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(54) Titre : TISSU POUR MACHINE A PAPIER
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(54) Title: FABRIC FOR PAPER MACHINE

(57) Abstract: A fabric for a paper machine, which fabric is made at least partly of fibrous and/or filamentous structures. A substantial amount of an antimicrobial agent is arranged in the fabric for the paper machine.

FABRIC FOR PAPER MACHINE

BACKGROUND OF THE INVENTION

[0001] The invention relates to a fabric for a paper machine, which fabric is made at least partly of fibrous and/or filamentous structures.

[0002] It is known that fabrics, such as wires and felts, for a paper machine are used in various machines, which produce weblike products from stock, such as paper machines, tissue machines, board machines and the like, which hereinafter will be referred to as a paper machine.

[0003] Currently, fabrics for paper machines are mainly made of polymer materials, but fabrics for paper machines made of metal, such as bronze, are also known. The fabrics are mainly prepared by weaving, needling or using so-called non-woven structures.

[0004] The fabrics for the paper machine have a problem that they attract, in particular, bacteria and fungi, and also viruses, yeasts, moulds, algae and other similar micro-organisms, which get into the process equipment along with the stock, or water or air used in the process. The paper machine provides micro-organisms with a favourable growth environment where suitable and constant humidity and temperature prevail. As a result, said microbe populations grow fast, and slime is formed in the fabrics and also on other surfaces of the paper machine. Slime has an adverse effect on the operation of the fabric, in particular, because water permeability of the fabrics will reduce, for instance. Slime often impedes the operation of other machine parts as well, and may cause corrosion, among other things. Moreover, micro-organisms may generate spots and odour in the manufactured fibre product, decomposition of fibrous raw material and additives or other deterioration. Thus the equipment must be regularly cleaned from micro-organisms, and the fabrics must be replaced, which causes interruptions in production and hence a variety of considerable costs.

[0005] There is a clear trend in paper machine technology to introduce closed systems and to use deinked waste paper pulp as fibrous raw material. As a result, problems caused by micro-organisms have become worse and more common. A known solution to the above-described problems is to add slimicides to process water, which slimicides inhibit, or at least slow down, the growth of micro-organisms. Slime prevention necessitates the use of large amounts of slimicides, which may be harmful as such, or some of the end

products originating therefrom, to the personnel handling them, or which may be environmentally hazardous. For instance, toxic fungal growth has been detected in waste masses from paper factories. Hence, waste masses cannot be destroyed by any other means than by treating them first with processes that cause costs. In addition, adoption of neutral or basic paper making processes has restricted the use of conventional slimicides: on the other hand, said processes provide particularly favourable conditions for the micro-organisms to live and proliferate.

BRIEF DESCRIPTION OF THE INVENTION

[0006] The object of the present invention is to provide a novel and improved fabric for a paper machine, which reduces slime forming on the paper machine.

[0007] The fabric for the paper machine is characterized in that a substantial amount of antimicrobial agent that reduces slime formation on the paper machine is arranged in the fabric for the paper machine.

[0008] By including antimicrobial agent in the fabric for the paper machine it is possible to achieve an advantage that the amount of micro-organisms occurring on the paper machine can be reduced or formation of certain microbe strains can even be prevented completely, whereby blocking of fabrics will be reduced or prevented and their service life will be longer. The use of known slimicides can also be reduced in process waters. Also, there will be less downtime resulting from micro-organisms.

[0009] Advantageously the fabric for the paper machine comprises fibres of polymer material, in which the antimicrobial agent is mixed and from which it gradually diffuses in a controllable manner onto the surface of the fibre, whereby the antimicrobial effect will last throughout the whole service life of said fabric for the paper machine.

DETAILED DESCRIPTION OF THE INVENTION

[0010] Paper machines, such as Fourdrinier machines, combined machines, cylinder vat machines, tissue machines, board machines, twin wire machines and the like, employ fabrics typical to each particular machine type. The fabrics for the paper machine are mainly wet end wires, press felts of the press section, drying wires and felts of the drying section and shoepress belts, i.e. press belts or sections thereof, but other fabrics for the paper machine are also known.

[0011] Fabrics for the paper machine are structures known per se, and they will not be described in greater detail in the present document. It should be mentioned, however, that wires employed at the wet end of the paper machine typically remove water from the stock to the dry solids content of about 20%. Said wires are placed either on one side or on both sides of the web. Depending on the press structure, in the press section of the paper machine there is a press felt on one side or on both sides of the web to be dried, into which felt the water in the stock penetrates in the drying phase. The function of the press felt is to convey the water away after the pressing without allowing it to migrate back to the web. The dry solids content of the web exiting the press section is typically about 35 to 45%. The drying section of the paper machine employs drying wires or drying felts, by means of which the paper web to be dried is conveyed through the drying section. In the drying section the web is dried to be in equilibrium with ambient air humidity.

[0012] The materials and structures of the fabrics for the paper machine vary depending on the function of the fabric and the type of the paper machine. The fabrics are mainly made of a synthetic polymer material or a polymer material mixture, but fabrics for paper machines made of natural polymers or metal, such as bronze, are also known. Materials belonging to said material groups can also be combined in the same fabric for the paper machine. The polymer materials used include, for instance, polyesters, such as polyethyleneterephtalate (PET) and polyethylenenaphtalate (PEN), polyamide (PA), polyphenylenesulphide (PPS), polyaryletherketones, such as polyetheretherketone (PEEK), polydimethylenecyclohexyleneterephtalate (PCTA), but other materials are also known. The material of the fabric for the paper machine is typically in fibrous or filamentous form, but it may also include components made of membrane-like and/or foamed material. The fabrics for paper machines are mainly formed by weaving or needling, in addition to which weftless or non-woven felts are also known. It should also be mentioned that the fabric for the paper machine may comprise one or more layers.

[0013] The fabric for the paper machine according to the invention includes an antimicrobial agent. In this document the antimicrobial agent refers to a compound which inhibits the generation, development and proliferation of one or more micro-organisms or any similar phenomena of microbial life. The action of the antimicrobial agent is based on the idea that it provides the de-

sired effect itself or it produces the desired effect through a physical or chemical reaction.

[0014] The antimicrobial agent or a precursor thereof can be arranged in the material forming the fabric for the paper machine without a carrier, or it can be first arranged in a suitable carrier, such as a coating substance, a polymer matrix, a ceramic matrix or the like, by means of which it is carried into the material forming the fabric. In one preferred embodiment the antimicrobial agent is arranged in a membrane-like or foamed material, which conveys it to the fabric for the paper machine.

[0015] In this document the term micro-organism refers to viruses, bacteria, protozoa, mould fungi and other fungi, yeasts, algae or the like organisms that are undesirable in connection with the paper machine.

[0016] The antimicrobial agent can be arranged in a variety of ways in the fabric for the paper machine. For instance, it is possible to apply the teachings of the article "Textiles Having the Ability to Deliver Reactive Chemical Systems" by R. Broughton, L. Slaten, G. Mills, D. Worley, C. Sunderman, S. Michielsen, Gang Sun, in *National Textile Center Annual Report*, November 2000, C98-A17. In the following, there are set forth some principles, by which the antimicrobial agent can be arranged in the fabric for the paper machine:

[0017] 1. A reactive antimicrobial agent is added to the surface of a reactive fibre or thread, or if the fibre or thread to be treated is non-reactive, reactive areas are first created on the surface thereof using simple chemical reactions, and the antimicrobial agent is added onto the surface of the reactive area. For instance, polyamide 66 can be treated with 2,2,5,5-tetramethylimidazolin-4-one by performing a pre-treatment with a formaldehyde solution. Another example is the activation of an inert polyamide fibre or thread by attaching a catalyst onto the surface thereof, which converts some of the surface of the fibre or thread into a polyacrylic acid. Said areas are crafted with a protoporphyrin IX. The protoporphyrin IX converts ambient oxygen to a microbicidal antimicrobial agent.

[0018] 2. The surface of monomers is activated, for instance, by adding reactive moieties thereto, or by directing strong photochemical or thermochemical energy thereto. Thereafter, the monomers are polymerized or small compounds are simply allowed to react to a polymer. The polymer is treated with the antimicrobial agent that attaches to the activated surface. The obtained polymer is further used in the preparation of the polymer material

needed for the manufacturing of the fibres and threads of the fabric for the paper machine.

[0019] 3. The antimicrobial agent is attached to the surface of the fibre or thread physically with an ionic bond. For instance, halamines, such as a cyclic N-halamine, or precursors thereof can be linked in this manner to the surface of the polymer material. As the halamines come into contact with certain micro-organisms they liberate chlorine that has an antimicrobial effect.

[0020] The N-halamine can be arranged in the fabric for the paper machine such that first its precursor poly-1,3-dichloro-5-methyl-5-(4'-vinylphenyl)hydantoin is attached to the surface of the fabric. Thereafter, the precursor is chlorinated to N-halamine.

[0021] Other similarly attachable compounds include hydantoin, triazine diones, imidazolidinone and pyrimidinone.

[0022] 4. The antimicrobial agent is copolymerized with a polymer into a copolymer. In this manner, the antimicrobial agent is distributed throughout the material made of the copolymer, and therefore it will not wear off from the material and its effect will last throughout the entire service life of the fabric for the paper machine.

[0023] 5. The antimicrobial agent is encapsulated inside a polymer material with a carrier. The carrier may be, for instance, ceramic material containing silver. Silver ions of the ceramic material are gradually diffused from the polymer material. The silver ions are antimicrobial to certain bacteria, among other things, and thus they inhibit the occurrence and growth of such bacteria in the fabric for the paper machine. One example is the product under the trade name Livefresh®, in which silver-containing ceramic particles are mixed in a polymer fibre of polyamide. An advantage of the method is a long-term antimicrobial effect, because the antimicrobial agent is released gradually in the course of a long period of time.

[0024] 6. The antimicrobial agent is mixed with the polymer material such that a substantially homogeneous mixture is formed, and components to be arranged in the fabric for the paper machine are formed of the obtained mixture. For instance, the above-mentioned N-halamines or precursors thereof can be dispersed in the polymer fibre or the polymer forming it. If the dispersion conditions are suitable, chlorination into N-halamine is advantageously performed prior to dispersion, because this allows a larger part of the precursor to be chlorinated. If the process conditions prevent the dispersion of the N-

halamine, its precursor is dispersed and the chlorination is performed after said dispersion. The method has an advantage that the antimicrobial agent is released from the polymer material in the course of a long period of time.

[0025] Other antimicrobial agents to be mixed with the polymer material of the fabric for the paper machine include triclosan and 10,10'-oxybisphenoxarsin (OBPA), which is also known under the trade name Perma-fresh®.

[0026] 7. Absorption of the antimicrobial agent into the material of the fabric for the paper machine using dyeing methods: some antimicrobial agents are very similar to dyes, and therefore they can be attached to the materials that can be dyed using dyeing methods. Examples of these include quaternary ammonium compounds, which have a positive charge, and thus they can be attached to negatively charged areas in the fibres.

[0027] By arranging a substantial amount of antimicrobial agent in the fabric for the paper machine it is possible to inhibit or at least substantially reduce the occurrence of micro-organisms in the fabrics for the paper machine, on other paper machine surfaces and in process fluids. At the same time, it will be possible to reduce the amount of slimicides known per se, or even give up using them completely. The substantial amount of the antimicrobial agent depends on the micro-organisms to be inhibited, the conditions prevailing on the paper machine and the desired level of cleanliness.

[0028] It is apparent to a person skilled in the art that as technology advances the basic idea of the invention can be implemented in a variety of ways. Thus, the invention and its embodiments are not restricted to the above-described examples, but they may vary within the scope of the claims. So, it is possible to use also other antimicrobial agents in the fabrics for the paper machine than those set forth in the above, such as metals and/or metal salts disclosed in the published application EP 0 783 048 A2. The antimicrobial agent may also be an organosilane compound, such as alkoxysilane, which was discussed in US patent 6,120,587, for instance. Also other antibacterial agents known per se or not known yet, but to be developed as technology advances, can be applied to the invention. In the fabric for the paper machine it is possible to use more than one antimicrobial agent: for instance, a combination of the alkoxysilane and the quaternary ammonium compound, such as 3-trimethoxysilylpropyldimethyloctadecylammonium chloride, which is also known under the trade name AEM 5700 Antimicrobial Agent.

CLAIMS

1. A fabric for a paper machine, which fabric is made at least partly of fibrous and/or filamentous structures, **characterized** in that a substantial amount of an antimicrobial agent that reduces slime formation on other paper machine surfaces than on the fabric is arranged in the fabric for the paper machine.

2. A fabric for a paper machine as claimed in claim 1, **characterized** by being a wet end wire.

3. A fabric for a paper machine as claimed in claim 1, **characterized** by being a press wire.

4. A fabric for a paper machine as claimed in claim 1, **characterized** by being a press felt.

5. A fabric for a paper machine as claimed in claim 1, **characterized** by being a drying wire or a drying felt.

6. A fabric for a paper machine as claimed in any one of the preceding claims, **characterized** in that the fibrous and/or filamentous structures comprise polymer material.

7. A fabric for a paper machine as claimed in claim 6, **characterized** in that the antimicrobial agent is mixed with said polymer material.

8. A fabric for a paper machine as claimed in claim 7, **characterized** in that the antimicrobial agent is mixed in the polymer material with a carrier.

9. A fabric for a paper machine as claimed in any one of the preceding claims, **characterized** in that the antimicrobial agent comprises one or more of the following compounds: 2,2,5,5-tetramethylimidazolidin-4-one, halamine, hydantoin, triazine diones, imidazolidinone, pyrimidinone, triclosan, 10,10'-oxybisphenoxarsin (OBPA), a quaternary ammonium compound, an organosilane compound, a 3-trimetoxysilylpropyldimethyloctadecylammonium chloride.

10. A fabric for a paper machine as claimed in any one of the preceding claims, **characterized** in that the antimicrobial agent comprises metal and/or metal salts.

11. A fabric for a paper machine as claimed in any one of the preceding claims, **characterized** in that it comprises membrane-like material and that the antimicrobial agent is arranged in said membrane-like mate-

rial.

12. A fabric for a paper machine as claimed in any one of the preceding claims, **characterized** in that it comprises foamed material and that the antimicrobial agent is arranged in said foamed material.

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