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(54) Method of controlling the surface properties of surfaces in a paper machine and use of the method in the surface treatment of surfaces in a paper machine

(57) The present invention relates to a method of controlling the surface properties of surfaces in a paper machine by virtue of treating said surfaces with a surface treatment compound to achieve desired surface properties. According to the invention, the surfaces are treated with a liquid surface treatment compound whose characteristics are controlled by modifying the backbone polymer chain of the surface treatment compound advantageously by halogenated macrooligomers, diols, triols, thiols and/or other polyols. The invention also concerns the use of the method in the surface treatment of surfaces in a paper machine.

EP 0 728 866 A2

Description

The present invention relates to a method of controlling the surface properties of surfaces in a paper machine by virtue of treating said surfaces with a surface treatment material to achieve desired surface properties.

Paper machines or similar equipment (including boxboard machines and pulp sheeting/drying machines, for instance) and various paper finishing machines have a plurality of different surfaces on which special requirements are set with regard to their surface properties such as desired degree of friction, predetermined surface energy, self-cleaning property, good web separation properties and wear resistance. Surfaces typically prone to accumulate debris are, e.g., dryer cylinders, web guide rolls, sizing press rolls and their surroundings. Special surface property requirements (besides self-cleaning) are also placed on, e.g., the center rolls of the press sections, sizing press rolls, composite rolls, different glide surfaces, doctor blades, etc.

One of the specific areas considered problematic today is formed by the porous facings of rolls and similar machine components. Such porous facings particularly include thermally-sprayed paper machine roll facings which generally are made as ceramic, metal or cermet facings. Porosity is a factor affecting the facing-substrate combination in a manner impairing its corrosion resistance, wear resistance of the facing layer, mechanical strength of the facing layer and the adhesion between the facing and the substrate material. The requirements set for, e.g., thermally-sprayed roll facings are widely varying: the facing must have good wear resistance, high strength of facing, corrosion resistance, certain desirable friction qualities, debris repellent property, etc. However, a thermally-sprayed surface alone does not usually provide these characteristics or combinations thereof, but rather, the surface properties must be modified as desired by virtue of various surface treatment compounds. For instance, the ceramic-covered center roll of the paper machine press section is assumed to permit the separation of the paper web from the roll surface as optimally as possible in terms of the paper-making process. To achieve the desired characteristics particularly for such a porous facing, the facing must in a great number of cases be treated with a special sealant or surface treatment compound whose purpose is to modify and control the surface properties in the desired manner improving, e.g., its surface energy specification, debris repellent property or a similar characteristic.

The use of a surface treatment compound can vastly improve the surface properties. For surface treatment of porous surfaces, such an organic liquid compound with suitable viscosity has been used that can be impregnated into the pores of the facing and then cured by a suitable method after the impregnation step. Conventionally, the organic surface treatment compounds have been selected from the group containing, e.g., different polymers such as epoxy resins, phenol resins, polyester resins, vinyl ester resins, various types of organic waxes and similar compounds, whereby the processing temperature of the surface treatment compound is typically in the order of 80-100 °C.

However, surface treatment compounds do not always function in the desired fashion, and therefore, a need has arisen to modify the properties of the surface treatment compound in a desired direction. For instance, the conventional organic sealant compounds used in surface treatment compounds have been found to increase, among other things, the adherence of the web on the surface of a sealed roll and to increase the wear of doctor blades as compared with a roll whose surface has not been sealed nor subjected to surface treatment. A factor contributing to this has been the sealing of the roll surface pores caused by the surface treatment compound. Then, the sealing of the roll surface alters the thickness of the moisture layer remaining between the web and the roll surface, whereby the separation of the web from the roll surface is impaired.

It is an object of the present invention to achieve a novel method of controlling the surface properties of surfaces in a paper machine, in which method the characteristics of a surface treatment compound can be varied in a desired manner so as to achieve a desired effect. To this end, the invention is principally characterized in that the surfaces are treated with a liquid surface treatment compound whose characteristics are controlled by modifying the backbone polymer chain of the surface treatment compound advantageously by halogenated macrooligomers, diols, triols, thiols and/or other polyols.

The invention offers significant benefits over conventional methods particularly in situations in which it is desirable to avoid soiling of surfaces and generally the adherence of debris on surfaces, to improve and aid the flow of fluids along surfaces and/or to improve the separation of a paper web or similar material from a surface, particularly from the surface of a roll. Particularly in such rolls or similar surfaces covered by a porous facing, the treatment according to the invention with a surface treatment compound also improves the strength and corrosion resistance properties of the facing. In the method according to the invention, the surface treatment compound has a general corrosion resistance improving effect also in cases where the surface treatment compound is applied directly onto a metal surface. Such objects include the flow surfaces of headboxes, pipings and similar machine elements. Also the treatment of, e.g., metal-faced rolls and cylinders, and composite-material rolls with the surface treatment compound according to the invention can reduce the surface energy of such rolls thus improving the separation of the web from the roll. Fabricated from, e.g., carbon fiber and epoxy resin using, e.g., filament winding techniques, a composite roll is an extremely light, yet sufficiently strong and stiff roll for paper machines. Such

a roll is today used as, e.g., web tension measuring roll whose surface is required to stay free of debris and possess good web separation properties. Other benefits and characteristics of the present invention will be evident from the exemplifying embodiments of the invention described in greater detail below.

The surface energy and chemically reactive groups of a surface treatment compound such as a sealant compound intended for sealing porous facings have a crucial effect on, among other things, the adherence of paper web to the surface treatment compound. If the surface energy of a solidified surface treatment compound or similar sealant can be lowered, the adhesion work required to separate the web from the surface treatment compound decreases, whereby the separation of the web from the roll surface is eased. Simultaneously, the probability of the formation of hydrogen bonds between the roll surface and the web is reduced. This example is given here to elucidate the factors related to roll facings and their treatment with surface treatment compounds. A feasible method of reducing the surface energy of a surface treatment compound is to artificially add halogen atoms to the polymer structure of the surface treatment compound. Halogen atoms in the polymer structure have an extremely electronegative role and thus can lower the surface energy. Resultingly, in the rolls the adherence of the web to the roll surface is reduced. In this text the term halogen particularly refers to fluorine, while in theory fluorine could be replaced by iodine or bromine, for instance.

In conventional methods halogens or halogen compounds are introduced into the surface treatment compound in the form of discrete particles having a particle size sufficiently small with regard to, e.g., the pore size of a porous facing. When the halogen species used is fluorine, for instance, it is embedded in the surface treatment compound as separate particles of a fluorinated polymer. However, such a particle compounding method has the following shortcoming among others: Firstly, the particles separate in the liquid polymer phase. Secondly, desired effect on the properties of the surface treatment compound cannot be obtained even at elevated particle concentrations. Thirdly, compounding with particles also increases the viscosity of the liquid polymer resulting in inferior impregnation of the facing pores by the particles, for example. Lastly, compounding with particles may impair the mechanical properties of the surface treatment compound.

The goal of the invention is achieved by modifying the chemical structure of the surface treatment compound by, e.g., halogenated macrooligomers, diols, triols, thiols and/or other polyols. Accordingly, if the halogen is fluorine, the chemical structure of a liquid organic surface treatment compound, for instance, can be modified by adding fluorinated macrooligomers or diols to the backbone polymer of the treatment compound. Problems involved with particle compounding can be avoided through the use fluorinated compounds, whereby also significant improvements are achieved in the properties of the surface treatment compound.

In the case the halogen species are brought into backbone of the surface treatment compound in the form of separate halogenated (e.g., fluorinated) polymer particles, they can be either in the dry form of separate particles or dispersed in a liquid carrier of low surface energy, whereby the particles are blended in the carrier medium with the surface treatment compound. The carrier can be a hydrocarbon or similar compound suited for the purpose. Prior to the curing of the surface treatment compound, the carrier is removed by a suitable heat treatment. By varying the amount of particles embedded in the surface treatment compound matrix, the adhesion characteristics of the surface with, e.g., a paper web can be modified. However, a problem arises from the addition of halogenated particles in the surface treatment compound matrix. Namely, the particles tend to enrich on the thin top layer of the facing, whereby a majority of the particles will be ground away if the facing need to be finished by sanding. Here, a significant portion of the advantageous web release property of the halogenated (fluorinated) polymer particles will be lost. Moreover, the amount of halogenated particles in the surface treatment compound must be relatively high, whereby the surface treatment compound becomes balsamlike and its penetration into the facing pores is hindered in situations where the surface treatment compound is used for sealing the pores of a facing.

As mentioned above, the chemical structure of the surface treatment compound can by altered by modifying the backbone polymer chain by, e.g., halogenated macrooligomers or diols. For instance, if the surface treatment compound is intended for sealing a porous facing and when the surface treatment compound used is an epoxy-resin-based surface treatment compound, the modification of such an epoxy-resin-based surface treatment compound by fluorinated macrooligomers is based on the reaction of reactive (mono- or bifunctional) ends of the polymer chain of fluorinated macrooligomers with the epoxy group of the resin. As noted above, fluorine is mentioned as only an advantageous alternative of the available halogens. Other usable halogens are iodine and bromine, for instance. Further, the surface treatment compound need not be limited to an epoxy resin or an epoxy-resin-based surface treatment compound alone, but rather, almost any thermosetting or thermoplastic polymer can be used in the surface treatment compound. Examples of suitable base materials for the surface treatment compound include epoxy resins, phenolic resins, polyester resins, vinylester resins, acrylate resins, methacrylate resins, organic waxes and similar compounds, and copolymers and terpolymers of these. In the exemplifying embodiment the macrooligomers usually exhibit poor solubility in the epoxy matrix, whereby the oligomers are initially converted into so-called adducts with different anhydrides, and then actual prepolymers are made from the adducts through a chain extension reaction. These prepolymers

exhibit good solubility in the base epoxy matrix and are capable of reacting with the epoxy groups of the resin. Hence, the base resins can be cured into solid, homogeneous structures having a predetermined/desired content of fluorine atoms. The fluorine atoms may occur in the form of different CF_x groups in the linear part of the polymer chain, or alternatively, as side groups. Then, the surface energy of the facing drops to a value of 15-20 mN/m.

The surface treatment compound may also consist of inorganic surface treatment compounds of suitable viscosity such as phosphates and silicates, for instance.

The above-described exemplifying embodiment is particularly suited for use of the surface treatment compound as the sealant of a porous roll facing. This is because the surface energy of fluorine-modified surface treatment compound is lower, whereby the adhesion work holding the web against the roll surface decreases and the separation of the web from the roll surface is eased. Additionally, the corrosion tolerance, heat resistance and mechanical properties of modified epoxy-based sealant compounds are improved. While the above-described exemplifying embodiments are related to the use of fluorine and fluorinated macrooligomers or diols, a final note must be made on the fact that fluorine may in principle be replaced by other halogenated compounds including at least those of iodine and bromine. Moreover, epoxy resin as the base polymer matrix can be replaced by any other polymer whose halogenation results in structures of lower surface energy. Such alternative base polymers are listed in the description of the invention above.

For those versed in the art it is obvious that the invention is not limited by the exemplifying embodiments described above, but rather, can be varied within the scope and inventive spirit of the annexed claims.

The present invention relates to a method of controlling the surface properties of surfaces in a paper machine by virtue of treating said surfaces with a surface treatment compound to achieve desired surface properties. According to the invention, the surfaces are treated with a liquid surface treatment compound whose characteristics are controlled by modifying the backbone polymer chain of the surface treatment compound advantageously by halogenated macrooligomers, diols, triols, thiols and/or other polyols. The invention also concerns the use of the method in the surface treatment of surfaces in a paper machine.

Claims

1. A method of controlling the surface properties of surfaces in a paper machine by virtue of treating said surfaces with a surface treatment compound to achieve desired surface properties, **characterized** in that the surfaces are treated with a liquid surface treatment compound whose characteristics are controlled by modifying the backbone polymer chain of the surface treatment compound advantageously by halogenated macrooligomers, diols, triols, thiols and/or other polyols.

2. A method as defined in claim 1, **characterized** in that the surface treatment compound is selected from a group of polymers.

3. A method as defined in claim 2, **characterized** in that a thermosetting polymer is used in the surface treatment compound.

4. A method as defined in claim 2 or 3, **characterized** in that the matrix polymer of the surface treatment compound is selected from the group containing epoxy resins, phenolic resins, polyester resins, vinylester resins, acrylate resins, methacrylate resins, organic waxes and similar compounds, and copolymers and terpolymers of these.

5. A method as defined in claim 2, **characterized** in that a thermoplastic polymer is used in the surface treatment compound.

6. A method as defined in claim 1, **characterized** in that an inorganic compound is used in the surface treatment compound such as phosphates, silicates and the like.

7. A method as defined in any foregoing claim, **characterized** in that the halogen species used in the method is fluorine.

8. A method as defined in any of foregoing claims 1-6, **characterized** in that the halogen species used in the method is iodine.

9. A method as defined in any of foregoing claims 1-6, **characterized** in that the halogen species used in the method is bromine.

10. Use of the method defined in any foregoing claim in the surface treatment of surfaces of paper machine rolls.

11. Use of the method defined in any of foregoing claims 1-9 in the surface treatment of a paper machine roll covered with a porous facing.

12. Use of the method defined in any of foregoing claims 1-9 in the surface treatment of a composite roll.

13. Use of the method defined in any of foregoing claims 1-9 in the surface treatment of flow surfaces in a paper machine.

14. Use of the method defined in any of foregoing claims 1-9 in the surface treatment of easily soiled surfaces in a paper machine.