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(54) **The method of manufacturing of bioactive technical fibre**

(57) The method of manufacturing of bioactive technical fibres consisting in that surface of the material 2 with properties of foil is covered with bioactive substance and fixed in the zone III of higher temperature, and next the material 2 is calendered in the zone IV and fibrillcd in the zone V, and next torn into pieces to receive the fibres 10.

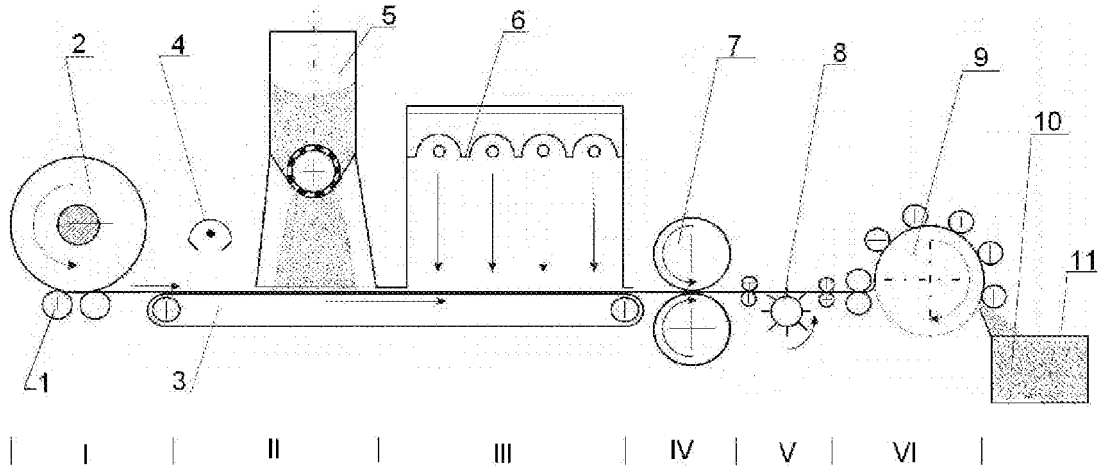

Fig. 1

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Description

[0001] The subject-matter of the invention is a new method of manufacturing of bioactive technical fibres having a widespread application both in everyday living and in medicine as a raw-material for manufacturing of bioactive textile materials.

[0002] Following more and more intensive development of civilization and isolation of man from microorganism potentially harmful to health or dangerous, problem of maintaining sterility or at least microbiological stability has been still a critical issue in many spheres of human life.

[0003] Before development of such field of science as microbiology, any bacteria or viruses causing losses in crops, breeding or resulting in complications during treatment of diseases, were not known all over the world. History reported plagues and crop failures resulting from such conditions, during which recovery meant rather subordination to natural process of elimination and natural selection of the strongest individuals. A breakthrough in overcoming such negative aspects of human lives were discoveries of modern medicines, for example antibiotics and various kinds of vaccinations both for human organisms and for animals and plants. Nevertheless, despite wide access to various chemical substances used to combat pathogenic microorganisms, both personal and material losses resulting from non-observance of sanitary regimes are still very common.

[0004] Potentially exposed to occurrence of biological danger are such places as medical facilities and outreach with postoperative care. In the above, infections resulting from non-observance of hygienic and sanitary regimes within surgical wound, occur most frequently.

[0005] Commonly known are means used in order to combat pockets of infection as well as pathogenic microbes. These can be disinfection and sterilizing preparations for contact surfaces used to wash and clean places where patients stay. Their action is, however, limited to removal of bacterial endospores and strains until the moment they are again introduced on the washed surface, for example by its touching with carelessly sterilized surgical instrument. Then, it is highly probable that contact with dirty surfaces during operation will cause infection (so-called intra-hospital infection).

[0006] In the case of outreach with postoperative care, the problem of sterility or bacteriostatics is considerably more serious. At home circumstances there are numerous objects, which are impossible to be disinfected. Thats why it is necessary to effectively protect the wound or environment where the patient stays, against intensified spread of microbes already present in this environment.

[0007] Also serious danger to human health results from all kinds of air-condition and ventilation systems provided with various types of filters, component of which are textile materials. Microbes are developing on the filter medium and, when distributed through the system, they cause danger both to people and animals health.

[0008] Solutions of such problems are textile materials preventing development of bacteria known, for example, from the Soviet patent description 469720. In the process of manufacturing, textiles are enriched with sulfo groups, and then □padded with solution of gentamicin. Production process and auxiliary activities nevertheless guarantee a low content of biocides in the fabric structure.

[0009] In the similar way, bioactive substances are being introduced into textile material, description of which is included into the Polish patent description 179483. Textile material is vaccinated with carboxylic acid groups and, after that and similarly to the Soviet patent, mixtures of antibiotics with basic properties are introduced.

[0010] Another example of manufacturing of fibres with antibacterial properties is the Polish patent description 174680. Synthetic fibres forming medical fabric are prebulged, and then put into a bath in water solution of biocide and, as a result of this, it obtains its specific properties.

[0011] On the other hand, the US patent 419656 discloses the method of fixation of active substance on nylon fabric with a stream of hot steam and bath in water solution of oil and bioactive substance.

[0012] Nowadays also less complicated methods of bioactive fibres manufacturing are used, consisting in mixing of molecules of active substance with fibre-forming substance, for example polyester, thanks to what during the regular production process fibres obtain bacteriostatic properties. It should be however noticed that as a result of being submerged in polyester, the major part of antibiotic molecules cannot have any contact with a zone of microbes presence, as a result of which a considerable part of active substance is being lost for ever already at the stage of polyester adding.

[0013] Another example of fabric with antiseptic properties are fabrics of TREVIRA type available on the market, characterized by very good bacteriostatic properties. One of these fabrics was described in the patent MX3009085. In the course of production textile material is padded with phosphorus compounds, and as a result it obtains antibacterial and antifungal properties with the simultaneous securing of permeability of dressing or clothes made of it. But in situations, when access of air is not required, it is indispensable to apply other substances to isolate the protected object or place from any source of potential infection.

[0014] To this end, commonly used are plastics such as, for example, food wrapping foil. Additionally, as professional scientific magazines such as e.g Journal of Agricultural and Chemistry announce, foils with properties similar to standard medical fabrics are now available on the market. Such properties are possessed by foil produced by the US Agricultural Department and the University in Ueida (Spain) and using as a basis natural apple paste and cinnamon oil. The latter substance is responsible for antibacterial properties, and usage of natural fruit prevents poisoning in case of eating food together with apple foil.

[0015] In case of dressings, foils described in the patent description WO01/51548 (Polish patent application p-355941) are used. Depending on workmanship, foil according to the patent description, possesses or does not possess pores passing steam through, whereas dimensions of these pores form barrier for bacteria present in any hospital environment. Application of the foil is connected with the fact, that it is resistant to action of the majority of bacteria, but it itself does not possess bactericidal or bacteriostatic properties. Pseudo-bacteriostatics results from dimensions of openings (pores) made in it, without which this will be not steam-permeable.

[0016] Application of materials preventing passing of microbes into the area protected by the above, and especially coated with bactericidal substances or bacteriostatic foil or fabrics, gives apparent effects such as decreased number of infections and decreased number of potential pockets of infection, but materials having been manufactured until now make it necessary to observe certain regimes both during production and usage of the above.

[0017] In the course of production such requirements refer to the method of coating fabric or foil with bioactive components, as well as to final finishing which needs application of additional substances or equipment for disinfection to eliminate auxiliary agents used in production. On the other hand, in the course of using such a product, one should be aware of the fact that not the whole bioactive substance has a contact with an area of potential infection and, what results from this fact □this area is not protected in a way it should be.

[0018] Solution of such problems consists in the application of technical fibres coated with bioactive substance and made basing on the method according to the invention, which not only ensures improvement of bacteriostatic and/or bactericidal properties of the final product e.g. of the fabric, but also enables lowering of manufacturing costs, improving considerably productivity of technical material produced with the application of this method.

[0019] The method according to the invention consists in coating and fixation of active substance, preferably having antiseptic and antibacterial properties, on the surface of material incorporating properties of foil and then, in producing fibres from it.

[0020] In order to obtain uniform and permanent bonding of active substance with material, it is being moved by means of step conveyor above and/or under the field where surface of material is charged electrostatically. Such charging is completed by means of any known technique, preferably by corona discharge or by means of rubbing with a kind of brushes, which place static charges on the surface of material. Electrostatic charging is carried out in the situation when bioactive substance indicates susceptibility to action of electrostatic field. Preferably, the electrode charging the surface of material is string electrode.

[0021] Next, the treated material is being transferred through the area, where it is coated, preferably by means of dusting at least one-sided, preferably double-sided, with biologically active substance. Preferably, properties of spread substance enable combating and preventing development of bacteria and viruses. Preferably, such a substance has a form of nano- or micro- powder, particles of which have dimensions falling within the range from 10^{-6} up to 10^{-9} m.

[0022] Directly after dusting of material surface with active substance, the material passes through a zone characterized by higher temperature. Preferably, a suitable temperature is obtained with the application of infrared radiator. Preferably, height of temperature corresponds to temperature of material melting, preferably such temperature is not higher than temperature of the treated material destruction. As a result of heat action and preferably thanks to application of auxiliary calenders, preferably roller calenders, the active substance is pressed to material surface, preferably being a foil. Preferably, when pressure is associated with cooling of the surface or when cooling follows directly after the material, preferably foil, has left the area of roller calender.

[0023] After passing through the calendering □ pressing zone material, preferably foil, is directed towards the known equipment for fibrillation and capillarization, or both fibrillation and capillarization simultaneously. Preferably, the structure of calendering zone ensures fulfillment of these functions, too. Preferably, when during passing through the zone of material fibrillation, preferably foil with active substance spread over at least one surface, is treated with the application of at least one needle fibrillator. On leaving a zone of fibrillation material, preferably foil, is being torn into thin fibres with a breaker. The final products received as a result of the above are technical bioactive fibres. These fibres may constitute a raw-material used over the successive production stage □formation of non-woven material. It is completed with the application of any known technique, and bacteriostatic properties of raw-material such as fibres, eliminate additional operations of disinfection or giving bactericidal and bacteriostatic properties.

[0024] From the final product different products can be produced, starting from technical products such as e.g. covers used to protect operational zones for medical staff clothing or filter materials for air filters installed in operating theaters. All of them preserve their properties as time goes by, and permanent joining of active substance only with fibre surface ensures contact of 100% of this substance with a potential pocket of inflation.

[0025] The subject-matter according to the invention has been schematically presented in the figure, where Fig. 1 shows the course of the entire process of bioactive fibres manufacturing.

[0026] The main component of the final product is material coated with biologically active substance and fibre made of the above. In order to obtain uniform and permanent bonding of active substance with treated material, pressed with under-roll rollers, the roll 1 of material

2 in the zone I, is moved by means of step conveyor 3 above and/or under the field, where surfaces of material are charged electrostatically with the string electrode 4 to the zone II. Such charging is completed by means of corona discharge or, according to the other example of making, by means of rubbing with a kind of brushes, placing static charges on the surface of material.

[0027] Next, the material 2 is being transferred through the area, where it is coated by means of dusting with biologically active substance with the application of pulverizer provided with dispenser 5. Properties of the spread substance enable combating and/or preventing development of bacteria and viruses. Such a substance has a form of nano- or micro- powder, particles of which have dimensions falling within the range from 10^{-6} up to 10^{-9} m.

[0028] Directly after dusting of material surface 2 with active substance, the material 2 passes through the zone III, where an area characterized by higher temperature is located. A suitable temperature is obtained with the application of infrared radiator 6. Height of temperature corresponds to initial temperature of material 2 melting and it is not higher than temperature of the treated material 2 destruction. As a result of heat action and thanks to application of auxiliary calenders 7, being roller calenders, the active substance is pressed to material surface 2. This pressure is associated with cooling of the surface, which follows directly after the material 2 has left the area of roller calenders 7.

[0029] After passing through the calendering □pressing zone IV, the material 2 is directed towards the known equipment for fibrillation 8 installed in the zone V. The equipment for fibrillation is a needle fibrillator On leaving the zone V, material 2 is being torn into thin fibres with a breaker 9 in the zone VI. The received fibres 10 fall into the container 11 and are the final product in a form of technical bioactive fibres. These fibres may constitute a raw-material used in the other textile processes, e.g. for formation of non-woven material. This can be completed with the application of any known technique, and bacteriostatic properties of raw-material such as fibres, eliminate additional operations of disinfection or giving bactericidal and bacteriostatic properties.

Claims

1. The method of manufacturing of bioactive technical fibres, **characterized in that** on surface of the material 2 with properties of foil, bioactive substance is spread and fixed in the zone III of higher temperature, and next □the material 2 is calendered in the zone IV and fibrilled in the zone V and, after that, torn into pieces in order receive the fibres 10

2. The method according to the claim 1, **characterized in that** web or sheet of the material 2 is being moved by means of the step conveyor 3 above and/or under the field II, where surface/-es of the material 2 is/are charged electrostatically.

3. The method according to the claim 2, **characterized in that** electrostatic charging of the material 2 is carried out by means of the electrode 4.

4. The method according to the claim 3, **characterized in that** the electrode 4 used to charge electrostatically surface of the material 2 is a string electrode.

5. The method according to the claim 2 or 3 or 4, **characterized in that** the material 2 is being transferred through the zone II, where it is coated at least one-sided with biologically active substance.

6. The method according to the claim 5, **characterized in that** properties of coating substance enable to combat or prevent development of bacteria or viruses.

7. The method according to the claim 5 or 6, **characterized in that** the substance has a form of nano- or micro-powder, particles of which have dimensions falling within the range from 10^{-6} up to 10^{-9} m.

8. The method according to the claim 7, **characterized in that** directly after the material 2 has been coated with active substance, the material 2 passes through the zone III **characterized by** the higher temperature.

9. The method according to the claim 1, **characterized in that** a suitable temperature is obtained with the application of infrared radiator.

10. The method according to the claim 8 or 9, **characterized in that** height of temperature corresponds to the initial temperature of melting for the material 2.

11. The method according to the claim 10, **characterized in that** bioactive substance is pressed to surface of the material 2 by means of the calenders 7 or when cooling occurs directly after the material 2 has left the area of roller calenders 7.

12. The method according to the claim 10 or 11, **characterized in that** pressure of the calenders 7 is associated with simultaneous cooling of the material 2 surface.

13. The method according to the claim 10 or 11, **characterized in that** cooling is carried out directly after the material 2 has left the area of the roller calenders 7.

14. The method according to the claim 12 or 13, **characterized in that** after passing through the calend-

ering □pressing zone IV, the material 2 is directed to the known equipment for fibrillation and/or capillarization 8.

15. The method according to the claim 14, **characterized in that** during passing through the fibrillation zone V, the material 2 with active substance spread over at least one surface of it, is treated by means of at least one needle fibrillator 8.

16. The method according to the claim 14 or 15, **characterized in that** after leaving the fibrillation zone V, the material 2 is torn to receive thin fibres 10 with the breaker 9.

17. The method according to the claim 1 or 2 or 3 or 4 or 5 or 8 or 10 or 11 or 12 or 13 or 14 or 15 or 16, **characterized in that** the material 2 is foil.

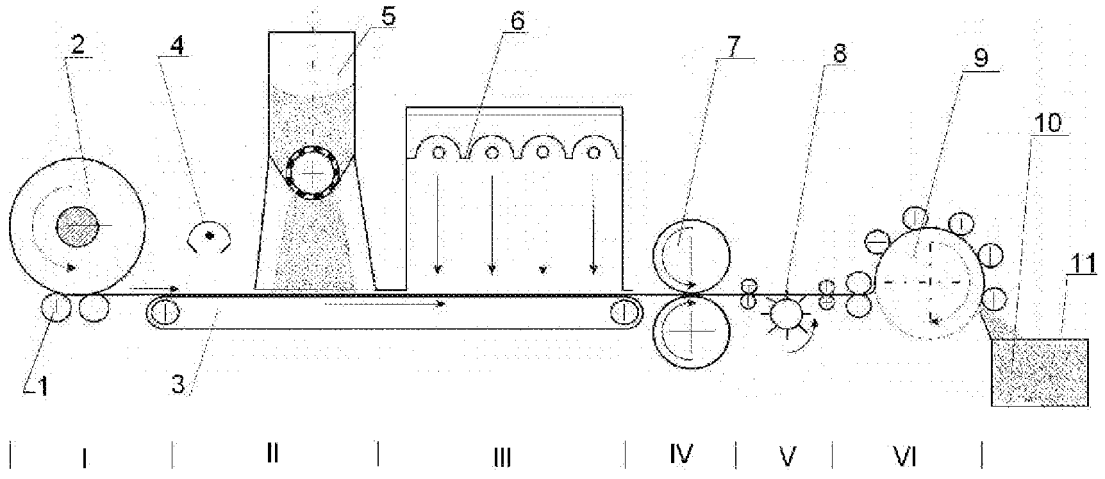

Fig. 1

List of markings:

1. under-roll rollers
2. beam of orientated material with properties of foil
3. step conveyor
4. string electrode of activator
5. pulveriser with dispenser
6. infrared radiator
7. roller calender
8. needle fibrillator
9. breaker
10. bioactive fibre
11. fibre container

I □zone where material as a raw-material is kept
II □zone of electrostaticstatic charging and powdering with active substance
III □zone of higher temperature
IV □zone of calendering
V □zone of fibrillation and/or cappilarization
VI □zone of breaker activity

REFERENCES CITED IN THE DESCRIPTION

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- PL P355941 **[0015]**