

The invention relates to a process for the preparation of cellulosic fibres by moulding a solution of cellulose in a tertiary amine oxide into filaments in a heated condition, cooling the filaments and then introducing them
5 into a precipitation bath in order to precipitate the dissolved cellulose, and to a device for carrying out the process.

US-PS 2,179,181 discloses that tertiary amine oxides are
10 capable of dissolving cellulose and that cellulosic fibres can be obtained from these solutions by precipitation. A process for the preparation of such solutions is disclosed, for example, in EP-A-0 356 419. According to this publication, a suspension of cellulose is first
15 prepared in an aqueous tertiary amine oxide. The amine oxide contains up to 40% by mass of water. The aqueous cellulose suspension is heated and water is distilled off under reduced pressure until the cellulose dissolves. The process is carried out in a specially developed,
20 evacuable stirred apparatus.

For the preparation of cellulosic fibres, it is known from DE-A-28 44 163 to arrange an air path or an air gap between spinneret and precipitation bath in order to
25 achieve a nozzle draft. Said nozzle draft is necessary since, after the moulded spinning solution has made contact with the aqueous precipitation bath stretching of the yarns is made very difficult. The fibre structure established in the air gap is fixed in the precipitation
30 bath.

A process of the type mentioned at the outset is disclosed in DE-A-28 30 685, according to which a solution of cellulose in a tertiary amine oxide is moulded into
35 filaments in a heated condition, and the filaments are cooled with air and then introduced into a precipitation bath to precipitate the dissolved cellulose. The surface

of the spun yarns is furthermore already wetted with water in order to reduce their tendency to stick to adjacent yarns.

5 It has been found that all the processes of the prior art are unsatisfactory in relation to filament formation and the textile properties of the fibres. Because of the short spinning gap between spinneret and precipitation bath, which is in the region of a few centimetres, and
10 the very short time, associated therewith, in which the properties of the fibre can be established, it is difficult to achieve, for example, a uniform titre, and a uniform strength and elongation for all the filaments of the filament bundle and for the fibres obtained after
15 precipitation.

This is the starting point of the invention, whose object is consequently to improve the process mentioned at the outset in such a way that, using a spinneret with high
20 orifice density, a dense yarn bundle can be spun in which the textile properties of the spun yarns can be adjusted better.

This object is achieved, according to the invention, in that, in a process for the preparation of cellulosic fibres in which a solution of cellulose in a tertiary amine oxide is moulded into filaments in a heated condition, and the filaments are cooled and then introduced into a precipitation bath in order to precipitate the
25 dissolved cellulose, the moulded solution is cooled by exposure to an essentially laminar gas flow before it is introduced into the precipitation bath.
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The invention is based on the finding that the textile
35 properties of the fibres can be influenced by blowing with an inert gas, preferably air. The cooling process of the filament emerging from the spinneret influences

not only the yarn quality, but also the stretching and the elongation of the filaments. According to the invention, it has been found that fibres having uniform properties can be prepared if the freshly extruded
5 filaments are blown with a cooling gas stream which has, if possible, no turbulence, that is to say is substantially laminar. This results in a decisive improvement in the spinning process.

10 A preferred variant of the process according to the invention is that the laminar gas flow is directed substantially at right angles to the filaments.

It has proved advantageous to pass the heated cellulosic
15 solution through a spinneret having a multiplicity of spinning orifices which are arranged in an annular fashion, whereby an annular filament bundle is formed, in which process the laminar gas flow is provided in the centre of the ring formed by the spinning orifices and is
20 directed radially outwards.

The invention also relates to a device for carrying out the process according to the invention, wherein the device includes an inlet for cooling gas and a spinneret
25 with spinning orifices which are arranged essentially in an annular fashion to form an annular filament bundle and which device is characterized in that the inlet for cooling gas is provided in the centre of the ring formed by the arrangement of the spinning orifices and the inlet
30 is designed in such a way that an essentially laminar gas flow strikes the filaments and the filaments are cooled by a laminar gas flow.

An expedient embodiment of the device according to the
35 invention is such that the inlet for the cooling gas has a pipe-shaped inlet and a baffle plate for deflecting the gas flow, the baffle plate being so arranged that the gas

flow remains as laminar as possible during deflection.

The invention furthermore relates to the use of the device according to the invention for the preparation of
5 cellulosic fibres from a solution of cellulose in a tertiary amine oxide.

The process according to the invention is explained in more detail by way of example with reference to the
10 drawing, in which Figure 1 shows diagrammatically the carrying-out of a dry/wet spinning process for the preparation of cellulosic fibres according to the prior art and Figure 2a shows a preferred embodiment of the spinning device according to the invention. Figure 2b
15 shows a detail of Figure 2a on an enlarged scale. As a comparison, Figure 3 shows a device which does not have the features according to the invention.

In Figure 1, 1 denotes a heatable spinneret (heating
20 system not shown), which is charged with spinning material 3, i.e. heated cellulose solution having a temperature of about 100°C, via the feedpipe 2. The pump 4 serves to meter the spinning material and to establish the pressure necessary for the extrusion. The yarn
25 bundle extruded from the spinneret 1 via the spinning orifices is denoted by the reference numeral 5.

The fibre bundle 5 is fed into the precipitation bath 6 via an air path which is defined by the distance of the
30 spinneret 1 from the surface of the precipitation bath 6, is collected by means of a deflection roll 7 and drawn off. The extruded yarn bundle 5 is cooled with air, which is shown in the figure diagrammatically by an arrow. A draft is achieved by drawing off the fibre
35 bundle 5 via the roll 7 at a greater velocity than it leaves the spinneret 1.

Figure 2a shows in section an annular, heatable spinneret 1' (heating system not shown) and a blowing device comprising a central tubular inlet 8 for cooling gas and a baffle plate 9 for deflecting the gas stream from the vertical direction into an essentially horizontal direction. The annular spinneret 1' is supplied at a point not shown in the drawing with spinning material 3' which is spun to form a dense annular yarn bundle 5' which is blown with cooling gas from the inside. The blowing direction is indicated in the figure by means of a broken arrow. The cooling air consequently emerges from a circular slot-type nozzle which is formed by the baffle plate 9 and by the counterpart 10.

The gas stream strikes the plate-shaped baffle plate 9, is deflected horizontally, emerges as a laminar gas flow and strikes the annular yarn bundle 5' on its inside.

To generate a laminar cooling gas flow, the embodiment shown in Figure 2a of the device according to the invention has a baffle plate which deflects the vertical cooling gas stream into an essentially horizontal gas flow without an abrupt transition. Figure 2b shows that part in Figure 2a in enlarged form which is provided for the maintenance of the laminar flow. The angles shown in Figure 2b preferably have the following values:

α (baffle plate):	$\leq 12^\circ$, preferably: $3 - 8^\circ$;
β (upper guide plate):	$\leq 10^\circ$, preferably: $4 - 8^\circ$;
δ (outer bead):	$\leq 30^\circ$, preferably: $15 - 25^\circ$;
σ ($\alpha + \beta$):	$\leq 22^\circ$.

An abrupt transition between the inlet 8 and the baffle plate 9 results in a compression of the air jet with the formation of high turbulence. Such a device, which is not according to the invention, is shown in Figure 3.

The blowing device shown in Figure 2b can either form a structural unit together with the annular spinneret 1' or be a separate component on which the spinneret 1' rests. Expediently, an insulation (not shown) is provided
5 between blowing device and spinneret in order to suppress a heat transfer from the spinning material to the cooling air.

It is also advantageous that the circular exit slot opens
10 at a total aperture angle of $\leq 22^\circ$ after deflection of the gas stream. The flow resistances for the cooling gas are minimized by the steady increase in cross section. A separation of the cooling gas flow is prevented by the small total aperture angle and a turbulence-free flow
15 towards the filaments is made possible.

It has furthermore been found that after passing through the yarn bundle, the gas stream partially returns into the yarn bundle again after being heated as a consequence
20 of vortex formation, which results in an inadequate and irregular cooling. The consequences are different drafting properties of the filament bundle, which may result in a filament bundle which is not uniformly loaded by the drafting force and consequently in capillary
25 tears, in spinning faults and in conglutinations. In order to prevent this and to optimize the spinning process further, a preferred embodiment of the device according to the invention has an annular bead 11 which deflects the cooling gas stream which has passed through
30 the yarn bundle slightly downwards from the plane of the spinneret.

The invention is described in still greater detail by the exemplary embodiments below.

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Example and comparison example

A cellulose solution prepared in accordance with the process described in EP-A-0 356 419 was filtered and spun in the heated condition in accordance with the process shown in Figure 1, the device shown in Figure 2a and, in the comparison example, the device shown in section in Figure 3 being used as spinning device. Both devices had the same internal diameter of the tubular inlet 8 for cooling gas (44 mm) and the same diameter of the baffle plate 9 (104 mm). In the example (device according to the invention), the angles α and β were each 5° ; the total aperture angle σ was consequently 10° . The angle δ was 5° .

The table reports the mass of cellulose solution (kg/h) spun per hour for the example and for the comparison example, its composition (% by mass), its temperature ($^\circ\text{C}$) during spinning, the orifice density (number of orifices/ mm^2) in the spinneret, the diameter of the spinning orifices (μ), the nozzle draft, the supply of cooling air (m^3/h), its temperature ($^\circ\text{C}$), the temperature ($^\circ\text{C}$) of the internal cooling air removed, the fibre draft, the NMMO content of the precipitation bath (% by mass of NMMO) and the final titre of the fibres prepared (dtex).

TABLE

	Example	Comparison example
Cellulose solution (kg/h)	27.6	27.6
Cellulose content (% by mass)	15	15
Temp. of the cellulose soln. ($^\circ\text{C}$)	117	117
Orifice density (orifices/ mm^2)	1.59	1.59
Orifice diameter (μm)	100	100

	Nozzle draft	14.5	12.4
	Cooling air (m ³ /h)	34.8	34.8
	Temp. of cooling air supplied	21	21
	Temp. of cooling air removed	36	36
5	Precipitation bath (% NMMO)	20	20
	Temp. of precipitation bath	20	20
	Minimum yarn titre (dtex)	1.18	1.38

- 10 It consequently emerges that the achievable yarn fineness (= minimum yarn titre in dtex) is very decisively influenced by the routing of the cooling gas as a result of the blowing device which is beneficially constructed in terms of flow. It was possible to achieve a nozzle draft
- 15 ratio of 14.5:1 only with the blowing device according to the invention, the yarn fineness being 1.18 dtex. In the comparison example, the achievable yarn fineness was about 20% less favourable.



CLAIMS

1. Process for the preparation of cellulosic fibres by moulding a solution of cellulose in a tertiary amine oxide into filaments in a heated condition, cooling the filaments and then introducing them into a precipitation bath in order to precipitate the dissolved cellulose, characterized in that the moulded solution is cooled by exposure to an essentially laminar gas flow before it is introduced into the precipitation bath.
2. Process in accordance with Claim 1, characterized in that the laminar gas stream is directed substantially at right angles to the filaments.
3. Process in accordance with Claim 1 or 2 for the preparation of cellulosic fibres, wherein the heated cellulose solution is led through a spinneret (1') having a multiplicity of spinning orifices which are arranged in an annular fashion, whereby an annular filament curtain (5') is formed, characterized in that the laminar gas flow is provided in the centre of the ring formed by the spinning orifices and is directed radially outwards.
4. Device for carrying out the process in accordance with one of Claims 1 to 3, wherein the device includes an inlet for cooling gas and a spinneret (1') with spinning orifices which are arranged essentially in annular fashion to form an annular filament bundle (5'), characterized in that the inlet for cooling gas is provided in the centre of the ring formed by the arrangement of the spinning orifices and the inlet is designed in such a way that an essentially laminar gas flow strikes the filaments and the filaments are cooled by a laminar gas flow.
5. Device in accordance with Claim 4, characterized in that the inlet for cooling gas has a pipe-shaped inlet



(8) and a baffle plate (9) for deflecting the gas flow, the baffle plate (9) being so arranged that the gas flow remains as laminar as possible during deflection.

- 5 6. Use of a device in accordance with one of Claims 4 or 5 for the preparation of cellulosic fibres from a solution of cellulose in a tertiary amine oxide.