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(54) Paper mill wire and felt cleaning.

(57) A composition and method for cleaning papermill wire and felt are disclosed which use surprisingly effective combinations of organic cleaning components, such as N-methyl-2-pyrrolidone and γ-bromofluoran (and certain of their structurally related compounds) with an alkali, such as sodium metasilicate and sodium hydroxide (and other alkali metal hydroxides), in both water and an organic cosolvent such as isopropanol, acetone, and 2-butoxyethanol (and other glycol ethers).

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WIRE AND FELT CLEANING

This invention relates to providing clean wires and felts for paper production and, more particularly, to chemical treatment for controlling deposits on papermill wire and felt.

BACKGROUND OF THE INVENTION

The manufacture of paper typically involves the processing of a carefully prepared aqueous fiber suspension to produce a highly uniform dry paper sheet. Three steps included in the typical process are sheet forming, where the suspension is directed over a porous mesh or "wire" upon which fibers are deposited while liquid filters through the wire; sheet pressing, where the formed sheet is passed through presses covered with porous "felt" to extract retained water from the sheet, to improve the sheet's uniformity, and to impart surface quality to sheet; and paper drying, where residual water is evaporated from the sheet. The sheet may then be further processed into the finished paper product.

It is well known that evaporation of water is energy intensive and thus relatively expensive. Consequently, efficient papermaking is dependent upon extracting water during the forming and pressing operations, and avoiding sheet defects which render the dried sheet unfit for use. Wires and felts are thus particularly important because they affect not only water removal but, because of their intimate contact with the sheet, the quality of the sheet itself. Soils allowed to collect on the wire and felt can affect their water removal efficiency and can be transferred to the sheet material to create defects.

The quality of the aqueous fiber suspension used to produce sheet is dependent upon many factors, including the wood and water used as raw materials, the composition of any recycled material added to the process, and the additives used during preparation of the suspension. Thus a variety of dissolved or suspended materials can be introduced into the manufacturing process, including both inorganic materials such as salts and silts, and materials which are organic in nature such as resins or "pitch" from the wood, and inks, latex, and adhesives from recycled paper products. A build up of "soil" containing inorganic and/or organic materials on wires and felts during the manufacturing process is recognized as a troublesome obstacle to efficient papermaking.

Methods of quickly and effectively removing deposits from the papermill wire and felt are of great importance to the industry. The paper machines could be shut down for cleaning, but ceasing operation for cleaning is undesireable because of the consequential loss of productivity. On-line cleaning is thus greatly preferred where it can be effectively practiced. It is common for a wire used in sheet forming to cycle continuously during production as a belt. The sheet-contact portion of the cycle begins where application of the fiber suspension to the wire belt is started and continues until the formed sheet is separated from the wire surface; and the return portion of the cycle returns the wire from the position where the formed sheet has been removed from its surface to the beginning of the sheet-contact portion. On-line wire cleaning has generally been performed during the return stage (i.e. where the wire is not in contact with the forming sheet) by treating the returning wire with a cleaning liquid (typically water); often by showering the wire with liquid under pressure. The showers can be assisted by mechanical surface cleaning. Use of water showers, with or without mechanical assistance, has not proved entirely satisfactory in preventing a build-up of either organic or inorganic metals from the wires, and additional materials have been used to provide cleaning liquids which are more effective. Inorganic materials have best been removed using water-based formulations containing either acids or alkalis together with other chemicals such as surfactants. The organic deposits have normally been removed using organic solvents including some formulations containing aromatic compounds with low flash points or chlorinated hydrocarbons.

Papermill felts also commonly circulate continuously in belt-like fashion between a sheet contact stage and a return stage.

A clean felt is essential for effective paper manufacture since this allows efficient removal of water from the paper sheet. The cleaning procedure should remove both organic and inorganic soils of both a general and localised nature, maintain felt porosity, and condition the fabric nap without chemcal or physical attack on the substrate. Mechanical removal, typically by blade contact, has been used to remove debris from the felt surface. However, cleaning liquids are also utilized to remove troublesome build-up of organic and inorganic deposits. The fabric composition and conformation of many papermill felts makes them susceptible to chemical degradation. The chemicals should be easily removed by rinsing. Both continuous and shock cleaning is used in most papermills. The chemicals used include organic solvents, often chlorinated hydrocarbons. Acid and alkali based systems are also used, but at lower concentrations than used in wire

cleaning. High concentrations of alkali metal hydroxides are often unsuitable for felt cleaning as they "attack" the fabric material.

Certain organic wire and felt cleaners which were used frequently in the past have become environmentally undesireable. Thus, greater need has developed for wire and felt cleaners which remove organic deposits without presenting an environmental hazard. Naturally, formulations used should not be destructive of the wire and felts. One material identified as suitable for this purpose is N-methyl-2-pyrrolidone. While this material might perform satisfactorily under some conditions, there is a continuing need for more effective wire and felt cleaners. The cost of N-methyl-2-pyrrolidone also discourages its use alone as a wire and felt cleaner. Moreover, there is a particular need for wire and felt cleaners which remove inorganic as well as organic deposits.

SUMMARY OF THE INVENTION

We have found that combining at least one of the organic cleaning components selected from N-methyl-2-pyrrolidone, γ-butyrolactone, and certain of their structurally related compounds with an alkali in both water and an organic cosolvent capable of providing a stable solution at high alkalinities is surprisingly effective in removing both organic and inorganic deposits from papermill wires and felts.

An object of this invention is to provide a stable papermill wire and felt cleaner which can effectively remove soil materials which have deposited on wire and felt.

A further object of this invention is to provide a wire and felt cleaning product which can be used to remove both organic and inorganic deposits.

Another object of this invention is to provide papermill felt cleaning which is relatively non-aggressive toward felt fabric.

Still another object of this invention is to provide papermill wire and felt cleaning which has improved effectiveness.

Yet another object of this invention is to provide papermill wire and felt cleaning in a manner which is environmentally acceptable.

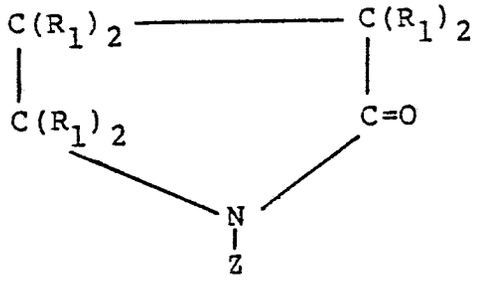
These and other objects and advantages of the present invention will become apparent from the following detailed description of the invention.

DETAILED DESCRIPTION

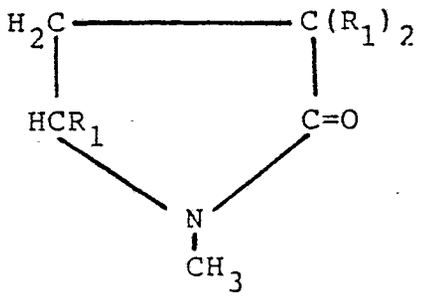
The present invention is directed to certain combinations of organic cleaning components with alkali materials which provide surprisingly effective removal of both organic and inorganic deposits from papermill wires and felts. The alkali materials of this invention can be any of the alkali materials suitable for use in aqueous solution to remove inorganic deposits from papermill wires and felts. These materials are believed to function by hydrolysing and solubilizing the inorganic deposits and include alkali metalhydroxides (most notably sodium hydroxide and potassium hydroxide) and alkali metal metasilicates, especially sodium metasilicate. The alkali metal hydroxides are preferred, with sodium hydroxide being the most preferred from an economic and effectiveness standpoint. The concentrations of these alkali materials needed to rapidly remove inorganic deposits can be detrimental to certain materials on which the deposits adhere, and the effectiveness of alkali when used alone is limited, particularly where organic deposits are present.

The preferred combinations of this invention include as the organic cleaning component N-methyl-2-pyrrolidone or structurally related compounds, having the general formula:

FORMULA A

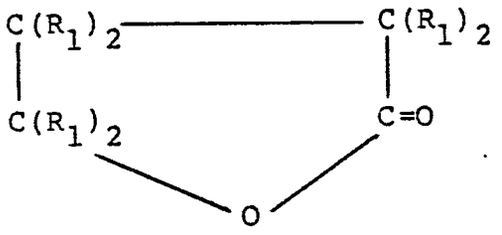


, especially the formula:



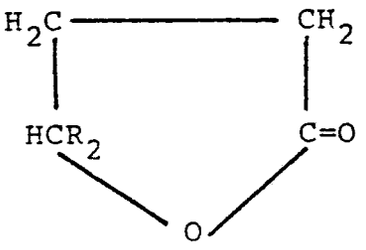
wherein each R_1 is independently selected from the group consisting of hydrogen, methyl or ethyl and Z is methyl or ethyl. These compounds will be referred to herein as "Formula A" compounds. Most preferred is N-methyl-2-pyrrolidone itself (i.e., each R_1 is hydrogen). N-methyl-2-pyrrolidone is a known component of various cleaning formulations for ovens, cookware, ceramic material, and has also been used in paint remover compositions. It has been suggested for use as a papermill wire and felt cleaner, and its relatively low toxicity makes it an acceptable material from an environmental standpoint.

The organic cleaning component of this invention may advantageously comprise γ-butyrolactone or structurally related compounds having the general structural formula:



FORMULA B

, especially the formula:



wherein R_2 is hydrogen or methyl and R_1 is as defined above. These compounds will be referred to herein as "Formula B" compounds. Preferably, R_2 is hydrogen (i.e., a preferred organic cleaning component is γ-bromofluoran). γ-bromofluoran has been used as a solvent for resins, as a paint remover, and the like. Its

effectiveness when used alone as a wire and felt cleaner is, however, limited.

We have found that by using certain organic cosolvents as well as water, the alkali materials described above can be combined with an organic cleaning component selected from the group consisting of Formula A compounds and Formula B compounds to provide stable and effective wire and felt cleaners. The preferred organic cleaning compounds of this invention are selected from the group consisting of N-methyl-2-pyrrolidone and γ-bromofluoran. Not only can organic and inorganic deposits be removed simultaneously, but their removal is accomplished at surprisingly low dosages. Thus, a particularly advantageous process is also provided for producing clean papermill wires and felts from soiled wires and felts.

Suitable organic cosolvents must be capable of providing stable aqueous solutions of Formula A compounds and/or Formula B compounds at high alkalinities. That is, the organic cosolvent must provide increased effectiveness at levels where there is no phase separation into generally organic and aqueous phases. The organic cosolvents which can be used in accordance with this invention to provide the improved effectiveness without causing phase separation include glycol ethers, isopropanol, and acetone. However, many of the cosolvents capable of providing product stability also have properties which are environmentally undesireable (eg. relatively low flash points), and thus should be avoided in many circumstances where exposure or release are of concern. Preferred organic cosolvents thus include glycol ethers having the general formula:

$$C_nH_{2n+1}O\,[CH_2CH_2CH_2O]_m\,[CH_2CH_2O]_k\,H$$

in which n is an integer from 1 to 4, m is an integer from zero to two, k is an integer from zero to two, and m plus k is at least one. A particularly preferred glycol ether is 2-butoxyethanol (i.e., n is 4, m is zero, and k is 1).

It is possible to apply the alkali material, the organic cleaning component, and the cosolvents of this invention separately during cleaning of a papermill wire or felt so that they mix during the cleaning process. When this is done, the weight ratio of applied components should be regulated so that a single phase cleaning system is provided during cleaning, and the surprisingly effective treatment of this invention is attained. Generally, the weight ratio of alkali to organic cosolvent is kept between about 1:80 and about 14:1; and where a Formula A compound is the organic cleaning component, its ratio to the organic cosolvent is kept between about 100:1 and about 1:40. Where a Formula B compound is the organic cleaning component rather than a Formula A compound, its ratio to the organic cosolvent is generally kept between about 40:1 and about 1:40. The amount of water present should be at least equal to the amount of organic cosolvent. It is generally more convenient, however, to provide the components together in the form of a composition.

Effective compositions formulated in accordance with this invention include those containing between about 0.5 and about 50 weight percent of Formula A compound, preferably N-methyl-2-pyrrolidone, between about 0.5 and about 20 weight percent organic cosolvent, between about 0.25 and about 7.0 weight percent alkali material, and between about 30.0 and about 98.8 weight percent water. Other effective compositions advantageously formulated in accordance with this invention contain between about 0.5 and about 20 weight percent Formula B compound, preferably γ-bromofluoran, between about 0.5 and about 20 weight percent organic cosolvent, between about 0.25 and about 7.0 weight percent alkali material, and between about 60.0 and about 98.8 percent water.

The preferred ranges are from about 5 to about 12 weight percent of an organic cleaning component selected from the group consisting of Formula A compounds and Formula B compounds; from about 2.5 to about 12.5 weight percent of organic cosolvent; from about 2.0 to about 5.5 weight percent of alkali; and from about 60.0 to about 88.0 weight percent water; particularly where the organic cleaning component is selected from the group consisting of N-methyl-2-pyrrolidone and γ-bromofluoran. The most preferred ranges are from about 7.5 to about 10.5 weight percent of said organic cleaning component; from about 7.5 to about 10.5 weight percent of organic cosolvent; from about 2.5 to about 5.0 weight percent of alkali; and from about 67.0 to about 82.5 weight percent water; particularly where 2-butoxyethanol and sodium hydroxide are used as the organic cosolvent and alkali material, respectively and the organic cleaning component is selected from the group consisting of N-methyl-2-pyrrolidone and γ-bromofluoran.

Other agents can optionally be added to the wire and felt treatment products, including corrosion inhibitors to protect metal substrates, thickening agents to increase contact times between the composition and the wire or felt, and surfactants such as amine oxides to improve the wetting of the wire or felt surface. Suitable corrosion inhibitors for use in this manner include alkanolamine salts of aryl sulphonamide carboxylic acids, such as the product Hostacor KS1-X available commercially from Hoechst. Preferred surfactants for use in this manner include n-alkyl ethoxy dimethylamine oxides where the alkyl has between about 12 and about 18 carbons, such as the product Empigen OY (25% active) available commercially from Albright and Wilson; and lauryl myristyl. dimethylamine oxides. such as the product Empigen OB (30%

active) commercially available from Albright and Wilson.

The treatment dosage depends on the nature of the soil material, and whether cleaning is continuous or periodic. The compositions may be employed at full strength (100%), for example by spraying the composition directly onto the felt and/or wires, especially where shock cleaning for rapid removal of build up deposits is necessary. However, particularly where continuous cleaning is practiced, the compositions may be advantageously diluted prior to treatment with water or other suitable liquid, such as the aqueous liquid of the papermaking process itself. The advantages of this invention are realized at dosages as low as 0.01 weight percent of a composition described above, based upon the amount of total liquid used to clean the wire or felt. "Continuous cleaning" as used herein means that the wire or felt is routinely treated at least once during the cycle between its sheet contact stage and its return stage. This routine treatment can advantageously occur during the period when the wire and felt is not in contact with sheet material (i.e. the return stage). The deposited material is then typically washed away with the draining treatment liquid. However, it is contemplated that addition of the composition to the papermill process water itself can also be practiced in accordance with this invention; and that continuous cleaning during the sheet contact portion can be effective. Cleaning during sheet contact provides inhibition of soil build-up and therefore functions in a preventive capacity rather than merely in a removal capacity. Continuous cleaning during sheet contact is especially appropriate for wire cleaning where the inorganic and organic materials can be washed through the wire with the filtered process water, and thus can be transported away from both the wire and the sheet without affecting the sheet-forming process.

In any case, the concentration of organic cleaning component in the liquid contacting the wire or felt should be at least about 5 ppm, and the free alkalinity of the liquid contacting the wire or felt should be at least about 2 ppm (expressed as the amount of NaOH equivalent to the free hydroxyl ion present). Typically, continuous treatment in accordance with this invention will provide between about 50 ppm and about 500 ppm of organic cleaning component, and between about 20 ppm and about 200 ppm free alkalinity (as NaOH).

Practice of the invention will become further apparent from the following non-limiting examples.

EXAMPLE I

A synthetic polyester-polyamide papermill wire soiled with both inorganic and organic material was soaked in substantially pure N-methyl-2-pyrrolidone for about 30 minutes. The papermill wire was then removed and the amount of soil removed was simply measured by determining the difference in wire weight due to treatment.

A second run was made using substantially pure 2-butoxyethanol instead of N-methyl-2-pyrrolidone, and a third run was made using a 50 percent solution of sodium hydroxide in water as the sole treatment agent.

A fourth run was made using a composition containing 4.3 weight percent sodium hydroxide, 8.8 weight percent 2-butoxyethanol, 5.3 weight percent (active) corrosion inhibitor and surfactants (added as Hostacor KS1-X, Empigen OY, and Empigen OB), and the remainder water; and a fifth run was made using a composition containing the same weight percentages of sodium hydroxide, 2-butoxyethanol, corrosion inhibitor, and surfactants as the fourth run, but also containing 8.8 percent of N-methyl-2-pyrrolidone and the remainder water. The results of these five runs are shown in Table I below.

TABLE I

RUN	WIRE AND FELT CLEANER FORMULATION	PERCENT SOIL REMOVED
1	100% N-methyl-2-pyrrolidone	21%
2	100% 2-butoxyethanol	30%
3	50% Sodium Hydroxide 50% Water	50%
4	4.3% Sodium Hydroxide 8.8% 2-butoxyethanol 81.6% Water 5.3% Corrosion Inhibitor and Surfactants	50%
5	4.3% Sodium Hydroxide 8.8% 2-butoxyethanol 8.8% N-methyl-2-pyrrolidone 72.8% Water 5.3% Corrosion Inhibitor and Surfactants	100%

It is evident from the results shown in Table I that the combination of N-methyl-2-pyrrolidone with the other components of this invention provided unexpectedly superior removal of organic and inorganic deposits from the wire. Moreover, the composition of run 5 was stable, and thus may be shipped, stored, and applied with the convenience of a single phase system.

EXAMPLE II

In a sixth run, papermill wire soiled with both inorganic and organic material was soaked in substantially pure γ-bromofluoran for about 30 minutes. The papermill wire was then removed and the amount of soil removal was measured in accordance with the procedure of Example I. A seventh run was then made by soaking a papermill wire soiled with both inorganic and organic material for 30 minutes in a composition containing 2.5 weight percent sodium hydroxide, 10 weight percent 2-butoxyethanol, 10 weight percent γ-bromofluoran, 5.3 weight percent (active) surfactants and corrosion inhibitor (added as Hostacor KS1-X, Empigen OY, and Empigen OB), and the remainder water. The results of these two runs are shown in Table II below.

TABLE II

RUN	WIRE AND FELT CLEANER FORMULATION	PERCENT SOIL REMOVED
6	100% γ-butyrolactone	19%
7	2.5% Sodium Hydroxide 10% 2-butoxyethanol 10% γ-butyrolactone 5.3% Surfactants and Corrosion Inhibitor 72.2% Water	71%

It is evident from the results of the sixth run that while some soil removal was achieved using γ-

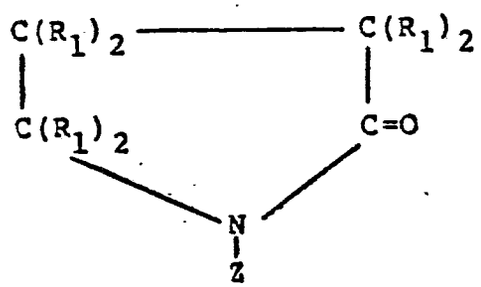
bromofluoran alone, the degree of removal was only roughly comparable to the removal achieved using N-methyl-2-pyrrolidone alone. The results of the seventh run show that the combination of γ-bromofluoran with the other components of this invention provided unexpectedly superior removal of organic and inorganic deposits from the wire. The composition of run 7 was stable and thus could be conveniently handled as a single phase system.

The examples describe various embodiments of the invention. Other embodiments will be apparent to those skilled in the art from a consideration of the specification or practice of the invention disclosed herein. It is understood that modifications and variations may be practiced without departing from the spirit and scope of the novel concepts of this invention. It is further understood that the invention is not confined to the particular formulations and examples herein illustrated, but it embraces such modified forms thereof as come within the scope of the following claims.

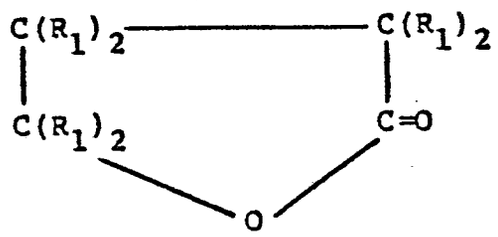
Claims

1. A papermill wire and felt cleaner comprising:

(a) an organic cleaning component selected from the group consisting of compounds represented by Formula A,



and compounds represented by Formula B,



wherein each R_1 is independently selected from hydrogen, methyl, and ethyl, and Z is methyl or ethyl,

(b) an alkali material selected from the group consisting of alkali metal hydroxides and alkali metal metasilicates;

(c) an organic cosolvent selected from the group consisting of glycol ethers, isopropanol, and acetone; and

(d) water;

wherein either the weight percent of compounds represented by Formula A is between about 0.5% and about 50% and the weight percent of water is at least about 30%, or the weight percent of compounds represented by Formula B is between about 0.5% and about 20% and the weight percent of water is at least about 60%; wherein the weight percent of the alkali material is between about 0.25% and about 7.0%; wherein the weight percent of water is about 98.8% or less and wherein the weight percent of the organic cosolvent is an amount between about 0.5% and about 20.0%, at which there is no phase separation.

2. A papermill wire and felt cleaner in accordance with Claim 1 wherein the organic cleaning component is N-methyl pyrrolidone.

3. A papermill wire and felt cleaner in accordance with Claim 1 wherein the organic cleaning component is γ-bromofluoran.

4. A papermill wire and felt cleaner in accordance with any one of the preceding claims containing from about 5 to about 12 weight percent of the organic cleaning component.

5. A papermill wire and felt cleaner in accordance with any one of the preceding claims wherein the alkali material is sodium hydroxide.

6. A papermill wire and felt cleaner in accordance with any one of the preceding claims containing from about 2.0 to about 5.5 weight percent of the alkali material.

7. A papermill wire and felt cleaner in accordance with any one of the preceding claims wherein the organic cosolvent is selected from those having the general formula:

$C_nH_{2n+1}O\,[CH_2CH_2CH_2O]_m\,[CH_2CH_2O]_k\,H$

wherein n is an integer from 1 to 4, m is an integer from 0 to 2, k is an integer from 0 to 2, and m + k totals at least one.

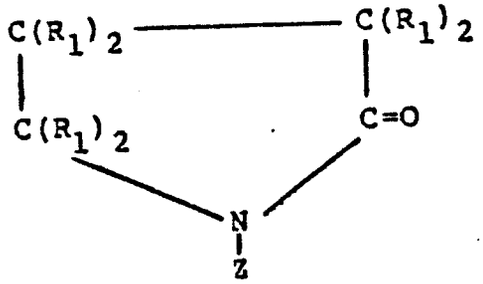
8. A papermill wire and felt cleaner in accordance with any one of the preceding claims wherein the organic cosolvent is 2-butoxyethanol.

9. A papermill wire and felt cleaner in accordance with any one of the preceding claims containing from about 2.5 to about 12.5 weight percent of organic cosolvent.

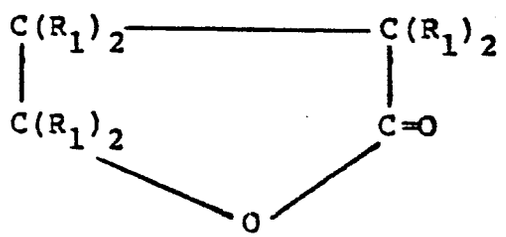
10. A papermill wire and felt cleaner in accordance with any one of the preceding claims further comprising at least one agent selected from the group consisting of corrosion inhibitors, thickening agents, and surfactants.

11. A method of treating papermill wire or felt to remove organic and inorganic deposits therefrom comprising contacting the wire or felt with a liquid mixture including:

(a) an organic cleaning component selected from the group consisting of compounds represented by Formula A.



and compounds represented by Formula B,



wherein each R_1 is independently selected from hydrogen, methyl, and ethyl and Z is methyl or ethyl;

(b) an alkali material selected from the group consisting of alkali metal hydroxides and alkali metal metasilicates;

(c) an organic cosolvent selected from the group consisting of glycol ethers, isopropanol, and acetone; and

(d) water;

said mixture having an organic cleaning component concentration of at least about 5 ppm based upon the total amount of liquid contacting the wire or felt; a free alkalinity of at least about 2 ppm based upon the total amount of liquid contacting the wire or felt; a weight ratio of alkali metal to organic cosolvent between about 1:80 and about 14:1: either a weight ratio of Formula A compounds, to organic solvent between about 100:1 and about 1:40 or a weight ratio of Formula B compounds to organic cosolvent between about 40:1 and about 1:40; and a water content at least as large as the organic cosolvent content.

12. A method according to Claim 11 in which the organic cleaning component is selected from the group consisting of N-methyl-2-pyrrolidone and γ-bromofluoran.

13. A method according to either Claim 11 or Claim 12 in which the concentration of the organic cleaning component in the mixture is between about 50 ppm and about 500 ppm based upon the total amount of liquid contacting the wire or felt; and in which the free alkalinity is between about 20 ppm and 200 ppm based upon the total amount of liquid contacting the wire or felt.

14. A method according to any one of Claims 11 through 13 in which the organic cleaning component, the alkali material and the organic cosolvent are added as a composition of Claims 1 to 10.

15. A method of cleaning papermill wires which cycle between a sheet contact stage and a return stage according to any one of of Claims 11 through 14 wherein the liquid mix is added to the papermill process water so that cleaning is accomplished during the sheet contact portion of the wire cycle.

16. A method according to any one of Claims 11 through 15 wherein the organic cleaning component, the alkali metal, and the organic cosolvent are added as a composition containing between about 5 to about 12 weight percent of the organic cleaning component; from about 2.5 to about 12.5 weight percent of organic cosolvent; from about 2.0 to about 5.5 weight percent alkali material; and from about 60.0 to about 88.0 weight percent water.

17. A method according to any one of Claims 11 through 16 wherein the organic cleaning material is N-methyl-2-pyrrolidone; the organic cosolvent is 2-butoxyethanol; and the alkali material is an alkali metal hydroxide.

18. A method according to any one of Claims 11 through 16 wherein the organic cleaning material is γ-bromofluoran; the organic cosolvent is 2-butoxyethanol; and the alkali material is an alkali metal hydroxide.

European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 87 30 1326

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
A	EP-A-0 021 149 (IBM) * Claims *	1	C 11 D 7/50 C 11 D 7/06 D 21 F 1/32
A	DE-A-3 434 128 (LICENTIA) * Claims *	1	
A	US-A-4 401 748 (I.E. WARD, Jr. et al.) * Claims *	1	

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

C 11 D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	19-10-1987	GOLLER P.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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