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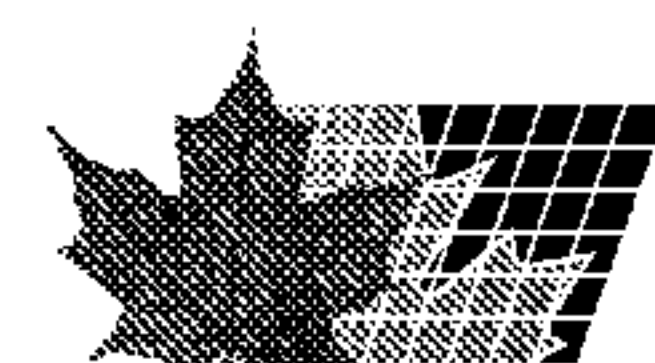
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(54) Title: TREATMENT OF CELLULOSIC MATERIAL AND COMPOSITIONS FOR USE IN THIS

(57) **Abrégé/Abstract:**

A process of de-inking waste paper can be operated under conditions using a simple combination of chemicals to result in a waste liquor that is substantially environmentally friendly. The process comprises forming a pulp from the waste paper in an aqueous medium that has a pH of between 6 and 9 and that is substantially free of dissolved phosphate and that includes an ink-dispersing amount of dispersing agent, and separating the ink from the pulp.





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(54) Title: TREATMENT OF CELLULOSIC MATERIAL AND COMPOSITIONS FOR USE IN THIS (57) Abstract A process of de-inking waste paper can be operated under conditions using a simple combination of chemicals to result in a waste liquor that is substantially environmentally friendly. The process comprises forming a pulp from the waste paper in an aqueous medium that has a pH of between 6 and 9 and that is substantially free of dissolved phosphate and that includes an ink-dispersing amount of dispersing agent, and separating the ink from the pulp.		

**Treatment of Cellulosic Material and
Compositions for use in this**

5 This invention relates to the de-inking of waste paper. In this specification we use the term "paper" to be generic to cellulosic sheet materials including filled and unfilled papers and paper board.

10 It is standard practice to reclaim waste paper to allow the reclaimed paper fibres to be used as part or all of the stock of subsequent paper production. The waste paper needs to be de-inked and it is standard practice to achieve this by forming a pulp from the waste paper in an aqueous medium that includes de-inking chemicals, and separating the ink from the pulp. This separation may be
15 by, for instance, washing and/or flotation.

Typical chemical processes for de-inking are described in U.S. 1,925,372, 2,525,594, 4,347,099 and 4,780,179, WO90/10749 and FR 2,281,456. As is apparent from these publications, typical de-inking chemicals have comprised a
20 complex mixture of chemicals. Generally they include a significant amount of alkaline material, with sodium silicate, hydroxide and carbonate frequently being proposed.

The literature shows that the pH of the resultant pulp
25 during the de-inking process is usually high, for instance above 9 and most usually above 10. Exposing the cellulosic fibres to this degree of alkalinity tends to cause yellowing of the fibres and so it is generally necessary to add a peroxide as a bleaching agent.

30 It is also known to include various other additives. For instance in U.S. 4,347,099 it is proposed to use a mixture of sodium hydroxide, hydrogen peroxide, a carboxylic polymer (usually polyacrylic acid or, preferably, poly hydroxy acrylic acid), dispersants such as
35 anionic, cationic or non-ionic surface active agents, and other additives such as collectors, foaming agents, alkali silicates and pH regulators. The use of this complex and

highly alkaline mixture is undesirable since the liquor that results from the de-inking process results in environmental disposal problems.

A simpler composition is described in WO90/10749 and
5 has been commercialized under the trade-mark Ennesco D and apparently consists solely of a mixture of sodium carbonate and sodium phosphate, optionally with hydrogen peroxide. The use of this can reduce some environmental problems but it introduces others, since the presence of large amounts
10 of dissolved phosphate in the de-inking liquor is environmentally undesirable.

It would therefore be desirable to be able to provide a de-inking process that could be operated under conditions that used a simple combination of chemicals that resulted
15 in a waste liquor the disposal of which created less environmental problems than the disposal of the highly alkaline and/or phosphate-containing liquors that result from the known processes.

A process according to the invention of de-inking
20 waste paper comprises forming a pulp from the waste paper in an aqueous medium that has a pH of between 6 and 9 and that is free of dissolved phosphate and that includes an ink-dispersing amount of a dispersing agent, and separating the ink from the pulp wherein the dispersing agent
25 comprises material selected from polymers of ethylenically unsaturated monomeric material comprising ethylenically unsaturated carboxylic acid salt and has molecular weight in the range 1,000 to 100,000.

The pH of the aqueous medium during the de-inking
30 process must be sufficiently high to assist release of the ink from the cellulosic fibres, and for this purpose it needs to be nearly neutral or slightly alkaline. Accordingly the pH must be at least 6, and often at least 6.5. For best results it is generally at least 7.0. The
35 pH must not be too high as otherwise it will cause yellowing of the fibres and so must be below 9. Generally

it is below 8.5 and frequently satisfactory results can be achieved at values up to about 8.

The desired pH may follow inevitably from the use of the chosen paper and dispersing agent. For instance if
5 the paper is substantially neutral or slightly alkaline (when dispersed in water) the desired pH may be achieved merely by dispersing the paper in water in the presence of the desired polymeric dispersing agent, especially when that is introduced as an alkali salt. Often, however, it
10 is desirable to make a deliberate addition of an alkali material and any environmentally acceptable, water soluble, alkali material can be used for this purpose, for instance sodium hydroxide or sodium silicate. Preferably the added alkali material has a buffering capacity so as to tend to
15 hold the pH at a chosen value, and the preferred materials for this purpose are sodium bicarbonate and, especially, sodium carbonate.

The efficiency of the de-inking process, including the efficiency of the initial release of the ink from the
20 fibres, can be significantly influenced by the pH that prevails during the process. Fluctuations in the pH can result in fluctuations in the efficiency of de-inking. The waste paper that is used as the feed for de-inking processes can be of a wide variety of paper types, some of
25 which may tend to be acidic while others tend to be alkaline. The incorporation of a buffer that will hold the pH of the stock at a preselected, substantially constant, pH despite variations in the nature of the paper therefore has the advantage of helping to maintain the de-inking performance at a uniform and satisfactory level.
30

Although the alkalinity is, for economy, generally introduced by the use of sodium salts or other compounds, it is also possible to use the equivalent potassium, ammonium or water soluble amine compounds.

35 The polymeric dispersing agent is preferably an anti-redeposition agent, for instance of the type used in laundry detergent compositions. Suitable anti-

red deposition agents are water soluble polymers formed from ethylenically unsaturated monomeric material comprising ethylenically unsaturated carboxylic or sulphonic groups.

5 The polymeric dispersing agent serves as an effective dispersing agent for the ink without interfering with the subsequent procedures for separating the ink from the fibres and without interfering with the subsequent procedures for collecting the fibres into a paper sheet material. Its molecular weight (measured by gel permeation chromatography) should normally be above 1,000 and generally above 2,000. Generally it is below 50,000.

Best results are generally obtained when the molecular weight is in the range 2,000 to 20,000.

15 If it is desired to provide the de-inking chemicals in solid form, it is convenient for the molecular weight to be sufficiently high to facilitate the formulation of the product as a solid, in which event the molecular weight is generally above 5,000 and frequently in the range 7,000 to 20,000. However when the de-inking chemicals are formulated as a solution the molecular weight can be lower. Best results are often obtained in the range 2,000 to 10,000, often around 2,500 to 6,000.

25 The monomeric material from which the polymeric dispersing agent is formed comprises ethylenically unsaturated carboxylic acid. This can be methacrylic acid, maleic acid, crotonic acid, itaconic acid or any of the other polymerisable carboxylic acids, but preferably it is acrylic acid or a mixture of acrylic (or sometimes methacrylic) acid with maleic acid (frequently including anhydride). The acrylic acid or other carboxylic monomeric material can be polymerised alone or with sulphonic monomer such as 2-acrylamido methyl propane sulphonate (AMPS), vinyl sulphonate or (meth) allyl sulphonate, and/or it can be copolymerised with non-ionic monomer, especially acrylamide. Generally the carboxylic monomer constitutes at least 50% by weight of the monomers and preferably the polymer is formed from

carboxylic monomer alone or a blend consisting of carboxylic and sulphonic monomers. Suitable polymers include polyacrylic acid, copolymers of this with maleic anhydride, and copolymers of acrylic acid with 10-50% by weight AMPS.

The polymer preferably has polydispersity below 2, preferably below 1.8 and most preferably below 1.5, and generally above 1.1, for instance as described in EP 129,329.

Particularly good results are obtained using mixtures of the polymer with another dispersing agent, in particular mixtures of one of the described polymeric dispersing agents, especially polyacrylic acid or a copolymer of acrylic acid with maleic acid (including anhydride) or AMPS, with a polyphosphonate or sequestering agent or CMC or methyl cellulose. The components in such mixtures typically are present in proportions ranging from 1:3 to 3:1 by weight.

Other suitable dispersing materials that can be used with the polymer in the invention, and which are frequently also suitable for use as anti-redeposition aids, include cellulosic derivatives, polyphosphonates, bentonites, and sequestering agents.

Suitable cellulosic derivatives include cellulose ethers, such as methyl cellulose, and carboxy methyl cellulose.

Suitable bentonites include the various swelling clays that are referred to colloquially as bentonites, including true bentonite, Fuller's Earth, hectorite and various swelling montmorillonites, such as activated calcium montmorillonite.

Suitable sequestering agents are amino carboxylic acid sequestering agents, such as ethylene diamine tetra acetic acid and nitrilo tri acetic acid.

Soluble phosphate should not be incorporated deliberately. Impurity amounts may be tolerated but preferably the amount is substantially zero.

The aqueous medium preferably also includes a surfactant, generally a non-ionic surfactant such as an ethoxylated phenol or fatty alcohol. The surfactant is preferably suitable for emulsifying oil into water.

5 Although the incorporation of a surfactant is useful when the final separation of the ink from the pulp is to be by flotation, the incorporation of the surfactant is of particular value when the separation is by washing.

10 When the separation is by flotation, a collector or other conventional flotation aid may be incorporated in conventional manner.

The invention also includes compositions suitable for incorporation in the pulp and comprising the polymeric dispersing agent and other additives that are incorporated, and in particular it comprises compositions comprising the polymeric dispersing agent and an alkaline material, preferably a buffering alkali such as sodium carbonate or sodium bicarbonate. Particularly preferred compositions are solid compositions in which the polymer has a molecular weight above 5,000 (often above 7,000), but below 20,000 or 50,000, and the alkali is sodium bicarbonate or, preferably, sodium carbonate. In general, the materials and molecular weights may be as described above.

25 The proportions of alkaline material and dispersing agent, on a dry weight basis, are generally 1:5 to 5:1 by weight, most preferably 2:1 to 1:2.

The amount of dispersing agent that is required for optimum performance can be selected by routine experimentation and is normally in the range 0.01 to 1% by weight based on the dry weight of the pulp, generally 0.05 to 0.5%. The amount of surfactant generally falls within the same ranges.

35 The de-inking may be conducted in the presence of additional materials but a particular advantage of the invention is that the chemicals used for it can consist essentially only of the dispersing agent, buffering alkali, optional surfactant and optional flotation aids and

collectors. Peroxide can be included if desired, but an advantage of the invention is that it is usually unnecessary. Accordingly the liquor resulting from the de-inking is relatively free of materials that would create environmental problems during disposal.

The de-inking process can be carried out in broadly conventional manner, except for the choice of the de-inking chemicals, as described above. The de-inking chemicals can be included in the aqueous liquor into which the waste paper is initially pulped, or the waste paper can be pulped to form an aqueous pulp into which the de-inking chemicals are then incorporated.

The overall de-inking process generally comprises a series of stages, typically consisting of an initial maceration or pulping stage (preferably conducted under very high shear), a screening stage to remove grit and oversized particles, one or more washing or flotation stages, and a thickening stage to form a clean pulp that can either be used as such or that may be drained to form a dried pulp. Typical de-inking processes are described in more detail in, for instance, Handbook for Pulp and Paper Technologists by G.A.Smook.

To demonstrate the benefit of the invention, the following experiment was conducted. The experiment was designed for use in the laboratory to give a good indication of the results that may be obtained in practice in a washing de-inking plant comprising the steps of pulping, thickening, washing and re-washing, in that order.

1. Mixture of 70% newsprint and 30% magazine was pulped with the specified de-inking chemicals included, at 3½% consistency for 20 minutes in a standard laboratory pulp disintegrator at 45°C.

2. For the blank test a sample of an equivalent pulped stock was provided, but having had no de-inking chemicals added to it, and was formed into a pad for brightness measurement = PAD A.

3. 1000 mls of the pulped stock was thickened to 10% consistency (to a weight of 300g) over a 710 micron stainless steel sieve.

4. For all tests, a portion of this thickened stock was
5 formed into a brightness pad for brightness measurement = PAD B.

5. 200g of the thickened pulp was diluted to 2000 mls using fresh water - consistency of 1%.

6. The diluted stock was thickened over a 710 micron
10 stainless steel sieve to a weight of 200g.

7. Stages 5 and 6 were repeated using fresh water.

8. A portion of the final washed stock was formed into a brightness pad for brightness measurement = PAD C.

15 The brightness of pads A, B and C were determined using a Technibrite reflectance spectrophotometer set to measure at 457nm.

The brightness of pad A was 41.4.

When no de-inking chemicals were included, the brightness values on pads B and C were 43.1 and 43.9
20 respectively.

In the following all % values represent % by weight of dry chemicals based on the dry weight of the pulp.

When the de-inking chemicals were a mixture providing 0.15% sodium carbonate, 0.15% sodium polyacrylic acid of
25 molecular weight in the range 2,500 to 10,000, and 0.25% nonyl phenol ethoxylate, the brightness values were 48.9 and 50.3 respectively.

When 0.3% solid sodium polyacrylic acid of molecular weight in the range 2,500 to 10,000 was added the
30 brightness values were 45.8 and 49.6 respectively.

When 0.3% liquid sodium polyacrylic acid of molecular weight 2,500 to 6,000 was added the brightness values were 44.6 and 48.1 respectively.

When the chemicals added at the de-inking stage
35 consisted of 0.3% ethylene diamine tetracarboxylic acid (sodium salt) the values on pads B and C were 45.1 and 45.2 respectively.

When a mixture of 0.15% of this compound with 0.15% of a copolymer of acrylic acid and AMPS was used, similar values were obtained.

5 When carboxyl methyl cellulose was used (as sodium salt) values of 44.7 and 48 respectively were obtained.

When 0.3% of the sodium salt of a polyphosphonate was used, values of 45.1 and 47.5 respectively were obtained, and slightly higher values were obtained when 0.15% of the same polyphosphonate was used with 0.15% sodium carbonate.

10 When 0.3% sodium activated calcium montmorillonite was used, values of 43.9 and 47.4 respectively were obtained.

The results illustrate that an improvement in brightness can be achieved on both pads B and C by inclusion of the specified de-inking chemicals. However,
15 it is acceptable to achieve an improvement on pad C only, and not pad B, since the presence of a greater amount of free water in pad C tends to be more conducive to ink removal.

CLAIMS

1. A process of de-inking waste paper, the process comprising forming a pulp from the waste paper in an aqueous medium that has a pH of between 6 and 9 and that is free of dissolved phosphate and separating the ink from the pulp, wherein the aqueous medium further comprises an ink dispersing amount of a dispersing agent which comprises a polymer formed from ethylenically unsaturated monomeric material comprising ethylenically unsaturated carboxylic acid salt and has a molecular weight in the range 1,000 to 100,000.

2. A process according to claim 1 wherein the polymer has a molecular weight in the range 2,000 to 20,000.

3. A process according to claim 1 or 2 wherein the polymer is an acrylic acid homopolymer or a copolymer of acrylic acid with maleic acid or 2-acrylamido methyl propane sulphonate.

4. A process according to claim 3 wherein the polymer is a homopolymer of acrylic acid and has a molecular weight in the range 2,500 to 6,000.

5. A process according to any one of claims 1 to 4 wherein the dispersing agent comprises a mixture of the polymer with a further dispersing agent which is a polyphosphonate, a sequestering agent, carboxymethylcellulose or methylcellulose, wherein a proportion of polymer: further dispersing agent is 1:3 to 3:1 by weight.

6. A process according to any one of claims 1 to 5 wherein the pH of the aqueous medium is in the range 6.5 to 8.

7. A process according to any one of claims 1 to 6 wherein a buffer is added to the aqueous medium to maintain the pH at a chosen value.

8. A process according to claim 7 wherein the buffer comprises sodium bicarbonate or sodium carbonate.

9. A process according to claim 7 or 8 wherein the proportions of buffer and dispersing agent, on a dry weight basis, are in the range 1:5 to 5:1 by weight.

10. A process according to any one of claims 1 to 9 wherein the amount of polymeric dispersing agent is in the range 0.01 to 1% by weight based on the dry weight of the pulp.

11. A composition for de-inking waste paper and that is suitable for incorporation in pulp that is to be de-inked and which is selected from solid compositions and solutions and which comprises a polymeric dispersing agent formed from ethylenically unsaturated monomer comprising ethylenically unsaturated carboxylic acid salt, and an alkaline buffer to maintain the pulp that is being deinked at a pH of between 6 and 9, and wherein the composition is free of soluble phosphate.

12. A composition according to claim 11 wherein the alkaline buffer comprises sodium bicarbonate or sodium carbonate.

13. A composition according to claim 11 or 12 wherein the proportions of alkaline buffer and dispersing agent, on a dry weight basis, are in the range 1:5 to 5:1 by weight.

14. A composition according to claim 11, 12 or 13 in which the polymeric dispersing agent has molecular weight in the range 2,000 to 20,000 and is an acrylic acid homopolymer or a copolymer of acrylic acid with maleic acid or 2-acrylamido methyl propane sulphonate.

15. A composition according to any one of claims 11 to 14 comprising a further dispersing agent which is a polyphosphonate, a sequestering agent, carboxymethylcellulose or methyl cellulose in a proportion of polymer: further dispersing agent of from 1:3 to 3:1 by weight.

16. A composition according to claim 15 further comprising a surfactant.

17. A process according to any one of claims 1 to 10 in which a composition according to any one of claims 11 to 16 has been incorporated into the aqueous medium.

18. A process according to any one of claims 1 to 10 and 17 conducted without the inclusion of peroxide.