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TREATMENT OF FIBROUS INSULATING MATERIALS

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18 Claims. (Cl. 204—1)

This invention relates to the art of preparing fibrous materials for use as insulating materials and is a division of my application Serial No. 68,914, filed November 13, 1925, which has become abandoned.

An object of the invention is to improve the electrical insulating characteristic of fibrous materials.

Another object of the invention is to improve the quality and reduce the cost of fibrous insulated conductors.

It is well known that different insulating materials vary widely in their electrical insulating characteristics such as direct current insulation resistance, effective electrostatic capacity, and alternating current conductance or leakance. Fibrous materials such as ordinary cotton and tussah floss silk possess good insulating characteristics when dry but it has been found that where these materials are exposed to moist air, their insulation resistance is considerably lowered regardless of their relative insulating properties. The insulating characteristics of all such materials fall off rapidly under rising humidity conditions.

While the amount of water absorption is not necessarily a distinct and proportionate measure of the insulation resistance of fibrous materials, nevertheless the presence of water produces a deleterious effect upon the insulating characteristics. Water acts as a solvent in which the various electrolytic substances contained in the fibrous material are dissociated into ions which are electrically conducting, and thereby decreases the insulating characteristics of the material.

Heretofore, the use of cotton as an electrical insulating material has been limited to those cases where only a moderate degree of insulation was desired. In cases where a higher insulation was desired, the cotton was either replaced with some medium having higher insulating characteristics or combined with some additional insulating medium such as rubber or a varnish composition. While in such cases higher insulating characteristics were produced, flexibility of the fibrous material was sacrificed or other difficulties were introduced such as excessive size of conductor or a tendency to corrosion.

It is commonly known that fibrous insulating material such as cotton, contains foreign matter which is partly represented by the ash remaining after thorough ignition of the material. It has been found that by the removal of such foreign matter cotton can be made to approach pure cellulose, and its insulating characteristics

or properties under rising humidity conditions therefore greatly improved since pure cellulose contains substantially no electrolytic materials which are dissociated into ions in the presence of moisture. Substantially the same principle applies to animal fibres which are non-cellulose material.

This invention provides a cheap and efficient fibrous material whose insulating characteristics have been improved without sacrificing appreciably either strength or flexibility.

In accordance with a feature of the invention there is provided a new and improved method of improving the electrical insulating characteristics of fibrous material by reducing the ionizable matter content of fibrous materials by means of an electric current. In accordance with another feature of the invention the electrical insulating characteristics of fibrous material are improved by suitable washing or leaching with water to reduce the ionizable matter content of the material. In accordance with still another feature of the invention, the insulating characteristics of fibrous materials are improved by treating the material to remove the ionizable substance contained therein and treating with a solution containing a substance which will be appreciably adsorbed by the surface of the individual fibres. In accordance with the feature of the invention first mentioned, the insulating characteristics of fibrous materials, such as cotton and tussah floss silk, may be improved by electrolytically reducing the ionizable matter content of the material to produce a substantially pure fibrous material and one possessing high insulating characteristics over the usual range of humidity conditions.

It has been found that when a direct current voltage is maintained in high humidities on a conductor having a fibrous insulating covering, there result progressive changes in the insulating characteristics of the fibrous covering tending toward improvement. This improvement has been found to be associated with a gradual depletion of the electrolyte constituents in the middle portion of the conducting path and an accumulation of the ash content in the vicinity of the electrodes. A suitable method of treating fibrous materials in the form of bolts or cops, for example, is to apply an electric potential between an electrode in contact with the center of the bolt and a second electrode in contact with the outer surface of the bolt for a suitable length of time in water or in a humid atmosphere.

The voltage applied in any particular case will depend primarily upon the size of the bolt and

the ash content of the material. With a given applied voltage, the duration of treatment will depend primarily upon the current leakage or current flow between the electrodes. With such a treatment, the ash content of the material being treated migrates to the vicinity of the electrodes whence it may be removed by continuous washing, leaving the intervening part of the material substantially free of ash. In accordance with a modification of this feature of the invention the ionizable matter content of the fibrous material is reduced by washing or leaching with water at a suitable temperature and for a suitable length of time. The water employed for the washing operation is preferably free from the ordinary electrolytic materials in order to prevent the occurrence of undesirable electrolytic materials in the finished product which would tend to decrease the insulating characteristics of the material. Pure water has been found satisfactory for this purpose.

A satisfactory method comprises washing the fibrous material with pure water for a period of time varying from one to three hours at a temperature varying from 80° C. to 100° C. However, the length of time and temperature of treatment will be dependent upon the rate of flow of water over the material, the amount of water employed and the ash content of the material. The values of these factors are preferably chosen so as to provide a finished product which is substantially free of foreign matter or "ash". The term "ash" is used interchangeably with foreign matter since it has been found that when the product is substantially free from ash, objectionable electrolytes are also absent.

After the ash content of the fibrous material has been reduced in either of the ways described above, the insulating characteristics may be further improved by treating the purified material with a solution containing a substance which is relatively irreversibly adsorbed on the surface of the fibres such as a solution containing compounds of the alkaline-earth metals. By the term "irreversibly adsorbed" is meant adsorption in which the material adsorbed is substantially "fast", the term "fast" having the same meaning as when applied to dyes. Sodium chloride is an example of a material which is not "fast", for although it is adsorbed by fibrous materials it is readily and quickly removable by washing with water. Calcium hydroxide, however, when adsorbed on the surfaces of fibres, is not readily removed by washing and is fast as an adsorbed material. By such a treatment, experiments have shown that the insulating characteristics of cotton, for example, may be made comparable to those of commercial silk, under high humidity conditions.

Lime water has been found to be an advantageous substance for use as the solute in a solution for the treatment of a purified material. Solutions substantially saturated with lime water have been found to be satisfactory. Other solutes which have been found satisfactory are the carbonates and hydroxides of the alkaline-earth metals. The term "alkaline-earth metals" is employed herein to designate the metals barium, strontium and calcium.

The choice of the metal and the anion to be employed in any given case will be determined primarily by the particular conditions prevailing in that case. As a general rule it has been found that adsorption increases with the size of the cation and with increasing valence. The

anion should preferably be one forming a volatile or non-acidic substance in water solution so that washing subsequent to the adsorption treatment will not be necessary.

The time and temperature of treatments have been found to vary with the solute employed, those solutes which are more strongly adsorbed necessitating shorter periods of treatment. In any case, it has been found, however, that the maximum adsorption is approached rapidly, usually only a few minutes treatment being required. A method which has been found satisfactory is to immerse the material to be treated in a saturated solution of calcium hydroxide (lime water) at a temperature of 20° C. for a period of two or three minutes. Longer immersing periods ranging up to two or three hours, for example, have not however been found to result in any injurious effect to the fibrous material.

In its preferred form, the invention comprises a method of treating fibrous materials to improve their insulating characteristics which is a combination of an initial purification and a subsequent adsorption treatment into one step and in which the fibrous material is immersed in a solution containing compounds of the alkaline-earth metals and between electrodes immersed in the solution and an electric current is passed between the electrodes for a suitable length of time. After a suitable length of treatment, the fibrous material is removed and dried. As described above, this treatment produces fibrous material having optimum electrical characteristics at certain definite points with respect to the electrodes. It has been found that the location of these definite optimum positions varies with the solute used in the electrolytic bath and must be determined for each material. When lime water is used in the electrolytic bath, for example, the optimum electrical characteristics have been found to be associated with the fibrous material lying mid-way between the electrodes.

The particular working conditions, such as duration and temperature of treatment, and the value of the current employed will vary with the solute used and the amount and quality of material to be treated. One method which has been found satisfactory is to apply a potential of 110 volts for twenty-four hours at a temperature of 25° C. when using a bath of saturated lime water 10 inches in length between electrodes. The resistance rises rapidly during the early portion of the treatment so that the current consumption in the later stages is very small. Another satisfactory method of treating fibrous materials to improve their insulating characteristics comprises washing the fibrous material for a period of time of sufficient duration to cause an appreciable reduction in the ash content with a water solution containing substances which are adsorbed by the surfaces of the fibres being treated, such as water solutions of compounds of the alkali earth metals. A solution whose adsorbing ion concentration is low may be satisfactorily employed in this process since the duration of treatment is made comparatively long to allow for a thorough washing of the fibres. Natural waters which contain an appreciable amount of compounds of the alkali earth metals and are relatively free from other salts have been found to be suitable for use in such a treatment.

The duration and temperature of the treatment will be dependent substantially upon the operating conditions of the plant. With one of these factors constant, however, the other fac-

tor has preferably such a value as to permit a thorough washing or leaching of the fibrous material. The proportion of water to cotton will be determined substantially by the apparatus employed, it being preferable to provide for an efficient circulation of water in and through the fibres.

A suitable method is to pass hot natural water of the above description through spools of insulating cotton in a machine of the type of the Franklin dyeing machine for a period ranging from one to three hours. After this time the material may be removed from the machine and dried when it is in condition for use as an improved insulating medium.

Tests have been made which illustrate the efficiency of insulating materials prepared in any of the manners herein described. It has been found, for example, that the direct current insulation resistance of cotton may be increased from 20 to 25 times, the effective electrostatic capacity decreased between 25 and 50% and the conductance or leakage measured with an alternating current of 1000 cycles is decreased to about 1/100 of the value before treatment. It will be seen therefore that the electrical characteristics of insulating materials prepared in accordance with the invention will be materially improved and that telephone or switchboard cords insulated with materials treated in this manner are particularly satisfactory under the conditions of atmosphere which are encountered in telephone exchanges.

A particular advantage of the invention is the conversion of cotton, which is cheap but which possesses poor insulation resistance in moist air, into a condition such that it has insulating characteristics in moist air comparable to those of commercial silk under severe humidity conditions.

While the invention has been described with particular reference to cotton, it is to be understood that it is applicable to other types of fibrous materials having the electrical or adsorption characteristics of cotton. By adsorption characteristics of a fibrous material is meant the property of the material which permits it to irreversibly adsorb ions, such as alkaline earth metal ions, in the manner described herein above.

The invention is also capable of other modifications and adaptations not specifically referred to but included within the scope of the appended claims.

What is claimed is:

1. The method of treating cotton to improve its insulating characteristics which comprises washing said cotton in an aqueous solution containing a calcium compound and substantially free from all other ionizable substances.

2. The method of treating cotton to improve its insulating characteristics which comprise immersing said cotton in a bath of saturated lime water maintained at a temperature of approximately 25° C. for a period of 24 hours and impressing a potential of approximately 110 volts between electrodes spaced approximately 10 inches apart in said bath and between which the cotton is positioned.

3. A fibrous insulating material comprising long cotton fibres substantially free from electrolytic substances, the surfaces of said fibres containing cations of an alkaline earth metal which have been irreversibly adsorbed thereby from a water solution containing an alkaline earth metal and substantially free of other electrolytes.

4. The method of treating cotton material to improve its insulating characteristics which comprises washing the material with a water solution containing a compound of an alkaline earth metal and substantially free of other electrolytes.

5. As a new article of manufacture, electrical insulating material comprising strands of cotton substantially free from ionizable impurities.

6. As a new article of manufacture, electrical insulating material comprising cotton strands which are substantially free from ionizable substances and which have electrical insulating characteristics comparable to those of commercial silk.

7. As a new article of manufacture, electrical insulating material comprising cotton which is substantially free from ionizable substances and the surfaces of the individual fibres of which contain a compound of an alkaline earth metal which is irreversibly adsorbed thereby.

8. The method of treating fibrous material having the adsorption characteristics of cotton to improve its insulating characteristics without materially altering its fibrous structure, which comprises removing electrolytically the ionizable substance contained therein and subsequently immersing said material in a solution containing a compound of an alkaline earth metal and substantially free of other electrolytes.

9. The method of treating fibrous material having the adsorption characteristics of cotton to improve its insulating characteristics, which comprises immersing said material in an electrolyte containing alkaline earth cations which are irreversibly adsorbed by said fibrous material and substantially free from other cations and passing electric current through said electrolyte for a period of time such that substantially all ionizable substances are removed from said material.

10. The method of treating fibrous material having the adsorption characteristics of cotton to improve its insulating characteristics, which comprises washing said material in water containing calcium cations which are irreversibly adsorbed by said fibrous material and substantially free from other cations for a period of time sufficient to remove substantially all ionizable material therefrom.

11. The method of treating fibrous material having the adsorption characteristics of cotton to improve its insulating properties which comprises removing the ionizable impurities therefrom by washing said material for a period from one to three hours with hot water containing an alkaline earth compound and relatively free from readily ionizable substances.

12. The method of improving the insulating properties of fibrous material having the adsorption characteristics of cotton, which comprises washing the material with lime water which is substantially free of other electrolytes.

13. The method of improving the insulating properties of cotton, which comprises washing the cotton in hard water containing an appreciable amount of compounds of alkaline earth metals and which is relatively free from readily ionizable impurities until substantially all ionizable impurities are removed from the cotton.

14. The method of improving the insulating properties of cotton, which comprises washing the cotton with lime water which is substantially free of other electrolytes.

15. Electrical insulating material comprising

fibrous material having the adsorption characteristics of cotton characterized by being substantially free from ionizable substances and by having a compound of an alkaline earth metal irreversible adsorbed on the surfaces of the individual fibres of the material.

16. Electrical insulating material comprising cotton strands characterized by being substantially free from ionizable impurities and by having electrical insulating characteristics under conditions of high humidity of the same order as those it possesses under ordinary conditions.

17. The method of improving the insulating

properties of commercial insulating cotton, which comprises washing said material with water which is substantially free from readily ionizable substances until substantially all ionizable impurities are removed therefrom.

18. An insulating material comprising spun cotton which has substantially constant electrical characteristics under varying conditions of humidity which has a calcium compound irreversibly adsorbed thereby, and which has been freed from substantially all impurities.

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