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(54) **Combination of poly (dadmac/acrylamide) and bentonite for deposition control in papermaking processes**

(57) A method for minimizing pitch, ink, and stickies particle deposits in the papermaking process by causing the retention of such particles onto fiber, comprising the steps of adding an effective pitch, ink, and stickies controlling amount of a water soluble diallyldimethyl ammonium chloride-acrylamide copolymer to a suspension of fiber in contact with the paper machine and associated parts and adding an effective pitch, ink, and stickies controlling amount of bentonite to the suspension, thereby increasing retention of pitch, ink, and stickies onto the fiber and minimizing the deposition of pitch, ink, and stickies particles on the paper machine and associated parts.

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Description

A method for minimizing pitch, ink, and stickies particle deposition in the papermaking process comprising the steps of adding an effective pitch, ink, and stickies controlling amount of a diallyldimethyl ammonium chloride copolymer to the fiber suspension and adding an effective pitch, ink, and stickies controlling amount of bentonite or talc to the suspension, thereby reducing the pitch, ink, and stickies particle deposition in the papermaking process.

The problem of pitch, ink, stickies particle deposition control in the papermaking process for all types of paper has previously been recognized. The pitch in the fibers of wood pulps is associated with naturally occurring lignin dispersing agents. Cooking and mechanical agitation which occur during the pulping by the sulfite process liberate pitch and these natural dispersing agents. However, as a result of the mechanical work on the fibers, the natural dispersing agents liberated along with the pitch are inadequate to keep the pitch from depositing on the equipment employed in beating, hydrating, refining, bleaching, and even on the wire used for forming the sheet. Because of the tendency of the pitch to agglomerate within the pulp suspension or deposit on the surfaces of the wire or other equipment, the pitch frequently causes the formation of spots or holes in the sheet formed. Additionally, the pitch may adhere to the wire or press rolls or dryer rolls and cause tearing of the sheet. The result of the pitch contamination is the production of sheets with numerous imperfections. Among other consequences of pitch particle deposition are the expense of cleaning the machinery frequently either with solvents or steam, and the loss of production during cleaning and replacing operations caused by breakdown of the sheet.

Organic contaminants, such as ink and adhesives which are present in recycled paper, can have a sticky or tacky nature. The problems of handling such contaminants, referred to as ink and stickies, is similar to the problems encountered with pitch.

Water soluble polymers, and in particular, cationic water soluble polymers, have been used in the production of paper for a number of purposes. Water soluble polymers have been added to pulps to improve fine and filler retention. In another instance, these polymers have been used to improve drainage of water from the pulp as it is formed into a sheet on wires or felts. Polymers have also been used to attach pitch particles to cellulose fibers while they were in a colloidal state thereby preventing them from agglomerating and accumulating on the surfaces of production equipment. Polymers also have been used for improved efficiency in retaining fillers, such as clays. In the case of cationic polymeric retention aids, it is necessary to combine them with flocculants to make their performance acceptable. U.S. Patent No. 5,098,520 and allowed U.S. Patent Application No. 08/148,069, the disclosure of which is incorporated herein by reference.

Previous products used for this purpose have included low molecular weight polymers of DADMAC-epichlorohydrin diamine polymers or other polyamines including polyethyleneimine. Due to the low molecular weight, these products were often less effective as retention aids and in some cases had to be supplemented with a high molecular weight flocculant to achieve their desired level of retention. Flocculants by themselves failed to give adequate retention of colloidal materials, often hurting machine runability.

The papermaking process, particularly the production of newsprint, presents a challenge to the papermaker with respect to optimizing production. Because newsprint is a low grade paper, it is increasingly common to use recycled fiber rather than virgin fiber in its make-up. Due to the nature of newsprint and the necessity to carefully control costs, problems such as retention, drainage and pitch, ink, and stickies particle deposition control must be solved economically. It would represent an advance in the art if newsprint mills, as well as other paper mills, could use one product which could solve or improve the several problems described above.

The present invention is predicated upon the discovery that intermediate molecular weight copolymers of DADMAC and acrylamide used in combination with bentonite or talc are capable of improving pitch, ink, and stickies particle retention to the fiber, thereby minimizing the deposition of pitch, ink, and stickies particles on the surfaces of the paper machine and associated parts (structures) which include, felts, pipes, wires, pumps, tanks, and the like in the production of all types of paper.

A method for minimizing pitch, ink, and stickies deposition in the papermaking process by causing the retention of such particles onto fiber, comprising the steps of adding an effective pitch, ink, and stickies controlling amount of a water-soluble diallyldimethyl ammonium chloride copolymer to a suspension of fiber in contact with the paper machine and associated parts and adding an effective pitch, ink, and stickies controlling amount of bentonite to the suspension in contact with the paper machine and associated parts, thereby increasing retention of pitch, ink, and stickies onto the fiber and minimizing pitch, ink, and stickies particles deposition on the paper machine and associated parts.

The bentonite and the diallyldimethyl ammonium chloride-acrylamide copolymer may be added simultaneously to the suspension in contact with the paper machine and associated parts.

An alternative embodiment of the invention is a method for minimizing pitch, ink, and stickies particle deposits in the papermaking process by causing of such retention particles onto fiber comprising the steps of adding an effective pitch, ink, and stickies controlling amount of a water soluble copolymer of diallyldimethyl ammonium chloride-acrylamide to a suspension of fiber in contact with the paper machine and associated parts and adding an effective amount of talc to the water in the suspension in contact with the paper machine and associated parts, thereby increasing reten-

tion of pitch, ink, and stickies onto the fiber and minimizing the deposition of pitch, ink, and stickies particles on the paper machine and associated parts.

DESCRIPTION OF THE INVENTION

The invention comprises a method for improving the papermaking process, particularly the production of newsprint, filled newsprint, coated paper, all grades containing mechanical pulp, board paper, by improving the pitch and stickies control in the pulp and papermaking process. The pitch, ink, stickies formation and deposits are minimized and in some cases eliminated. Specifically, it comprises adding an effective pitch, ink, and stickies controlling amount of a water soluble diallyldimethyl ammonium chloride copolymer to a suspension of fiber in contact with the paper machine and associated parts and an effective pitch, ink, and stickies controlling amount of bentonite is also added to the suspension in contact with the paper machine and associated parts, thereby increasing retention of pitch, ink, and stickies onto the fiber and minimizing the deposition of pitch, ink, and stickies particles on the paper machine and associated parts.

The term "paper machine", as used herein, includes felts, pumps, wires, tanks, pipes, and similar associated parts as well as all metal surfaces where the fiber suspension contacts the surface of the paper machine. The term "suspension" as used herein includes pulp, fiber suspended in water, furnishes and the like.

The bentonite and the diallyldimethyl ammonium chloride-acrylamide copolymer may be added simultaneously to the suspension in contact with the paper machine and associated parts.

An alternative embodiment of the invention is a method for minimizing pitch, ink, and stickies particle deposits in the papermaking process by causing of such retention particles onto fiber comprising the steps of adding an effective pitch, ink, and stickies controlling amount of a water soluble copolymer of diallyldimethyl ammonium chloride-acrylamide to a suspension of fiber in contact with the paper machine and associated parts and adding an effective amount of talc to the water in the suspension in contact with the paper machine and associated parts, thereby increasing retention of pitch, ink, and stickies onto the fiber and minimizing the deposition of pitch, ink, and stickies particles on the paper machine and associated parts.

The talc and the diallyldimethyl ammonium chloride-acrylamide copolymer may be added simultaneously to the suspension in contact with the paper machine and associated parts. The ratio of bentonite (and alternatively, talc) to diallyldimethyl ammonium chloride-acrylamide copolymer is preferably from about 0.01 to about 50, more preferably from about 0.1 to about 30 and most preferably from about 1 to about 10.

The copolymer/bentonite combination may be added to papermaking systems to improve pitch, ink, and stickies control. This copolymer/bentonite combination is also effective in treating newsprint made from either virgin or recycled fibers. It is understood that the term, "newsprint" as used herein includes other grades of paper which contain mechanical pulp, recycled or deinked pulp.

THE DADMAC-ACRYLAMIDE COPOLYMERS

The acrylamide copolymers can contain DADMAC at weight ratios relative to acrylamide ranging from about 99:1 to about 1:99. The preferred copolymers of DADMAC and acrylamide contain DADMAC and acrylamide monomers in mole ratios of about 4:1 to about 1:4, and preferably the DADMAC-acrylamide polymer contains from about 2:1 to about 1:2 mole ratio of DADMAC monomer to acrylamide monomer, and most preferably the DADMAC to acrylamide monomer weight ratio is about 60:40 to about 40:60.

The DADMAC-acrylamide polymer can have a molecular weight ranging from about 10,000 up to about 15,000,000, which molecular weight is a weight average molecular weight, but preferably the polymers have a molecular weight ranging between about 20,000 to about 3,000,000. Most preferably, the polymers used have molecular weights ranging between about 75,000 to about 2,000,000. These are intermediate molecular weight ranges for these copolymers.

The DADMAC-acrylamide copolymers are added to the pulp slurry as early in the process as the point before where the furnish pulps are blended together. Often this is before what is called the machine chest or blend chest. It may also be added at any point up to the headbox on the paper machine. The preferred points are usually between the primary fan pump up to the headbox of the paper machine. Both bentonite, or alternatively, talc, can be fed at any point to the papermaking process or suspension, at any point in the paper machine. The bentonite (alternatively talc) can be added as a dry powder or as a hydrated suspension obtained by dispersing powdered material in water.

Dosages of Bentonite/Talc and Copolymer	
Bentonite or Talc	Copolymer
0.05 - 10	0.03 - 1.5
0.1 - 5	0.1 - 0.6
0.5 - 2	0.15 - 0.5

The DADMAC-acrylamide polymers are effective in treating both mechanical pulp containing furnishes as well as those incorporating deinked or recycled fiber. These recycled deinked furnishes often carry with them residual inks, latex polymers, and other chemicals which can cause operational and runability problems.

Bentonite is a colloidal clay composed predominantly of montmorillonite. The Wyoming or Western variety of bentonite is a sodium bentonite which has a high water swelling capacity. The Southern variety is a calcium bentonite with negligible swelling capacity. The bentonite can be any of the materials commercially referred to as bentonites or bentonite-type clays. Preferably, the bentonite is of the type having a high swelling capacity in water, such as sodium potassium bentonite. Bentonite clay has the desirable property of being thixotropic and shear thinning, i.e., it forms a network which is easily destroyed by the application of shear, but then reforms when shear is removed. The dry particle size of the bentonite is preferably at least 90 % below 100 microns and most preferably at least 60 % below 50 microns. The surface area of the bentonite particles before swelling is preferably at least 30 and more preferably at least 50, and most preferably between 60 to 90 m²/gm. The surface area after swelling is preferably between 400 and 800 m²/gm. The preferred type of the bentonite swells at least 15 or 20 times. The particle size after swelling is preferably at least 90 % below 2 microns.

Talc, an inexpensive material which is commonly used for pitch, ink and stickies deposition control in pulp and paper mills, is a crystalline powder of a natural hydrous magnesium silicate. Colloidal pitch adsorbs onto the hydrophobic surfaces of the talc crystal, thereby preventing the formation of large pitch agglomerates. The talc/pitch particles are retained in the fiber mat as its forms, thereby preventing the recirculation, concentration and eventual deposition of these particles in the system. However, the exposure of the talc/pitch agglomerate to shear will often create a fresh, sticky surface which can cause deposit problems further on in the papermaking process. In addition, other disadvantages to using talc include the high talc dosage rates often required to give good pitch, ink, and stickies deposition control and its abrasiveness which decreases the useful life of paper machine components such as wires, pick-up rolls and felts.

COPOLYMER TREATMENT LEVELS

The amount of copolymer which has been found effective ranges from a concentration of approximately 0.08 pounds active polymer per ton of pulp solids up to and including about 6.0 pounds active polymer per ton of solids.

Preferably, treatment levels range between about 0.13 pounds polymer per ton total solids to about 3.3 pounds per ton. Most preferably, the effective treatment ranges are between about 0.20 pounds per ton to about 2.0 pounds per ton, although each source of newsprint pulp can and does have its own character and the treatment level demand.

EVALUATION OF THE INVENTION

In a Canadian newsprint mill, polyethylene imine was being used as a first pass retention agent. A DADMAC-acrylamide copolymer of this invention was substituted for the polyethylene imine and out-performed it as a retention agent by 30%. Improvements were noted in the areas of drainage, fines retention, filler retention, retention of colloidal pitch, ink, stickies, and other detrimental substances.

The following examples are presented to describe preferred embodiments and utilities of the invention and are not meant to limit the invention unless otherwise stated in the claims appended hereto.

Example 1

Britt Jar Test

The Britt Jar Test was employed to obtain results shown in Table 1 at a commercial papermaking operation. A Britt

CF Dynamic Drainage Jar developed by K. W. Britt of New York State University, was utilized which generally consists of an upper chamber of about 1 liter capacity and a bottom drainage chamber, the chambers being separated by a support screen and a drainage screen. Below the drainage chamber is a downward extending flexible tube equipped with a clamp for closure. The upper chamber is provided with a variable speed, high torque motor equipped with a 2-inch 3-bladed propeller to create controlled shear conditions in the upper chamber. The test was conducted by placing 500 ml of the cellulosic stock from the headbox in the upper chamber and then subjecting the stock to the following sequence:

Time	Action
0 seconds	Commence shear stirring at 800 rpm.
5 seconds	Add the cationic polymer.
10 seconds	Add the bentonite.
15 seconds	Open the tube clamp to commence drainage, and continue drainage until 105 ml liquid is obtained.

The material so drained from the Britt jar (the "filtrate") is collected and diluted with water to one-third of its initial volume. The turbidity of such diluted filtrate, measured in Nephelometric Turbidity Units or NTUs, may subsequently be determined. The turbidity of such a filtrate is inversely proportional to the papermaking retention performance; the lower the turbidity value, the higher is the retention of filler and/or fines.

Another method for evaluating pitch, ink, and stickies particle deposition using a Britt Jar technique is a microscopic pitch counting procedure. The headbox sample of pulp slurry was treated in the Britt jar and a sample of effluent was collected under dynamic conditions. To measure retention of such particles, the microscopic counting of the particles was done on a hamacytometer. Pitch retention was expressed as the percentage reduction of pitch particles as compared with the headbox sample. The efficiency of pitch removal is calculated according to the following equation:

$$\text{Pitch Removal Efficiency (\%)} = [(\text{COUNT Blank} - \text{COUNT treated}) / \text{COUNT blank}] \times 100$$

For comparison purposes, a blank experiment may be run. A 500 ml sample from the headbox is stirred for 15 seconds and then drained as above.

Table 1 indicates that the combination of polymer and bentonite decreases pitch deposits more efficiently than polymer or bentonite alone, as indicated by the decreased count number.

TABLE 1

Results for Thermochemical Pulp Samples								
treatment	dosage (kg/ton)	count 1	count 2	avg count	stnd dev	pitch conc. (million/mL)	% retention	% improv
blank		80	61	71	13.4	62.0	18	0
polymer ¹	0.5 ²	60	54	57	4.2	50.2	33	19
polymer ¹	1 ²	53	49	51	2.8	44.9	40	28
bentonite	1	75	70	73	3.5	63.8	15	-3
bentonite	3	66	62	64	2.8	56.3	25	9
betonite/-polymer ¹	1/1 ²	36	38	37	1.4	32.6	57	48
betonite/-polymer ¹	3/1 ²	32	30	31	1.4	27.3	64	56

¹ polymer = 50/50 mole ratio copolymer of diallyldimethyl ammonium chloride and acrylamide.

² dosage based on 40% actives solution

Example 2

The results of Table 2 were obtained by use of the procedure described in Example 1. Here also, lower deposit counts for the combination of polymer and bentonite indicate superior performance over treatment with individual components.

TABLE 2

Results for Deinked Pulp Samples								
Treatment	Dosage (kg/ton)	Count 1	Count 2	avg count	std dev	pitch conc. (million/mL)	% retention	% improv
blank		41	53	47	8.5	41.4	8	0
polymer ¹	1 ²	20	17	19	2.1	16.3	64	61
bentonite	3	23	28	26	3.5	22.4	50	46
bentonite	0.1	40	34	37	4.2	32.6	27	21
bentonite/-polymer ¹	3/1 ²	9	12	11	2.1	9.2	79	78
bentonite/-polymer ¹	0.1/1 ²	10	8	9	1.4	7.9	82	81

¹ polymer = 50/50 mole ratio copolymer of diallyldimethyl ammonium chloride and acrylamide.

² dosage based on 40% actives solution

Example 3

The results of Table 3 were obtained by use of the procedure described in Example 1. The combined treatment showed enhanced performance over polymer or bentonite applied singly.

TABLE 3

Results for 50/50 Mix of Deinked/Thermochemical Pulp Samples							
Treatment	Dosage (kg/ton)	Count 1	Count 2	avg count	std dev	pitch conc. (million/mL)	% improv
blank		77	73	75	2.8	66.0	0
polymer ¹	1 ²	38	39	39	0.7	33.9	49
bentonite	3	43	41	42	1.4	37.0	44
bentonite	0.1	38	35	37	2.1	32.1	51
bentonite/polymer ¹	3/1 ²	35	27	31	5.7	27.3	59
bentonite/polymer ¹	0.1/1 ²	30	27	29	2.1	25.1	62

¹ polymer = 50/50 mole ratio copolymer of diallyldimethyl ammonium chloride and acrylamide.

² dosage based on 40% actives solution

Example 4

To test the amount of pitch, ink, and stickies particle deposition in papermaking systems treated with the compositions of the instant invention, a coupon test was employed. A 500 ml sample of dry lap kraft pulp from the mill is obtained. 100 ml of a 1% synthetic pitch solution in isopropanol is added to the pulp sample. The sample is stirred with a spatula and the pH is adjusted to 6.2 - 6.3 with concentrated HCl. The pulp mixture is then stirred in a blender. 5ml of

an 0.5 M $\text{CaCl}_2 \cdot 2 \text{H}_2\text{O}$ solution is added to the stirring pulp mixture. Treating agents to be evaluated are added next. A pre-weighed Teflon coupon is suspended in the stirring pulp mixture. After a predetermined length of time, the coupon is removed and rinsed with water. The coupon is oven dried, and subsequently weighed to determine the amount of deposition. A decrease in percent deposition above the value obtained for the blank experiment indicates that the treatment inhibits deposition.

Table 4 indicates that the combination of copolymer and talc or copolymer and bentonite can effectively reduce pitch, ink, and stickies particle deposition.

TABLE 4

treatment	dosage (kg/ton)	total wt.	coupon wt	deposit wt.	% deposition	% improv
blank		46.3786	45.9784	0.4002	40	
polymer ¹	1 ²	44.9370	44.7200	0.2170	22	46
polymer ¹	1 ²	45.1785	45.0807	0.0978	16	76
bentonite	3	45.6149	45.2875	0.3274	33	18
bentonite/polymer ¹	1 ²	45.3268	45.3099	0.0169	2	96
talc	10	46.3536	45.8809	0.4727	47	-18
talc/polymer ¹	10/1 ²	46.3352	46.2445	0.0907	9	77

¹ polymer = 50/50 mole ratio copolymer of diallyldimethyl ammonium chloride and acrylamide.

² dosage based on 40% actives solution

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 method for minimizing pitch, ink, and stickies particle deposits in papermaking process by causing the retention of such particles onto fiber, comprising the steps of:

(a) adding a water soluble diallyldimethyl ammonium chloride-acrylamide copolymer to a suspension of fiber in a contact with the paper machine and associated parts; and

(b) adding bentonite having a high swelling capacity in water or of talc to the suspension in a contact with the paper machine or associated parts, thereby to increase retention of pitch, ink and stickies onto the fiber and minimize the deposition of pitch, ink and stickies particles on the paper machine and associated parts.

2. A method according to claim 1 wherein the mole weight ratio of the diallyldimethyl ammonium chloride to acrylamide in the copolymer is from about 99:1 to about 1:99 and the molecular weight range of the diallyldimethyl ammonium chloride-acrylamide copolymer is from about 10,000 to about 15,000,000.

3. A method according to claim 1 or claim 2 wherein the bentonite or talc and the diallyldimethyl ammonium chloride-acrylamide copolymer are added simultaneously to the papermaking process or suspension in contact with the paper machine and associated parts.

4. A method according to claim 1, claim 2 or claim 3 wherein ratio of the bentonite or talc to diallyldimethyl ammonium chloride-acrylamide copolymer is from about 0.01 to about 50.

5. A method according to any one of the preceding claims wherein from about 0.03 to about 1.5 kg of the diallyldimethyl ammonium chloride-acrylamide copolymer per ton of fiber in suspension is added to the suspension in contact with the paper machine and associated parts.

6. A method according to any one of the preceding claims wherein from about 0.05 to about 10 kg of the bentonite or talc per ton of fiber in suspension is added to the suspension in a contact with the paper machine and associated parts.

7. A method according to any one of the preceding claims wherein the mole ratio of diallyldimethyl ammonium chloride to acrylamide is from about 4:1 to about 1:4 and the molecular weight range of the copolymer is from about 20,000 to about 3,000,000.

5 8. A method according to claim 7 wherein the mole ratio of diallylmethyl ammonium chloride to acrylamide is from about 2:1 to about 1:2 and the molecular weight range of the copolymer is from about 75,000 to about 2,000,000.

9. A method according to any one of the preceding claims in which the bentonite is used.

10 10. A method according to any one of the preceding claims in which the talc is used.

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