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(54) Papermaking process using multi-polymer retention and drainage aid

(57) The claimed invention comprises a papermaking process comprising forming an aqueous cellulosic papermaking slurry, adding to the slurry a mineral filler, adding to the slurry after the addition of the mineral filler a cationic polymeric coagulant, then adding to the slurry an effective flocculating amount of a high molecular weight anionic polymer selected from the group consisting of acrylamide/sodium acrylate copolymers and copolymers of acrylamide and acrylamido methyl propyl sulfonate (AMPS), adding a low molecular weight anionic polymer selected from the group consisting of polyacrylic acid and methacrylic acid, draining the slurry to form a sheet, and drying to form a paper sheet.

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Description

Background of the Invention

1. Field of the Invention

The present invention is in the technical field of papermaking and more particularly in the technical field of wet-end additives to papermaking furnish.

2. Description of the Prior Art

In the manufacture of paper an aqueous cellulosic suspension or slurry is formed into a paper sheet. The cellulosic slurry is generally diluted to a consistency (percent dry weight of solids in the slurry) of less than 1 percent and often below 0.5 percent ahead of the paper machine, while the finished sheet must have less then 6 weight percent water. Hence the dewatering aspects of papermaking are extremely important to the efficiency and cost of the manufacture.

The dewatering method of the least cost in the process is drainage, and thereafter more expensive methods re used for, for instance vacuum, pressing, felt blanket blotting and pressing, evaporation and the like, and in practice a combination of such methods are employed to dewater, or dry the sheet to the desired water content. Since drainage is both the first dewatering method employed and the least expensive, improvement in the efficiency of drainage will decrease the amount of water required to be removed by other methods and hence improve the overall efficiency of dewatering and reduce the cost thereof.

Another aspect of papermaking that is extremely important to the efficiency and cost of the manufacture is retention of furnish components on and within the fiber mat being formed during papermaking. A papermaking furnish contains generally particles that range in size from about the 2 to 3 millimeter size of cellulosic fibers, to fillers at a few microns, and to colloids. Within this range are cellulosic fines, mineral fillers (employed to increase opacity, brightness and other paper characteristics) and other small particles that generally, without the inclusion of one or more retention aids, would in significant portion pass through the spaces (pores) between the cellulosic fibers in the fiber mat being formed during papermaking and the forming fabric.

One method of improving the retention of cellulosic fines, mineral fillers and other furnish components on the fiber mat is the use of a coagulant/flocculant system, added ahead of the paper machine. In such a system there is first added a coagulant, for instance a low molecular weight cationic synthetic polymer or a cationic starch to the furnish, which coagulant generally reduces the negative surface charges present on the particles in the furnish, particularly cellulosic fines and mineral fillers, and thereby accomplishes a degree of agglomeration of such particles, followed by the addition of a flocculant. When the flocculant is anionic, the coagulant also provides anchoring sites of attachment for the flocculant. Such flocculant generally is a high molecular weight anionic synthetic polymer which bridges the particles and/or agglomerates, from one surface to another, binding the small particles into large agglomerates or attaching them to the large fibers. The presence of such large agglomerates in the furnish as the fiber mat of the paper sheet is being formed increases retention. The agglomerates are filtered out of the water onto the fiber web, where unagglomerated particles would to a great extent pass through such paper web.

Another system employed to provide an improved combination of retention and dewatering is described in United States Patent No. 4,753,710 and United States Patent No. 4,913,775, inventors Langley et al., issued respectively June 28, 1988 and April 3, 1990, incorporated hereinto by reference. In brief, such method adds to the aqueous cellulosic papermaking suspension first a high molecular weight linear cationic polymer before shearing the suspension, followed by the addition of bentonite after shearing. The shearing generally is provided by one or more of the cleaning, mixing and pumping stages of the papermaking process, and the shearing breaks down the large flocs formed by the high molecular weight polymer into microflocs, and further agglomeration then ensues with the addition of the bentonite clay particles.

Another system uses the combination of cationic starch followed by colloidal silica to increase the amount of material retained on the web by the method of charge neutralization and adsorption of smaller agglomerates. This system is described in United States Patent No. 4,388,150, inventors Sunden et al., issued June 14, 1983.

Greater retention of fines and fillers permits, for a given grade of paper, a reduction in the cellulosic fiber content of such paper. As pulps of less quality are employed to reduce papermaking costs, the retention aspect of papermaking becomes even more important because the fines content of such lower quality pulps is greater generally than that of pulps of higher quality.

Greater retention of fines, fillers and other slurry components reduces the amount of such substances lost to the white water and hence reduces the amount of material wastes, the cost of waste disposal and the adverse environmental effects therefrom.

Another important characteristic of a given papermaking process is the formation of the paper sheet produced. Sheet uniformity or formation may be determined by the variance in light transmission within a paper sheet, and a high variance is indicative of poor formation. As retention increases to a high level, for instance a retention level of 80 to 90 percent, the formation parameter generally abruptly declines from good formation to poor formation. It is at least theoretically believed that as the retention mechanisms of a given papermaking process shift from filtration to adsorption,

the deleterious effect on formation, as high retention levels are achieved, will diminish, and a good combination of high retention with good formation is attributed to the use of bentonite in U. S. Patent No. 4,913,775.

It is generally desirable to reduce the amount of material employed in a papermaking process for a given purpose, without diminishing the result sought. Such add-on reductions may realize both a material cost savings and handling and processing benefits.

It is also desirable to use additives that can be delivered to the paper machine without undue problems. An additive that is difficult to dissolve, slurry or otherwise disperse in the aqueous medium may require expensive equipment to feed it to the paper machine. When difficulties in delivery to the paper machine are-encountered, the additive is often maintained in aqueous slurry form by virtue of high energy input equipment. In contrast, additives that are easily dissolved or dispersed in water require less energy and expense and their uniformity of feed is more reliable.

Summary of the Invention

The claimed invention comprises a papermaking process comprising forming an aqueous cellulosic papermaking slurry, adding to the slurry a mineral filler, adding to the slurry after the addition of the mineral filler a cationic polymeric coagulant, then adding to the slurry an effective flocculating amount of a high molecular weight anionic polymer selected from the group consisting of acrylamide/sodium acrylate copolymers and copolymers of acrylamide and acrylamido methyl propyl sulfonate (AMPS), adding a low molecular weight anionic polymer selected from the group consisting of polyacrylic acid and methacrylic acid, draining the slurry to form a sheet, and drying to form a paper sheet.

Description of the Preferred Embodiments

According to the invention, a water soluble polymer is added to a cellulosic slurry before the formation of a paper product. The water soluble polymer should become substantially dispersed within the slurry before formation ofthe paper product. The low molecular weight anionic polymer of the invention is added after the addition of a cationic polymeric coagulant and a high molecular weight anionic polymer. The addition of the low molecular weight anionic polymer in an aqueous medium, for instance as a water solution or disbursing, facilitates the dispersion of the polymer into the slurry. In a preferred embodiment, the polymer is added to the cellulosic slurry before the processing steps of draining and forming the paper sheet.

In the preferred embodiment of the invention the cationic coagulant may be chosen from among the following compounds: epi-DMA (dimethyl acrylate), ammonia crosslinked epi-DMA, DADMAC (Diallyl dimethyl ammonium chloride) and copolymers of DADMAC and acrylamide or acrylate, polyethylene imines, polyamido amides, cyanoguanidine and condensation derivatives of various amines.

In a preferred embodiment, the high molecular weight of the invenion is chosen from among copolymers of acrylamide and sodium acrylate and copolymers of acrylamide and AMPS. Preferably, the charge densities of these copolymers vary between 0.7 to 1.7 meq(milliequivalents) per gram of polymer. Further, the molecular weight of the copolymers is preferably greater than 1 million daltons. Most preferably, the molecular weight is greater than 10 million daltons.

The present process is believed applicable to all grades and types of paper products, and further applicable for use on all types of pulps including, without limitation, chemical pulps, including sulfate and sulfite pulps from both hard and soft woods and acid pulps, thermo-mechanical pulps, mechanical pulps and ground wood pulps, although it is believed that the advantages of the process ofthe present invention are best achieved when the pulp employed is of the chemical pulp type, particularly alkaline chemical.

In preferred embodiment the filler used in the cellulosic slurry is anionic, or at least partially anionic when present in the furnish. Other mineral, or inorganic, fillers may however, be used, or used in part, such as titanium dioxide, kaolin clay and the like.

The amount of inorganic filler generally employed in an alkaline papermaking stock is from about 10 to about 30 parts by weight of the filler, as $CaCO_3$, per hundred parts by weight of dry pulp in the slurry, but the amount of such filler may at times be as low as abut 5, or even about 2, parts by weight, and as high as about 40 or even 50 parts by weight, same basis.

The amount of high molecular weight anionic polymer that may be used in the process of the present invention may be within the range of from about 0.01 to about 1.5 parts by weight per hundred parts by weight of dry solids in the cellulosic slurry, including both pulp and filler solids. In a preferred embodiment the polymer is used in the amount of from about 0.05 to about 0.5 parts by weight per hundred parts by weight of dry solids in the cellulosic slurry.

The level of such polymer may also be correlated with the amount of filler in the cellulosic stock. The polymer used may be within the range of from about 0.01 to about 20 parts by weight per hundred parts by weight of the filler, as CaCO3, and preferably will be in the range of from about 0.1 to about 10 parts by weight, and more preferably form about 0.1 to about 2.5 parts by weight, same basis.

with latex polymers.

Changes can be made in the composition, operation and arrangement of the method of the present invention described herein without departing from the concept and scope of the invention as defined in the following claims:

Claims

1. A papermaking process comprising:

   forming an aqueous cellulosic papermaking slurry;

   adding to the slurry a mineral filler,

   adding to the slurry after the addition of the mineral filler a polymeric cationic coagulant;

   adding to the slurry an effective amount of a high molecular weight anionic polymer having a molecular weight greater than 1 million daltons selected from the group consisting of copolymers of acrylamide and sodium acrylate and copolymers of acrylamide and acrylamido methyl propyl sulfonate;

   adding a low molecular weight anionic polymer selected from the group consisting of polyacrylic acid and methacrylic acid;

   draining the slurry to form a sheet; and

   drying to form a paper sheet.

2. The process of claim 1 wherein the slurry is drained on a papermaking screen and is pumped to the site of the papermaking screen prior to draining.

3. The process of claim 1 wherein the slurry is selected from the group consisting of an acid pulp slurry, alkaline chemical pulp slurry, thermo-mechanical pulp slurry, mechanical pulp slurry and ground wood pulp slurry.

4. The process of claim 1 wherein the mineral filler is alkaline carbonate.

5. The process of claim 1 wherein the mineral filler is added to the slurry in an amount of from about 2 to about 50 parts per hundred parts by weight of dry pulp contained in the slurry.

6. The process of Claim 1 wherein the molecular weight of the high molecular weight anionic polymer is greater than 10 million daltons.