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(54) **METHOD FOR PRODUCING FIBERS AND NON-WOVEN FABRICS BY SOLUTION BLOW SPINNING AND NON-WOVEN FABRIC PRODUCED THEREBY**

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(71) Applicant: **Groz-Beckert KG**, Albstadt (DE)  
(72) Inventors: **Arun Prasad Venugopal**, Weinheim (DE); **Andreas Tulke**, Albstadt (DE); **Georgios Toskas**, Altenriet (DE)

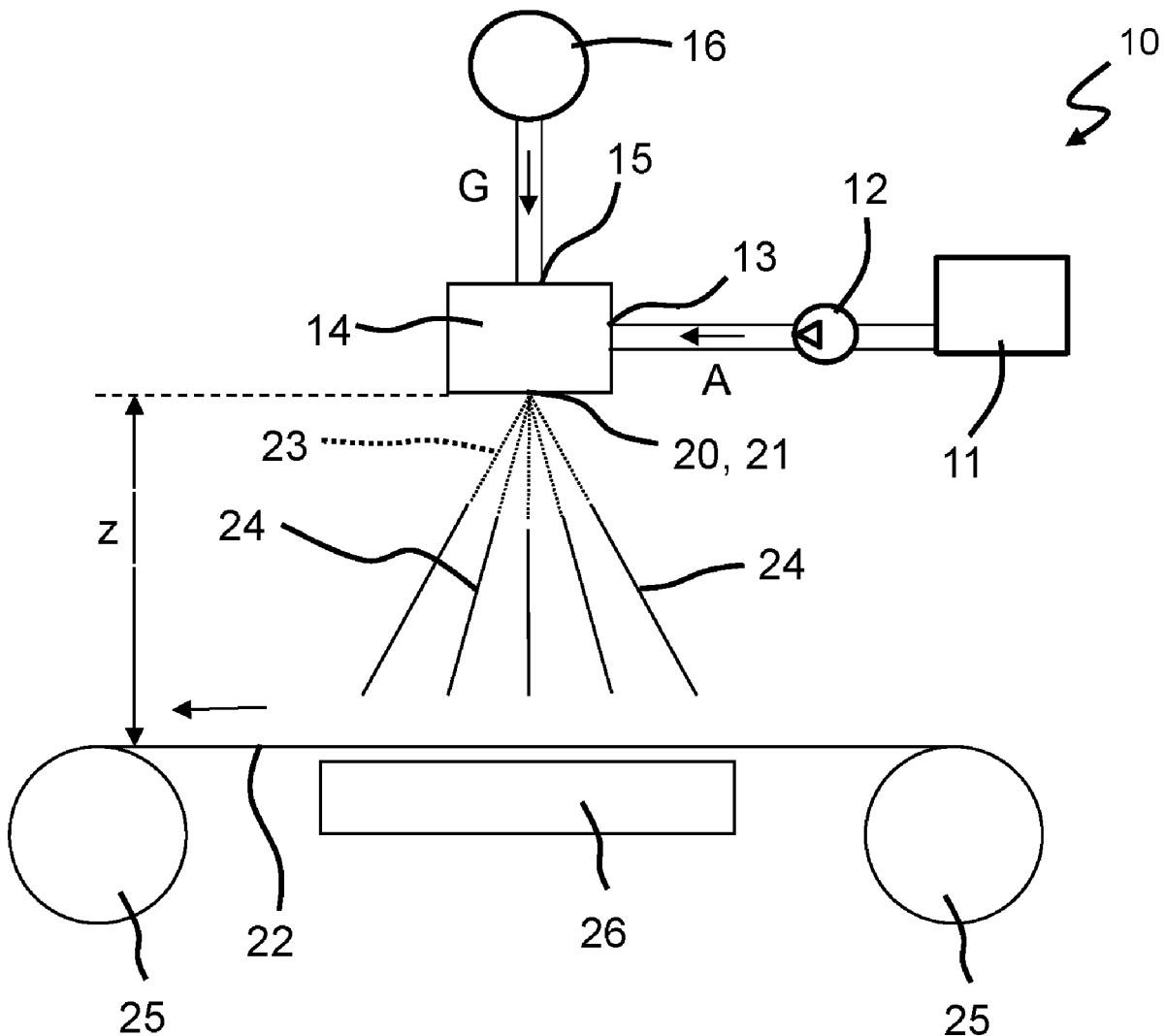
(57) **ABSTRACT**

The invention refers to the use of a parent solution (A) during a method for producing fibers for a fiber fleece by a so-called solution blow spinning. Water is used as solvent for the parent solution (A). At least one water-soluble polymer and preferably exactly one water-soluble polymer is dissolved in the water of the parent solution (A). The parent solution (A) additionally contains at least one surfactant and optionally plasticizer for the used at least one polymer respectively. By means of a parent solution (A) it is possible to produce fibers (24) by solution blow spinning.

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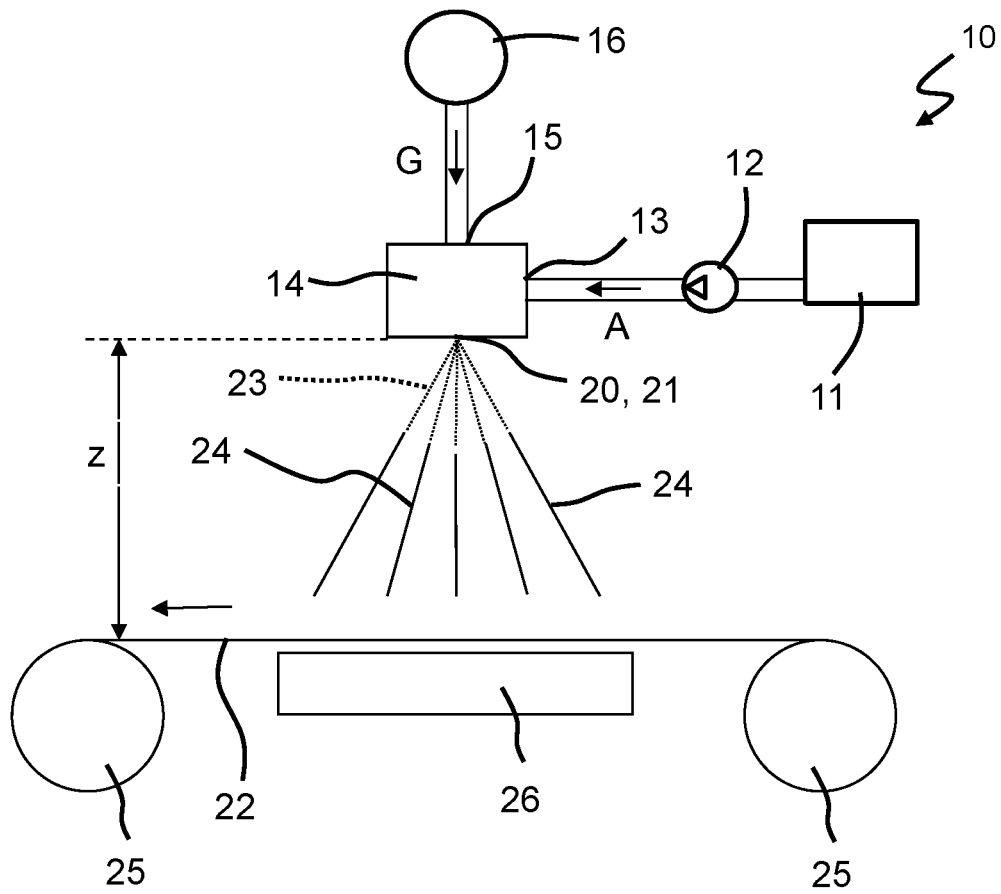


Fig. 1

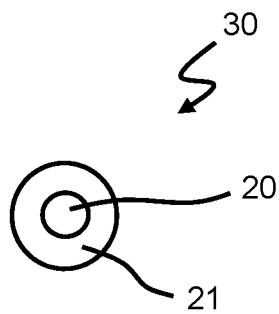


Fig. 2

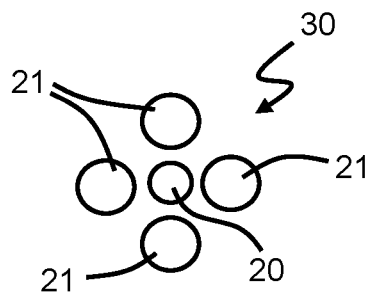


Fig. 3

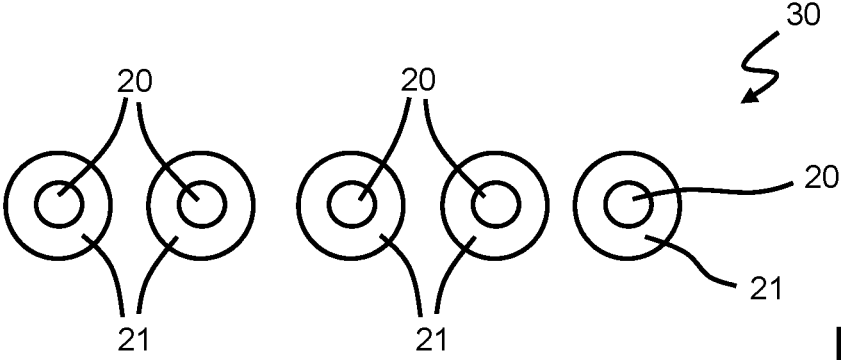


Fig. 4

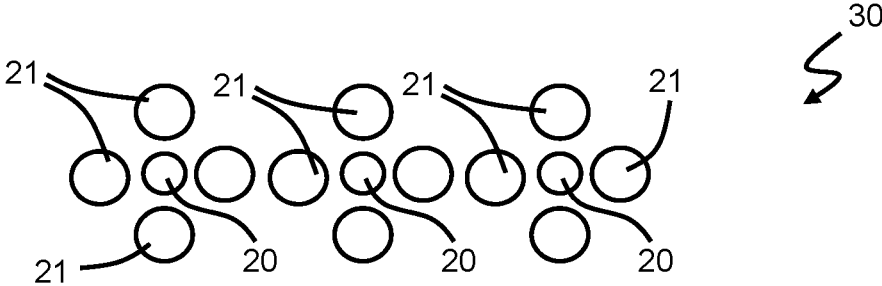


Fig. 5

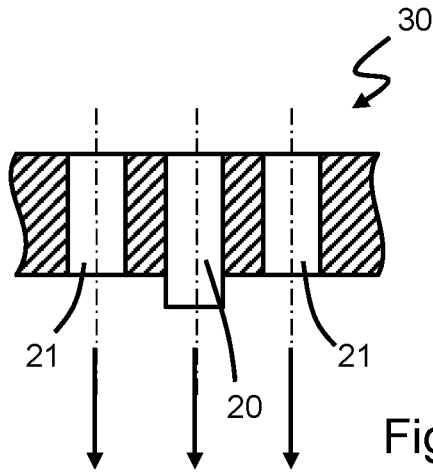


Fig. 6

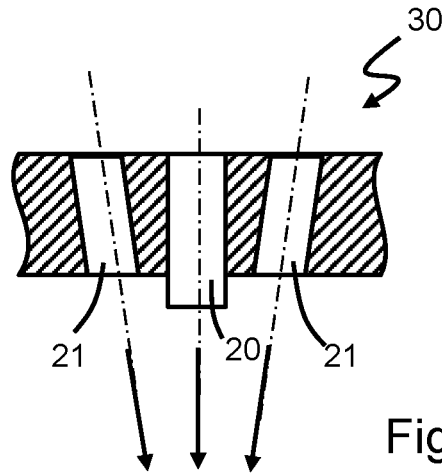


Fig. 7

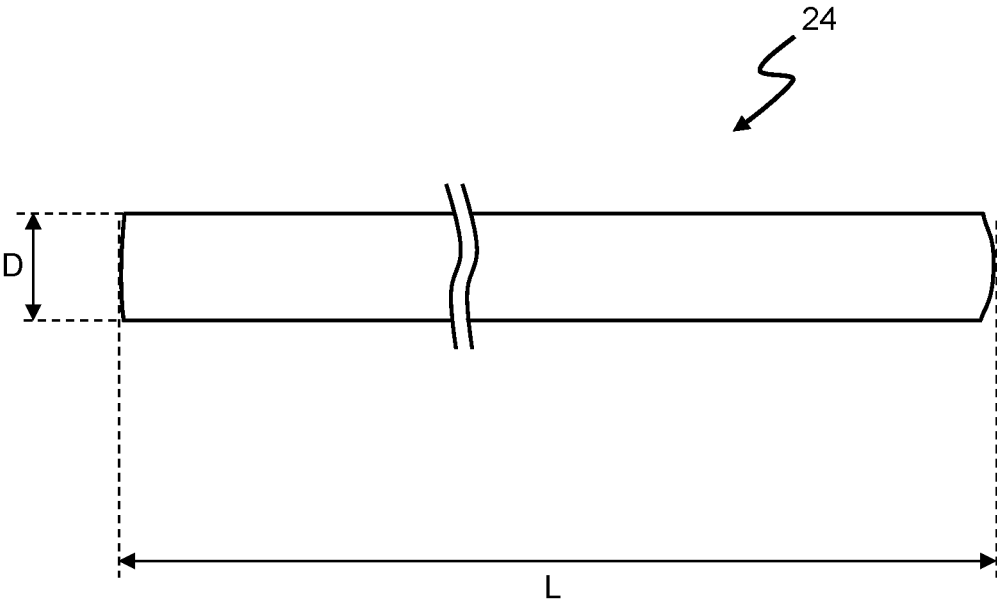


Fig. 8

**METHOD FOR PRODUCING FIBERS AND  
NON-WOVEN FABRICS BY SOLUTION  
BLOW SPINNING AND NON-WOVEN  
FABRIC PRODUCED THEREBY**

**[0001]** The invention relates to the use of a parent solution for producing fibers, particularly microfibers or sub-microfibers or nanofibers by solution blow spinning as well as such a spinning method for producing fibers and a non-woven fabric produced by the method. The solution blow spinning is a spinning method, in which a parent solution exits from at least one output nozzle and is conveyed to a collector, in doing so solid fibers are formed. Accordingly, the fibers are synthetic fibers.

**[0002]** Different methods exist for producing fibers. For example methods are known during which fibers are produced by pressing of a liquid or semi-liquid mass through openings. Such methods are referenced as melt or wet or dry spinning methods, depending on how the respective mass was produced or liquefied.

**[0003]** If particularly fine fibers shall be produced, i.e. fibers with a small fiber diameter, centrifugal spinning methods as well as the electrostatic spinning or the solution blow spinning are particularly suitable. Such fibers are particularly necessary for manufacturing of filters. The drawback of the current methods is that usually solutions are used for production of the fibers that are detrimental to the environment and/or incriminating for the health of the working personnel. Also such solutions are often costly. Therefore, for environmental and cost reasons, water is increasingly provided as solution (i.e. the use of aqueous solutions of water-soluble polymers) in the afore-mentioned methods. Water is environmental friendly, non-toxic and cheap.

**[0004]** The use of water as solution for spinning methods is already known. For example JP 2010-150712 A shows a method for producing of fibers by electrostatic spinning, in which aqueous solutions of water-soluble polymers are used.

**[0005]** The electrostatic spinning has a comparable low productivity for principle reasons. As a consequence, the fiber production by electrostatic spinning is very expensive. The electrostatic spinning can be economically used only for the production of fibers that are used in very upscale products.

**[0006]** U.S. Pat. No. 8,641,960 B1 describes a solution blow spinning, in which solutions of respective polymers are transferred by means of a process gas stream in solid fibers for producing of very fine polymer fibers. Such a solution blow spinning is of advantage compared with electrostatic spinning, because it allows a productivity that is a hundred to a thousand times higher. However, so far producing fibers with a sufficient or high quality from environmental friendly aqueous solutions by solution blow spinning failed.

**[0007]** It can be considered as object of the present invention to produce fibers and particularly high-grade fibers environmental friendly and efficiently.

**[0008]** This object is solved by the use of a parent solution in the solution blow spinning with features of claim 1 as well as a method with the features of claim 16.

**[0009]** According to the invention, the production of fibers by means of solution blow spinning uses a parent solution, in which water is used as solvent. At least the portion of water as solvent is in the range of 30% to 99%, preferably 50% to 95% and further preferably 60% to 90%. At least one

and preferably exactly one water-soluble polymer is dissolved in the solvent. Additionally the parent solution comprises at least one tenside. The tenside is a surface-active substance that can also be referred to as surfactant.

**[0010]** It has turned out that due to the use of the described parent solution, the production of qualitative good and/or high-grade fibers having a substantially constant fiber diameter can be achieved. The fibers can be produced as microfibers, sub-microfibers or nanofibers, i.e. with a fiber diameter in the micrometer range or sub-micrometer range or nanometer range by solution blow spinning. Thereby the sequence in which the added agents are dissolved in the solvent is not of particular importance. The composition of the parent solution is significant.

**[0011]** During solution blow spinning one or more fluid jets are created without atomizing the liquid into spray. The liquid jets exit through a nozzle and are stretched by a process gas, particularly pressurized air. In doing so, fibers are created. The liquid jets are preferably substantially orientated parallel with each other.

**[0012]** The created fibers are comprised preferably a ratio of length to a mean thickness of at least 100:1, preferably at least 500:1, preferably at least 1000:1 and further preferably at least 10000:1. Preferably the fibers have a length of at least 1 mm, preferably of at least 3 mm and further preferably of at least 5 mm.

**[0013]** It is advantageous, if exclusively water is used as solvent in the parent solution. The at least one water-soluble polymer and the at least one surfactant respectively are not considered as solvents.

**[0014]** It is advantageous, if the parent solution comprises exclusively water-soluble polymers. Other polymers that are not water-soluble are contained in the parent solution. At least one of the contained water-soluble polymers in the parent solution can be polyvinyl alcohol and/or polyvinyl methyl ether and/or polyethylene oxide and/or polyvinyl pyrrolidone and/or polyethylene glycol and/or polyacrylic acid and/or polyacrylamide.

**[0015]** It is advantageous, if the concentration of water in the parent solution is in the range of 30 wt-% to 99 wt-%, preferably from 50 wt-% to 95 wt-% further preferably from 60 wt-% to 90 wt-%.

**[0016]** The at least one water-soluble polymer can be selected from known polymers or polymer groups. The following list contains a non-exclusive listing of usable water-soluble polymers:

**[0017]** cellulose derivatives, like methyl cellulose, sodium carboxymethyl cellulose, hydroxymethyl cellulose, hydroxypropyl cellulose, hydroxypropylmethyl cellulose;

**[0018]** natural rubbers like gelatin, metal alginates (Na, K, Ca, Zn, Al), Agar;

**[0019]** starch derivatives like hydroxyethyl starch ether, hydroxypropyl starch;

**[0020]** dextran, hydroxyalkyl dextran, carboxyl lower alkyl dextran;

**[0021]** water-soluble polysaccharides like xanthan, pullulan, ulvan;

**[0022]** polyamino acids with a free carboxyl group like aspartic acid or glutamic acid;

**[0023]** polyalkylene glycol like polyethylene glycol and polypropylene glycol;

**[0024]** synthetic derivatives of polyethylene oxide, polyvinyl alcohol, polyvinyl methyl ether, polyvinyl

pyrrolidone, polyallyl- and diallylamines, polydimethylaminoethyl dimethacrylat, polyacrylic acid, polystyrene sulfonates, polyacrylamide, neutralized carbopol rubber and copolymers and mixtures of the named polymers.

**[0025]** In the parent solution can be contained exactly one or more of the named polymers.

**[0026]** Also copolymers or mixtures of the above-mentioned polymers can be used.

**[0027]** In the parent solution plasticizers can be contained for the present at least one polymer, like for example polyethylene glycol, polypropylene glycol, glycerine, trimethylolpropane, di-/tripropylene glycol or chemical compositions related therewith. When the concentration in the parent solution is determined, the plasticizers are added to the polymer portion and not to the solvent portion or the surfactant.

**[0028]** The concentration of the at least one water-soluble polymer in the parent solution is preferably in the range of 1 wt-% to 70 wt-%, preferably in the range of 5 wt-% to 50 wt-% and further preferably in the range of 10 wt-% to 40 wt-% including an optionally present plasticizer. The indicated concentration applies, if only one water-soluble polymer is present in the parent solution as well as for parent solutions with a plurality of water-soluble polymers.

**[0029]** In a preferred embodiment the parent solution comprises exactly one water-soluble polymer that can be completed with a suitable plasticizer for the used polymer.

**[0030]** It is further preferred, if the concentration of the at least one surfactant in the parent solution is in the range of 0.001 wt-% to 50 wt-% and further preferably in the range of 0.01 wt-% to 5 wt-% and further preferably in the range of 0.1 wt-% to 1.5 wt-%. It is preferred, if exactly one surfactant is contained in the parent solution.

**[0031]** It is preferred, if a tenside is used that evaporates during the solution blow spinning substantially or completely. Thus, no or only minor residuals of the surfactant remain in the produced fibers. In doing so, it is avoided that residuals of the surfactant lead to a negative impact of the mechanical properties and/or the chemical resistance of the produced fibers. Further, surfactant residuals can be disadvantageous for medical applications.

**[0032]** For the parent solution A any surfactant can be used that is indicated in the table below. In the table the trade name of the surfactant and indications of its composition are indicated respectively.

Name of surfactant	Composition
Abil	Silicone-based surfactants
Aerosol	Mostly sulfosuccinates
Aerosol OT (AOT)	Sodium dioctylsulfosuccinate
Akypo	Mostly alkyl ether carboxylates
Alkamide	Alkanolamides
Amiet	Ethoxylated amines and amides
Ammonyx	Amine oxides
Ampholak	Amphoterics
Arlacel	Fatty acid esters and ethoxylated fatty acid esters
Arlatone	Ethoxylated fatty acid esters
Armeen	Fatty amines
Atlas	Mostly ethoxylated compositions
Atlox	Surfactants and surfactant mixtures for pesticide formulations
Berol	Various, mostly ethoxylated compositions
Biodac	Ethoxylated C10 alcohol

-continued

Name of surfactant	Composition
Brij	Ethoxylated fatty alcohols
Britex	Ethoxylated fatty alcohols
Calgene	Various ester surfactants
Chemal	Ethoxylated fatty alcohols
Chemax	Various ethoxylated compositions
Chimipal	Alkanolamides and various ethoxylated compositions
Cithrol A, ML, MO und MS	Ethoxylated fatty acids
Cithrol, others	Glycol and glycerol ethers
Crodamine	Amine oxides
Crodet	Ethoxylated fatty acids
Dehydol	Ethoxylated fatty alcohols
Dehydrophen	Ethoxylated alkylphenols
Dehypon	Ethoxylated fatty alcohols, special, e.g. end-blocked
Dobanol	Ethoxylated fatty alcohols
Dowfax	Diphenyloxide-based sulfonates
Elfan	Various sulfates and sulfonates
Emal	Sulfates of alcohols and ethoxylated alcohols
Emcol	Various contents
Empicol	Sulfates of alcohols and ethoxylated alcohols, alkyl ether carboxylates
Empilan	Alkanolamides and various ethoxylated compositions
Empimin	Sulfates and sulfosuccinates
Emulan	Various ethoxylated compositions
Emulgante	Ethoxylated C16-C18 alcohols
Emulson	Various contents
Ethylan	Mostly ethoxylated compositions
Eumulgin	Various ethoxylated compositions
Findet	Various ethoxylated compositions
Fluorad	Fluorocarbon-based surfactants
Genapol	Ethoxylated fatty alcohols
Geroxon	Mostly sulfosuccinates and taurates
Glucopon	Sugar-based surfactants
Hamposyl	N-Acylsarcosinates
Hostapur	Alpha olefin sulfonates and petroleum sulfonates
Iconol	Various ethoxylated compositions
Igepal	Various ethoxylated compositions
Imbentim	Ethoxylated alkylphenols
Liallet	Ethoxylated fatty alcohols
Lipolan	Alpha olefin sulfonates
Lorodac	Ethoxylated fatty alcohols
Lutensol	Various ethoxylated compositions
Mackam	Amphoterics
Macol	Various ethoxylated compositions
Manro	Sulfates, sulfonates and alkanolamides
Marlipal	Ethoxylated fatty alcohols
Marlophen NP	Ethoxylated nonylphenol
Miranol	Imidazolines
Mirataine	Betaines
Monamid	Alkanolamides
Montane	Sorbitan derivatives
Myverol	Monoglycerides
Neodol	Ethoxylated fatty alcohols
Newcol	Various contents
Nikkol	Various contents
Ninol	Alkanolamides
Nissan Nonion	Various ethoxylated compositions
Trydet	Ethoxylated fatty acids and ester
Trylon	Ethoxylated fatty alcohols and oils
Tween	Ethoxylated sorbitan
Ufarol	Alkylbenzene sulfonates and sulfates of fatty alcohols and ethoxylated fatty alcohols
Ufaryl	Alkylbenzene sulfonates
Ufasan	Alkylbenzene sulfonates
Ungerol	Sulfates of ethoxylated fatty alcohols
Varamide	Alkanolamides
Variquat	Quaternary ammonium surfactants
Volpo	Ethoxylated fatty alcohols

-continued

Name of surfactant	Composition
Witcamide	Alkanolamides
Witconate	Alkylaryl sulfonates
Witconol	Glycol and glycerol esters
Ninol	Alkanolamides
Nissan Nonion	Various ethoxylated compositions

**[0033]** In one embodiment the parent solution can contain solid particles, e.g. organic and/or inorganic solid particles like SiO<sub>2</sub>, TiO<sub>2</sub>, ZrO<sub>2</sub>, CuO, ZnO or Ag, preferably with particle diameters that are smaller than the mean fiber diameter.

**[0034]** Preferably the parent solution no additional components to the solvent, to the at least one polymer, to the surfactant and to an optionally present plasticizer and to optionally present solid particles.

**[0035]** During solution blow spinning the parent solution emanates from at least one first output nozzle of a device. Concurrently a process gas emanates from at least one second output nozzle. At least one second output nozzle is assigned to each first output nozzle. The emanating process gas exits with high velocity. In doing so, the parent solution exiting the first output opening is taken or carried by the process gas.

**[0036]** Preferably the process gas is supplied under a pressure of 0.1 to 1000 psi, preferably from 5 to 80 psi and further preferably 10 to 60 psi to the at least one second output nozzle.

**[0037]** In one embodiment air or pressurized air can be used as process gas. The air can be supplied under a pressure of 10 to 80 psi to the at least one second output nozzle.

**[0038]** The parent solution can be supplied to the at least one first output nozzle by a pump device. A metering pump, e.g. a gear pump, an eccentric spiral pump, a reciprocating piston pump, a hose pump, a diaphragm pump or another displacement pump can be used as pump device.

**[0039]** Exactly one second output nozzle can be assigned to each first output nozzle. In such an embodiment the second output nozzle can surround the first output nozzle partly or completely, preferably ring-shaped. In a different embodiment at least two second output nozzles are assigned to each first output nozzle. The second output nozzles can be arranged uniformly distributed around the parameter of the first output nozzles. Also linear arrangements of the output nozzles can be used.

**[0040]** The output direction that is defined by the at least one first output nozzle and the output direction that is defined by the assigned at least one second output nozzle can be orientated parallel to each other. Alternatively, it is also possible that the output direction of the at least one second output nozzle is inclined relative to the output direction of the assigned at least one first output nozzle.

**[0041]** Due to the exiting process gas, a liquid jet of the parent solution is formed at least in a distance of some millimeters, e.g. of 0 to 100 mm or 0.5 to 20 mm or 1 to 5 mm. This liquid jet is carried or transported by the process gas. During the transport of the parent solution in the direction toward a collector, a contained solvent and/or the contained surfactant vaporizes preferably substantially completely, at least to 85% or at least to 90% or at least to 95% or at least to 99%. In doing so, the polymer contained in the

parent solution solidifies, that is no longer dissolved in the solvent. Solvent fibers created thereby are collected on the collector.

**[0042]** The nozzle collector distance of the at least one output nozzle to the collector has preferably an amount of at least 20 cm and further preferably of at least 25 cm. In one embodiment the nozzle collector distance can have an amount of about 30 to 70 cm. Preferably, the nozzle collector distance is smaller than 200 cm and further preferably smaller than 100 cm.

**[0043]** It is preferred that the boiling point of the solvent and/or the surfactant is thus small that the solvent and/or the surfactant evaporates after exiting from the at least one first nozzle.

**[0044]** The process gas may have a focusing and/or concentrating effect onto the exiting solution. The formation of a fluid jet of the exiting parent solution can be influenced by selection of process parameters, e.g. the composition of the parent solution and/or the temperature of the parent solution and/or the temperature of the process gas and/or the environment temperature and/or the temperature of the output nozzle arrangement and/or the velocity of the process gas and/or the chemical composition of the used process gas and/or a suction power of a suction device arranged at the collector.

**[0045]** The fiber diameter of the produced fibers has typically an amount of one twentieth to one thousandth of the opening diameter of the at least one first output opening. The fiber diameter is smaller than the diameter of the fluid jet exiting the at least one first output opening. A reduction of the fiber diameter relative to the diameter of the exiting fluid jet can be achieved and set by process parameters, e.g. the velocity of the exiting process gas. If, for example, the exiting velocity of the process gas is increased, the liquid jet is so to speak stretched along its path such that its diameter is reduced. Additionally, the solvent and/or surfactant is evaporated such that the liquid volume is reduced after exiting from the at least one first output nozzle.

**[0046]** Using the solution blow spinning it is for example possible to produce fibers in the micrometer or sub-micrometer or nanometer range with diameters of the at least one first output nozzle of, e.g. 0.2 to 1 mm. In one embodiment the produced fibers have a mean diameter of about 50 nanometers to 3 micrometers.

**[0047]** The process gas can be supplied to the at least one second output nozzle (21) with a temperature of 0° C. to 100° C., preferably 10° C. to 90° C. and further preferably 20° C. to 80° C.

**[0048]** After the production of the fibers it can be advantageous, if a post-treatment of the fibers is performed, e.g. by irradiation with an energy ridge radiation like UV light and/or a heat treatment and/or a plasma/corona treatment and/or a chemical treatment and/or another treatment for cross-linking. Due to such a post-treatment, it is possible to obtain fibers that are not water-soluble. Such a post-treatment can be performed simply and cheaply.

**[0049]** All of the ranges indicated in the description (“from . . . to . . .”) have to be apprehended as including the indicated range limit as long as not indicated otherwise.

**[0050]** Preferred embodiments of the invention result from the dependent claims, the description and the drawings. In the following preferred embodiments of the invention are explained in detail with reference to the attached drawings. The drawings show:

[0051] FIG. 1 a schematic diagram-like illustration of a device for producing fibers by solution blow spinning,

[0052] FIGS. 2 and 3 a schematic principle illustration of different output nozzle arrangements respectively, each having a first output nozzle and at least one assigned second output nozzle in a top view on the output nozzles,

[0053] FIGS. 4 and 5 a schematic principle illustration of different linear output nozzle arrangements of a plurality of first and second output nozzles in a top view onto the output nozzles,

[0054] FIGS. 6 and 7 a schematic cross-section view of an embodiment of an output nozzle arrangement, each having at least one first output nozzle and at least one assigned second output nozzle respectively and

[0055] FIG. 8 a highly schematic illustration of an embodiment of a produced fiber.

[0056] FIG. 1 shows a device 10 for the execution of a solution blow spinning method. The device 10 has a reservoir 11 for providing a parent solution A. A parent solution A is conveyed by a pump device 12 to a solution fluid connection 13 of a spin nozzle device 14.

[0057] Additionally, the spin nozzle device 14 comprises a process gas connection 15 by means of which a pressurized process gas G is supplied to the spin nozzle device 14. The process gas G can be formed by air or pressurized air for example. It can be extracted from a pressure reservoir 16. Alternatively, instead of the pressure reservoir 16 a compressor or the like can be present in order to draw air from the environment and to provide pressurized air as process gas G. The process gas G can also be a different gas, like nitrogen, helium or hydrogen.

[0058] The spin nozzle device 14 has at least one first output nozzle 20. At least one second output nozzle 21 is assigned to each first output nozzle 20. If a plurality of first output nozzles 20 is present, they can have exit or emission directions that are orientated differently, as schematically illustrated in FIG. 1.

[0059] The at least one first output nozzle 20 is fluidically connected with the solution fluid connection 13. The at least one second output nozzle 21 is fluidically connected with the process gas connection 15. Thus, the parent solution A exits through the at least one first output nozzle 20 and the process gas G exits through the at least one second output nozzle 21.

[0060] The process gas G exiting concurrently with the parent solution A carries the parent solution A and conveys it from the spin nozzle device 14 away in direction toward a collector 22. Due to the high velocity of the process gas G, one or more liquid jets 23 of the parent solution A are formed above the mouth of the respective first output nozzle 20. During the further path toward the collector 22, a solvent contained in the parent solution A and where applicable additional liquid components of the parent solution A evaporate, such that solid fibers 24 are formed that are collected at the collector 22.

[0061] The collector 22 can have moveable parts, e.g. a moving conveyor that is moved via drive rolls 25. In a modification compared with the illustrated embodiment, the collector 22 can also be formed immovably, statically.

[0062] The collector 22 is preferably gas permeable and can be formed, for example, by a grid or mesh-shaped carrier like a fine-meshed net. At the side opposite the spin nozzle device 14 of the collector 22 a suction device 26 can be present. The suction device 26 can be configured to move the

fibers 24 forming between the spin nozzle device 14 and the collector 22 toward the collector 22 by drawing of an air stream.

[0063] The nozzle collector distance  $z$  between the at least one first output nozzle 20 and the collector 22 and/or between the at least one second output nozzle 21 and the collector 22 has an amount of 20 cm or 25 cm. In the illustrated embodiment the nozzle collector distance  $z$  can have an amount of about 30 to 70 cm. Preferably the nozzle collector distance  $z$  is smaller than 200 cm and further preferably smaller than 100 cm.

[0064] In FIGS. 2 to 7 different embodiments of an output nozzle arrangement 30 of the spin nozzle device 14 are schematically illustrated as an example respectively. The spin nozzle device 14 can comprise one or more of the illustrated output nozzle arrangements 30. These can be arranged or orientated parallel or inclined with each other at the spin nozzle device 14. Each output nozzle arrangement 30 comprises at least one and, for example, exactly one first output nozzle 20 for the parent solution A and at least one assigned second output nozzle 21 for the process gas G.

[0065] In the embodiment illustrated in FIG. 2 the nozzle arrangement 30 contains exactly one first output nozzle 20 and exactly one assigned second output nozzle 21. The first output nozzle 20 is arranged in the center of a completely ring-shaped second output nozzle 21 that surrounds the first output nozzle 20 coaxially completely in the embodiment.

[0066] In the embodiment shown in FIG. 3 the output nozzle group 30 comprises exactly one first output nozzle 20 and a plurality of assigned second output nozzles 21 arranged adjacent thereto, e.g. four second output nozzles 21. The number of the second output nozzles 21 can vary, wherein at least two second output nozzles 21 are present. The second output nozzles 21 are preferably uniformly distributed in the peripheral direction around the first output nozzle 20. The second output nozzles can also have a curved slit form and partly surround the first output nozzle 20 in its peripheral direction.

[0067] In general a cross-section form of the output nozzles 20, 21 can be selected arbitrarily. According to the embodiment, circular or circular ring-shaped cross-sections are illustrated respectively. Also other polygonal or slit-like straight or curved cross-section contours can be provided, particularly for the at least one second output nozzle 21 of each output nozzle group 30.

[0068] FIGS. 4 and 5 show only by way of example that the output nozzles 20, 21 can be arranged in one or more rows side-by-side in a linear arrangement.

[0069] FIGS. 6 and 7 illustrate that the dashed dotted illustrated center length axis of the output nozzles 20, 21 of one output nozzle group 30 can be orientated parallel with each other (FIG. 6) or alternatively can be orientated inclined with regard to each other (FIG. 7). In the embodiment that is schematically shown in FIG. 7, the exit direction for the process gas G of the at least one second output nozzle 21 is inclined compared with the exit direction of the parent solution A, according to the example, such that the process gas G is orientated obliquely to the center length axis or the exit direction of the first output nozzle 20 at several circumferential locations.

[0070] The mouth of the at least one first output nozzle 20 is arranged with distance and preferably downstream of the process gas stream from the mouth of the at least one



assigned second output nozzle **21**. The distance can have an amount of, e.g. 0.5 to 20 mm or 1 to 10 mm or 1 to 5 mm or 2 to 3 mm.

**[0071]** The orientations of the exit directions according to FIGS. **6** and **7** can be provided for the output nozzle group **30** of FIG. **2** as well as for the output nozzle group **30** of FIG. **3**.

**[0072]** For formation of the parent solution A at least one and preferably exactly one water-soluble polymer from which the fibers **24** shall be formed, is dissolved in a solvent and according to the example in water. The parent solution additionally contains at least one surfactant. Also for the at least one polymer of the parent solution A a plasticizer can be contained in the parent solution A. The polymer can be dissolved in solid form, e.g. as powder, in form of small balls or pellets or the like in the water of the parent solution A that serves as solvent.

**[0073]** The concentration of the at least one water-soluble polymer in the parent solution A can have an amount of 1 wt-% to 70 wt-%, preferably 5 wt-% to 50 wt-%, further preferably 10 wt-% to 40 wt-%. If a plasticizer is used for the at least one polymer, the values of the concentration refer to the total sum of the at least one polymer including the plasticizer.

**[0074]** In preferred embodiments the concentration of the water and the parent solution has an amount of 30 wt-% to 99 wt-%, preferably 50 wt-% to 95 wt-% and further preferably 60 wt-% to 90 wt-%.

**[0075]** In the embodiment the concentration of the surfactant in the parent solution A has an amount of 0.001 wt-% to 50 wt-%, preferably 0.01% to 5 wt-% and further preferably 0.1 wt-% to 1.5 wt-%.

**[0076]** The process gas G can be supplied at the process gas connection **13** with a pressure of up to 1000 psi, preferably with a pressure of 5 to 80 psi. If air is used as process gas G, the pressure can be in the range of 10 to 60 psi. The process gas G has a temperature in the range of 0° C. to 100° C., preferably 10° C. to 90° C. and further preferably of 20° C. to 80° C. when supplied to the spin nozzle device **14**. According to the example, the process gas temperature of the process gas G during supply to the spin nozzle device **14** is higher than the environment temperature, e.g. a room temperature, and can be in the range of 35° C. to 70° C.

**[0077]** The fibers **24** formed by polymer chains are obtained in the method, because the solvent, here water, and/or the at least one surfactant evaporates completely or at least partly on the way between the spin nozzle device **14** and the collector **22**. That is the solvent and/or the surfactant evaporate by at least 85% or at least by 90% or at least by 95% or at least by 99%.

**[0078]** During the method by use of the device **10**, the fibers **24** are formed. A fiber fleece of fibers **24** is created on the collector **22**, wherein preferably the fiber diameter is in the micrometer range, in the sub-micrometer range or in the nanometer range. The fibers **24** consist substantially of the polymer present in the parent solution A optionally additionally of the plasticizer used for the at least one polymer.

**[0079]** The created fibers **24** have preferably a ratio of a length L to a mean thickness D of at least 100:1, preferably at least 500:1, further preferably at least 1000:1 and yet further preferably at least 10000:1. Preferably the fibers **24** have a length L of at least 1 mm, preferably of at least 3 mm and further preferably of at least 5 mm.

**[0080]** Subsequently, examples 1 to 4 are indicated that describe a possible composition of a parent solution A and features of the device **10**.

#### EXAMPLE 1

**[0081]** For producing the polymer solution 10 wt-% of polyvinyl alcohol powder (with a molecular weight of 130000 u) are dissolved in distilled water (88 wt-%) and 2 wt-% of the surfactant polyoxyethylen(23)lauryl ether (known under the trade name Brij-35) are added. From the polymer solution fine fibers **24** are produced by the solution blow spinning method. The method is executed by using pressurized air as process gas G that is supplied with a pressure of 10 psi to the at least one second output nozzle **21**. The at least one first output nozzle **20** has a diameter of 0.6 mm (at the exit opening). The distance between the at least one first output nozzle **20** and the collector **22** has an amount of 65 cm. The fibers produced with this method have a fiber diameter with a diameter in the range of 50 to 400 nm. The mean value of the diameter of the created fibers **24** is at 200 nm.

#### EXAMPLE 2

**[0082]** The polymer solution is produced of 12 wt-% polyvinyl alcohol (molecular weight 130000 u) that is dissolved in distilled water that is present in the parent solution A with 87 wt-%. The parent solution A comprises 1 wt-% isopropanol. The method is executed under use of pressurized air as process gas G that is supplied to the at least one second output nozzle **21** under a pressure of 20 psi. The at least one first output nozzle **20** has a diameter of 0.6 mm (at the exit opening). The distance between the at least one first output nozzle **20** and the collector **22** has an amount of 65 cm. The fibers **24** produced with this method have a fiber diameter with a range of 100 to 450 nm. The mean value of the diameter of the created fibers **24** is at 240 nm.

#### EXAMPLE 3

**[0083]** 10 wt-% polyvinyl alcohol (molecular weight 130000 u) and 2 wt-% polyvinyl methyl ether are dissolved in 87 wt-% water. The parent solution A also contains 1 wt-% isopropanol. The method is executed under use of pressurized air as process gas G that is supplied with a pressure of 20 psi to the at least one second output nozzle **21**. The at least one first output nozzle **20** has a diameter of 0.8 mm (at the exit opening). The distance between the at least one first output nozzle **20** and the collector **22** has an amount of 65 cm. The fibers **24** produced with this method have a fiber diameter in the range of 100 to 500 nm. The mean value of the diameter of the created fibers **24** is at 250 nm.

#### EXAMPLE 4

**[0084]** 3 wt-% of polyethylene oxide (molecular weight 600.000 u) are dissolved in 96 wt-% of distilled water. The parent solution A also contains 2 wt-% isopropanol. The method is executed under use of pressurized air as process gas G that is supplied under a pressure of 40 psi to the at least one second output nozzle **21**. The at least one first output nozzle has a diameter of 0.6 mm. The distance between the at least one first output nozzle **20** and the collector **22** has an amount of 65 cm. The fibers **24** produced

with this method have a fiber diameter in the range of 100 to 500 nm. The mean value of the diameter of the created fibers **24** is at 250 nm.

**[0085]** The four examples above or in general the spinning method according to the invention can be further optimized by the use of additional and/or alternative surfactants. For example, each surfactant and/or polymer can be used that is contained in the tables indicated at the beginning of the description.

**[0086]** Further specific examples result particularly from the selection of the composition of the components of the parent solution A in the ranges, as indicated in the description.

**[0087]** The features of the device **10** indicated in the examples 1 to 4 can also be used for other compositions of the parent solution A respectively.

**[0088]** The invention refers to the use of a parent solution A during a method for producing fibers for a fiber fleece by a so-called solution blow spinning. Water is used as solvent for the parent solution A. At least one water-soluble polymer and preferably exactly one water-soluble polymer is dissolved in the water of the parent solution A. The parent solution A additionally contains at least one surfactant and optionally plasticizer for the used at least one polymer respectively. By means of a parent solution A it is possible to produce fibers **24** by solution blow spinning environmental friendly.

#### REFERENCE LIST

<b>[0089]</b>	<b>10</b> device
<b>[0090]</b>	<b>11</b> reservoir
<b>[0091]</b>	<b>12</b> pump device
<b>[0092]</b>	<b>13</b> solution fluid connection
<b>[0093]</b>	<b>14</b> spin nozzle device
<b>[0094]</b>	<b>15</b> process gas connection
<b>[0095]</b>	<b>16</b> pressure reservoir
<b>[0096]</b>	<b>20</b> first output nozzle
<b>[0097]</b>	<b>21</b> second output nozzle
<b>[0098]</b>	<b>22</b> collector
<b>[0099]</b>	<b>23</b> liquid jet
<b>[0100]</b>	<b>24</b> fiber
<b>[0101]</b>	<b>25</b> drive roll
<b>[0102]</b>	<b>26</b> suction device
<b>[0103]</b>	<b>30</b> output nozzle group
<b>[0104]</b>	A parent solution
<b>[0105]</b>	D thickness of the fiber
<b>[0106]</b>	G process gas
<b>[0107]</b>	L length of the fiber
<b>[0108]</b>	z nozzle collector distance

**1.** A method for producing fibers and fleece materials (**24**) by solution blow spinning using a parent solution (A), the method comprising:

- formulating the parent solution (A) using water as a solvent,
- dissolving at least one water-soluble polymer in the parent solution (A),
- adding at least one surfactant to the parent solution (A); and
- producing at least one of a fiber and a fleece material by solution blow spinning using the parent solution (A).

**2.** The method according to claim **1**, wherein formulating the parent solution (A) includes using water exclusively as the solvent.

**3.** The method according to claim **1**, wherein the at least one water-soluble polymer in the parent solution (A) contains exclusively polymers that are water-soluble.

**4.** The method according to claim **1**, wherein the at least one water-soluble polymer is one or any combination of polyvinyl alcohol, polyvinyl methyl ether, polyethylene oxide, polyvinyl pyrrolidone, polyethylene glycol, polyacrylic acid, and polyacrylamide.

**5.** The method according to claim **1**, wherein the concentration of the water in the parent solution (A) has an amount of 30 wt-% to 99 wt-%.

**6.** The method according to claim **5**, wherein the concentration of the water in the parent solution (A) has an amount of 50 wt-% to 95 wt-%.

**7.** The method according to claim **6**, wherein the concentration of water in the parent solution (A) has an amount of 60 wt-% to 90 wt-%.

**8.** The method according to claim **1**, wherein the concentration of the at least one water-soluble polymer in the parent solution (A) has an amount of 1 wt-% to 70 wt-%.

**9.** The method according to claim **8**, wherein the concentration of the at least one water-soluble polymer in the parent solution (A) has an amount of 5 wt-% to 50 wt-%.

**10.** The method according to claim **8**, wherein the concentration of the at least one water-soluble polymer in the parent solution (A) has an amount of 10 wt-% to 40 wt-%.

**11.** The method according to claim **1**, wherein the concentration of the at least one surfactant in the parent solution (A) has an amount of 0.001 wt-% to 50 wt-%.

**12.** The method according to claim **11**, wherein the concentration of the at least one surfactant in the parent solution (A) has an amount of 0.01 wt-% to 5 wt-%.

**13.** The method according to claim **12**, wherein the concentration of the at least one surfactant in the parent solution (A) has an amount of 0.1 wt-% to 1.5 wt-%.

**14.** The method according to claim **1**, wherein the at least one surfactant has a characteristic to at least partly evaporate during the solution blow spinning.

**15.** The method according to claim **1**, wherein the parent solution comprises solid particles.

**16.** The method according to claim **1**, further comprising: emitting the parent solution (A) from at least one first output nozzle (**20**), emitting a process gas (G) from at least one second output nozzle (**21**) that is arranged adjacent to the at least one first output nozzle (**20**) while concurrently with the emitting the parent solution (A) from the at least one first output nozzle.

**17.** The method according to claim **16**, further comprising producing one or any combination of microfibers, sub-microfibers, nanofibers, and fleece materials formed thereof.

**18.** The method according to claim **16**, further comprising supplying the process gas (G) to the at least one second output nozzle (**21**) at a pressure of 0.1 to 100 psi.

**19.** The method according to claim **18**, further comprising supplying the process gas (G) to the at least one second output nozzle (**21**) a pressure of 5 to 80 psi.

**20.** The method according to claim **19**, further comprising supplying the process gas (G) to the at least one second output nozzle (**21**) a pressure of 10 to 60 psi.

**21.** The method according to claim **16**, further comprising supplying the process gas (G) to the at least one second output nozzle (**21**), wherein the process gas (G) has a temperature of 0° C. to 100° C.

**22.** The method according to claim **21**, wherein the process gas (G) has a temperature of 10° C. to 90° C.

**23.** The method according to claim **21**, wherein the process gas (G) has a temperature of 20° C. to 80° C.

**24.** The method according to claim **16**, wherein the solvent in the parent solution (A) evaporates at least partly after the parent solution is emitted from the at least one first output nozzle (**20**).

**25.** (canceled)

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