby lessening the tendency for agglomeration of the cellulosic fibers and filler particles and resulting in improved sheet formation due to better distribution of the fiber and filler components, and thereafter forming paper therefrom.

4. A process of increasing the dispersion of the carbonate filler particles and wood pulp fibers in a cigarette paper furnish composed essentially of about 5% to 35% carbonate filler and the remainder wood pulp fibers, whereby flocculation of the filler and fibers is minimized and the cigarette paper produced from this furnish is im-
proved in formation and watermark characteristics, comprising incorporating in said furnish approximately 0.1% to 1%, based on weight of dry filler, of a soluble polyphosphate that changes the normally positive electrical charge on the filler to a negative charge, so that the thus changed negatively charged filler particles will have lessened tendency to agglomerate with the wood fibers and thereby provide more uniform distribution of filler and fiber particles in the finished cigarette paper sheet.

5. A process of increasing the dispersion of the carbonate filler particles and wood pulp fibers in a cigarette paper furnish composed essentially of about 5% to 35% carbonate filler and the remainder wood pulp fibers, whereby flocculation of the filler and fibers is minimized and the cigarette paper produced from this furnish is improved in formation and watermark characteristics, comprising incorporating in said furnish approximately 0.1% to 1%, based on weight of dry filler, of a soluble polyphosphate that changes the normally positive electrical charge on the filler to a negative charge, so that the thus changed negatively charged filler particles will have lessened tendency to agglomerate with the wood fibers and thereby provide more uniform distribution of filler and fiber particles in the finished cigarette paper sheet, said soluble polyphosphate being selected from the group consisting of tetrasodium pyrophosphate, sodium hexametaphosphate, sodium tetratosphate, sodium tripolysphosphate, and further improving the formation and watermark characteristics of the cigarette paper by incorporating in the paper furnish approximately 0.01% to 2% of deacetylated karanja gum that disperses the wood fibers.

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