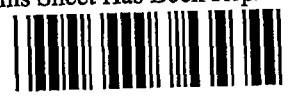


Apparatus for high speed spinning multifilament yarns and use thereof

This Sheet Has Been Replaced



Akzo nv, Arnhem

5 Description:

The present invention relates to apparatus for high speed spinning multifilament yarns from fibre-forming polymers at wind-up speeds of at least 2,000 m/min, comprising a spinnerette, a cooling means
10 for solidifying the filaments, a convergence element for the filaments and a wind-up means and having, at least between the spinnerette and the first convergence element, an essentially vertical spinline. The invention also concerns the use of this apparatus for manufacturing
15 polyester filament yarns.

In the manufacture of multifilament yarns from fibre-forming polymers the economics are crucially affected by the wind-up speed. Wind-up speeds of 3,500 to about 5,000 m/min are common today, while wind-up speeds
20 of more than 5,000 m/min to about 12,000 m/min are also known. At these high wind-up speeds, in particular at wind-up speeds above 5,000 m/min, it is known from prior art manufacturing processes that the design of the apparatus used plays an ever greater part, whereas purely
25 process features are increasingly less significant.

For instance, EP-A-56 963 describes a process for manufacturing a polyester fibre using a wind-up speed of at least 5,000 m/min wherein the extruded filaments are initially guided through a heating zone at least 50 mm in
30 length and then directly into a suction means before they are wound up. As is discernible from the drawing, the apparatus described for carrying out this process has a notably simple design.

Further simplification of this known apparatus is
35 revealed in EP-A-95 712, wherein the heating zone is initially followed by a cooling means for solidifying filaments and then by a convergence element for the filaments, after which the multifilament yarn is wound

THIS SHEET HAS BEEN
REPLACED



up. Essential parts of this apparatus are the heating zone below the spinnerette, the location for bundling the filaments and the wind-up speed of 7,000 m/min or more. Similar apparatus is described in EP-A-117 215, wherein
5 not only the location for converging the filaments but also the distance between the spinnerette and the wind-up means are specified as essential features.

Although the descriptions of the aforementioned pieces of apparatus mention that a cooling means is
10 necessary for solidifying the filaments, they do not provide any indications about the design of the cooling means.

EP-A-244 216 observes in relation to the design of the cooling means that the cooling air should be
15 supplied under controlled conditions radially from out to in via a wire mesh cylinder. This apparatus additionally requires a sharp reduction in the exit cross-section of the wire mesh cylinder to a narrow tube, as a result of which the start-up of spinning is very complicated.

20 In WO 90/02222 the filament yarns are spun into a closed spinchamber. When this spin chamber is used as cooling means, cooling air is sucked in via an injector. To start up spinning it is initially necessary to remove the injector, as a result of which the start-up of
25 spinning is very complicated.

It is an object of the present invention to provide apparatus of the type mentioned at the beginning that is simple in structure and suitable for manufacturing multifilament yarns from fibre-forming polymers at
30 wind-up speeds of at least 2,000 m/min, in particular at least 5,000 m/min, where, furthermore, the start-up of spinning shall be simple to accomplish and the use of which for manufacturing multifilament yarns shall be particularly versatile.

35 This object is achieved when the cooling means is a porous tube which is open in the spinning direction and concentric relative to the spinline, which porous tube is neither preceded nor followed by any further means for charging and/or discharging a cooling medium.

THIS SHEET HAS BEEN
REPLACED



This is because it was found that the manufacture of multifilament yarns especially at very high wind-up speeds is particularly successful without an active supply of a cooling medium. It is surprisingly completely
5 sufficient for the spinnerette to be followed by a porous tube which is open in the spinning direction without having to provide further attachments to the tube for charging a cooling medium or for sealing off from the outside. It is even completely sufficient for the air
10 which surrounds the porous tube to be at room temperature, so that the apparatus of the invention is particularly economical to operate. Additionally to the above-recited features of the cooling means employed in the apparatus of the invention it is merely necessary to
15 arrange the porous tube concentrically relative to the spinline. A length of 200 to 1,800 mm for the porous tube has been found to be favourable.

Using spinning apparatus of the type defined it is possible to process virtually any spinnable polymer
20 into multifilament yarn. Especially polyethylene terephthalate, polyamide, nylon-6, nylon-6,6, copolymers thereof and mixtures of these polymers are best suited for spinning by apparatus of the invention.

Owing to the simple construction of cooling means
25 of apparatus of the invention it is also very simple to adapt the length of the tube to optimal spinning at all times. It is merely necessary to provide a set of porous tubes of different lengths within the range from 200 to 1,800 mm, in which the lengths of the individual tubes
30 differ for example by increments of about 100 mm. However, for further simplification the porous tube may also have a telescopic structure. To manufacture fully oriented yarns (FOYs), which are wound up at a speed of 5,000 to 10,000 m/min, it is particularly advantageous
35 for the porous tube to be from 200 to 1,200 mm in length, whereas partially oriented yarns (POYs), which in general are wound up at 2,000 to 5,000 m/min, will be produced using a porous tube from 900 to 1,800 mm in length. To manufacture thicker filaments or filament yarns having a



higher total linear density the porous tube used should have a length at the upper end of the above-specified length range.

It is fully sufficient for the porous tube to have a constant cross-section in its longitudinal direction, which makes the start-up of spinning with the apparatus particularly simple to accomplish, since the filaments pass through the tubular zone in free-fall and can be collected underneath the tube. However, it is also possible to use other tube shapes, for example frustoconical tubes.

The cooling air required for solidifying the filaments is aspirated through the porous tube by the filaments themselves, owing to their high speed. Pre-treatment of the cooling air is not necessary. Especially in the case of polyester filament yarns the usual atmospheric conditions in the vicinity of the apparatus of the invention are sufficient, which is why the operating personnel can work on the apparatus of the invention under comfortable conditions. Compared with known apparatus the apparatus of the invention requires less space, since no ducts are necessary for supplying conditioned air. The start-up of spinning is less wasteful. The apparatus is also notable for particularly low energy requirements, since no conditioning of the cooling air and no further means for influencing the temperature of the yarn are required until the yarn is wound up.

Especially at very high spinning speeds it is an advantage for the spinline to be essentially vertical between spinnerette and wind-up.

In the apparatus of the invention it has proved to be particularly advantageous for the porous tube to be cylindrical, in which case the cross-section of the cylinder may have virtually any widely-used geometric shape such as, for example, that of a circle, ellipse, octagon or hexagon. It is particularly advantageous for the inner cross-section of the porous tube to have at least approximately the same geometrical shape as the outer contour of the filament bundle. This results in a

THIS SHEET HAS BEEN
REPLACED



particularly uniform solidification of the individual filaments. It is advantageous here for the distance between the outer contour of the filament bundle and the inner surface of the porous tube at the entry cross-section to be selected in such a way that contact with the tube wall is avoided in any event. A suitable figure for the distance between filament bundle contour and tube wall is 5 to 40 mm, the distance being shorter, for example 5 to 20 mm, in the case of shorter porous tubes and greater, for example 20 to 30 mm, optionally up to 40 mm, in the case of longer tubes.

In the choice of material for the porous tube it is merely necessary to ensure that the porous tube can be attached directly to the spinnerette and thus that it will not soften at the temperatures prevailing in the spinnerette. Suitable materials for this purpose are in particular metals, especially steel. At least the porous tube should adjoin the spinnerette, the spin pack or a cooling delay means interposed between spinnerette and porous tube in such a way that, in the region of the porous tube, air ingress is possible only via the pore system of the porous tube and that uncontrolled inflow of cooling medium into the region underneath the spinnerette is effectively avoided.

The porosity of the tube can in the simplest case be achieved with a perforated tube or else with sintered metals. In principle, any porous tube is suitable whose porosity will, at an air flow rate of 1 m/s, produce a pressure drop of about 3 to 150 Pa, advantageously in the region of 10 Pa. However, it is particularly advantageous for the porous tube to be formed of a metal sieve, in which case a metal sieve of 60 mesh is most suitable. To stabilize the metal sieve a further tube of perforated metal can be arranged inside it.

The porous tube can be connected directly to the spinnerette. However, it is also possible to connect between the spinnerette and the porous tube a device up to 300 mm in length which will inhibit the cooling of the filaments and is adjoined by the porous tube.

THIS SHEET HAS BEEN
REPLACED



Inhibition of filament cooling can be effected for example as a result of the fact that the means inhibiting the cooling comprises a hot airstream enveloping the filaments. This ensures a particularly uniform
5 delayed cooling of the filaments. Advantageous results are achieved when the hot air jacket has a temperature which corresponds approximately to the temperature of the spinnerette.

The hot air jacket can be put into effect
10 particularly advantageously when the spinnerette is a multiple spinnerette where the melt is extruded in the centre and where there are arranged concentrically around the centre one or more orifices through which exits a hot airstream which envelops the filaments. It is particu-
15 larly advantageous here for the orifice arranged concentrically around the centre to be an annular gap. The use of such spinnerettes for the delayed cooling of filaments is known per se from DE-A-3 941 824 and EP-A-
0 455 897.

20 Inhibition of filament cooling can also be achieved in a particularly simple manner when the means inhibiting the cooling of filaments is a heated tube or in particular an unheated tube.

This means inhibiting the cooling of filaments is
25 particularly simple when a part, up to 300 mm in length, of the end of the porous tube facing the spinnerette is sealed off. The sealed-off part is preferably situated directly underneath the spinnerette.

Inhibited filament cooling results in delayed
30 cooling of the filaments, as a result of which smooth processing is promoted in particular at low filament linear densities.

However, to manufacture thicker filaments or if relatively long porous tubes are used it is advantageous
35 for the sealing of the porous tube to be situated at a distance of 200 to 300 mm away from the spinnerette.

The apparatus of the invention is particularly advantageous when the convergence element is situated at a distance of 400 to 2,200 mm away from the spinnerette,

but at least about 100 mm below the porous tube. In the simplest case the convergence element can be a yarn guide. However, it is particularly advantageous for the convergence element to be a conventional spin finish applicator.

The apparatus of the invention also makes it possible to achieve particularly large distances between spinnerette and wind-up, for example up to 9,000 mm. The apparatus of the invention is particularly suitable when the wind-up means is situated about 2,000 to 4,000 mm underneath the spinnerette. At spinning speeds of 6,000 m/min or more for manufacturing FOY a distance between spinnerette and wind-up of 2,000 to 3,500 mm, preferably 2,400 mm, is most suitable, and in the case of spinning speeds of 2,000 to 5,000 for manufacturing POY a distance of 2,500 to 3,500 mm, preferably 3,000 mm, is most suitable, although for the manufacture of yarns having a filament linear density of more than 3 dtex or a total linear density of more than 100 dtex this distance should be extended to as far as 4,000 mm. Such apparatus is notable in particular for its lack of height, as a result of which the operating personnel need work only on one floor. Installation of the apparatus according to the invention from scratch thus also results in lower building costs. The apparatus of the invention is particularly notable for reliability.

In most cases a means for entangling the filaments is disposed upstream of the wind-up means.

A further reduction in spinning problems is achieved by disposing upstream of the spinnerette a line for feeding the polymer melt from an extruder to the spinnerette, in which line there is disposed at least one static mixer. In this way the uniformity properties of the spun filament yarns are also advantageously influenced.

It is of advantage for the static mixers to be disposed within the melt line at one or more locations between extruder and spinnerette.

It is particularly advantageous for the static





mixers to be disposed directly upstream of a filter packet situated upstream of the spinnerette. It is preferable to ensure that the filter packet upstream of the spinnerette achieves very intensive filtration.

5 If the apparatus of the invention is used for manufacturing polyester filament yarns at wind-up speeds of up to 10,000 m/min, the yarns obtained as a result exhibit low coefficients of variation, low boiling-water and hot-air shrinkage values and are particularly simply
10 and deeply dyeable. The use of the apparatus of the invention for manufacturing polyester yarns at wind-up speeds of 6,000 to 8,000 m/min has proved particularly advantageous. As mentioned earlier, the use of the apparatus has also been found to be particularly
15 advantageous for manufacturing filament yarns from polyethylene terephthalate, polyamide, nylon-6, nylon-6,6, copolymers thereof or mixtures of these polymers. The apparatus is likewise highly suitable in use for manufacturing filament yarns at wind-up speeds of
20 2,000 to 8,000 m/min with filament linear densities of 0.1 to 5 dtex. Using the apparatus of the invention it is thus also possible to manufacture in a particularly favourable manner microfibres, whose linear densities are within the range from about 0.1 to 1.5 dtex, although it
25 is advisable to reduce the wind-up speed and the machine height as the filament linear density of the filament yarns to be produced decreases.

 The apparatus of the invention is also suitable for manufacturing POY yarns. Preference is therefore also
30 given to using the apparatus of the invention for manufacturing polyester yarns by winding up at speeds of 2,000 to 5,000 m/min.

 The apparatus of the invention will now be more particularly described with reference to the figure.

35 A spin pack 1 contains a spinnerette 2. The spinnerette 2 extrudes a plurality of filaments 3, which enter a porous tube 4 directly underneath the spinnerette. On leaving the porous tube 4 the filaments pass through a convergence element 6 - a yarn guide in

the depicted case - to form a yarn. For better cohesion of the filaments within the yarn an air-jet entangler 7 can be installed upstream of the wind-up means 8. The air-jet entangler 7 advantageously takes the form of parallel plate nozzles, which are advantageously operated at pressures of 1.5 to 8 bar, the pressure chosen increasing with the spinning speed. Along the spinline A - A there may additionally be arranged yarn monitoring systems such as, for example, broken-filament detectors and cutters (not depicted).

The use of the apparatus will now be more particularly described in the following examples, although first a table will summarize the essential features of the apparatus according to the invention, the processing conditions maintained and the properties of the yarns obtained.

This Sheet Has Been Replaced



THIS SHEET HAS BEEN
REPLACED

This Sheet Has Been Replaced



Table

Polymer	A	B	C	D	E	F
Relative viscosity	PET	PET	PET	PET	PET	PET
Moisture content of granules	1.640	1.640	1.638	1.636	1.639	1.633
	50	5	50	13	6	5
	[10 ⁻³ % H ₂ O]					
Dryer temperature	150	150	150	150	170	150
	[°C]					
Moisture content of granules after drying	4	3-4	3-4	4	4	4
	[10 ⁻³ % H ₂ O]					
Relative viscosity	1.642	1.640	1.642	1.646	1.659	1.641
Extruder						
Temperature, zone 1	305	305	305	300	305	320
Temperature, zone 2	310	300	305	295	300	315
Temperature, zone 3	295	290	296	290	292	300
Temperature, zone 4	290	290	292	290	290	295
Temperature, head	290	294	300	290	291	292
Pressure	140	155	160	130-200	180	150
	[bar]					
Melt temperature, extruder	287	291	292	285	293	298
	[°C]					

THIS SHEET HAS BEEN REPLACED

This Sheet Has Been Replaced



Continuation 1 of Table

	A	B	C	D	E	F
Spin pack pressure	[bar]	90	185	170	205	175
Spinnerette	[micron]	36/200	24/250	36/Y	24/250	24.250
Diameter, spinnerette	[mm]	80	80	80	80	80
Temperature, spinnerette	[°C]	284	296	302	293	294.5
Throughput	[g/min]	40.7	34.8	31.2	53.6	61.2
Relative melt viscosity		1.625	1.601	1.599	1.622	1.595
Length, cooling retardation	[mm]	0	0	0	100	50
Porous tube						
(sieve on perforated metal)	[mesh]	60	60	60	60	60
Length, porous tube	[mm]	1,400	700	500	700	800
Diameter, porous tube	[mm]	80	80	80	80	80
Convergence element and spin finisher		pin	pin	pin	pin	pin
	10 mm dia.	10 mm dia.	10 mm dia.	10 mm dia.	10 mm dia.	10 mm dia.
Distance spinnerette - spin finisher	[mm]	1,995	900	920	1,000	1,020
Add-on	[%]	0.42	0.60	0.70	0.50	0.50
Pressure, entanglement jet	[bar]	1.5	6	3.5	6	7.0
Wind-up speed	[m/min]	3,500	7,000	6,250	7,000	8,000
Wind-up tension	[cN]	20-21	13-14	18	14-16	22

THIS SHEET HAS BEEN REPLACED

This Sheet Has Been Replaced



Continuation 2 of Table

	A	B	C	D	E	F
Yarn data						
Uster CV 100	0.71	1.06	0.01	1.43	1.18	0.9-1.0
As-spun breaks	[%]					
	-	18.8	5.7	9.4	7.1	-

Number of filaments	36	24	36	36	24	24
Total linear density	115.9	49.7	50.6	50.0	75.2	76.5
Breaking extension	102.8	31.5	36.0	36.0	37.7	23.5
Tenacity	27.3	32.0	33.5	33.8	36.9	30.0
Boiling-water shrinkage	39.4	2.6	2.8	2.8	2.5	2.5
Hot-air shrinkage	42.7	3.3	3.6	3.6	3.3	3.4
Birefringence	0.0544	0.114	0.115		0.113	0.102
Density	1.3485	1.339	1.387	1.384	1.401	1.383
Entanglement spacing	9.4	6.0	5.0	5.16	6.6	7.6
Coefficient of variation	52.3	64	10.5	12.6	32.0	37.0
Levelness		8.5	7.7	8.0	8.0	8.0
Barriness		8.0	8.3	8.0	8.0	8.0
Specks		6.0	6.0	6.0	6.0	6.0

THIS SHEET HAS BEEN
REPLACED

The following remarks will assist comprehension of the table:

In run D the 36 holes of the spinnerette used each had a Y-profile for a triangular cross-section, corresponding to a diameter of about 250 μm .

The moisture content of the granules was determined by heating a sample to 200°C in a vacuum and reading off the autogenous vapour pressure. By means of a calibration curve it is possible to determine the moisture content of the granules.

The relative solution viscosity was determined in a standard Ubbelohde viscometer on a 1% strength solution in n-cresol. The measurement was carried out at 25°C. The quantities measured are, on the one hand, the flow time of the solution and, on the other, the flow time of the solvent within the same viscometer, from which the relative viscosity is calculated as the ratio of the two flow times.

The entanglement jet used was a parallel plate nozzle in which the plate spacing was 1.2 mm and the diameter of the perpendicular air line was 1.1 mm.

The Uster CV 100 values of linear density uniformity were determined with an Uster tester II-C at 20°C and 65% relative humidity. The test speed was 100 m/min over 2.5 min.

To measure the hot-air shrinkage hanks are reeled with a yarn length of 10 mm. After one hour's relaxation at 20°C room temperature and 65% relative humidity the starting length is determined under a load of 0.5 cN/tex. This is followed by 15 minutes of hot air in an oven at 190°C. After one hour's conditioning at 20°C and 65% relative humidity the hank is remeasured. The change in length is expressed relative to the original value.

The entanglement spacing is measured with the Entanglement tester from Rothschild. The test is carried out at 20°C and 25% relative humidity. In the examined linear density range between 50 and 200 dtex the pre-tension is 10 cN and the pin trip level is 20 cN.

The levelness of dyeability is determined by



cleaning hoses knitted from the yarns in a solution consisting of water and detergent at a temperature of 30 to 35°, then pulling the hoses over formers and setting them on a frame in a steamer preheated to 110°C. The residence time is 10 min. The dyeing is then carried out in a solution of water, 60% acetic acid and the dye Foron Blue E-BL. The residence time in the dyeing liquor is about 50 min at temperatures of about 125°. Finally, the hoses are dried and visually assessed according to standardized criteria on a scale from 1 to 10, where 10 denotes very good. The barriness or stripiness of the dyeings is also rated on a scale from 1 to 10, where 10 again denotes a particularly uniform material. As regards specks (thick places in the yarn) the rating scale extends from 1 to 6, where 6 denotes complete absence of specks.

As is evident from the preceding table, use of the apparatus according to the invention results in yarns of very good Uster CV 100 uniformity and good levelness and nonbarriness when dyed.

This Sheet Has Been Replaced



THIS SHEET HAS BEEN
REPLACED

Apparatus for high speed spinning multifilament yarns and use thereof

This Sheet Has Been Replaced



Akzo nv, Arnhem

5 Claims:

1. Apparatus for melt spinning multifilament yarns from fibre-forming polymers at wind-up speeds of at least 2,000 m/min, comprising a spinnerette (2), a cooling means (4) for solidifying the filaments, a convergence element (6) for the filaments and a wind-up means (8) and having, at least between the spinnerette (2) and the first convergence element (6), an essentially vertical spinline (A-A), characterized in that the cooling means is a porous tube (4) which is open in the spinning direction and concentric relative to the spinline (A-A) and neither upstream nor downstream of which are there any further means for charging and/or discharging a cooling medium.
2. Apparatus according to Claim 1, characterized in that the spinline is essentially vertical between spinnerette (2) and wind-up (8).
3. Apparatus according to Claim 1 or 2, characterized in that the porous tube (4) forming the cooling means has a length of 200 to 1,800 mm.
4. Apparatus according to one or more of Claims 1 to 3, characterized in that the porous tube exhibits a pressure drop of about 3 to 150 Pa when air flows through its walls at a speed of 1 m/s.
5. Apparatus according to one or more of Claims 1 to 4, characterized in that the porous tube (4) is a cylinder whose inner cross-section has at least approximately the same geometrical shape as the outer contour of the filament bundle (3).
6. Apparatus according to one or more of Claims 1 to 5, characterized in that the porous tube (4) comprises a metal sieve with or without a perforated metal sheet support.
7. Apparatus according to Claim 6, characterized in



THIS SHEET HAS BEEN
REPLACED



that the metal sieve is a sieve of 60 mesh.

8. Apparatus according to one or more of Claims 1 to 7, characterized in that the porous tube (4) is connected directly to the spinnerette (2).

5 9. Apparatus according to one or more of Claims 1 to 7, characterized in that there is disposed directly underneath the spinnerette (2) a means, up to 300 mm in length, which inhibits the cooling of the filaments and which is adjoined by the porous tube (4).

10 10. Apparatus according to Claim 9, characterized in that the means inhibiting the cooling of the filaments comprises a hot airstream enveloping the filaments.

11. Apparatus according to Claim 10, characterized in that the spinnerette is a multiple spinnerette where the
15 melt is extended in the centre and where there are arranged concentrically around the centre one or more orifices through which exits a hot airstream which envelops the filaments.

12. Apparatus according to Claim 11, characterized in
20 that the orifice arranged concentrically around the centre is an annular gap.

13. Apparatus according to Claim 9, characterized in that the means inhibiting the cooling of the filaments is a heated tube.

25 14. Apparatus according to Claim 9, characterized in that the means inhibiting the cooling of the filaments is an unheated tube.

15. Apparatus according to one or more of Claims 1 to 8, characterized in that to inhibit filament cooling a
30 part (5), up to 300 mm in length, of the end of the porous tube (4) facing the spinnerette (2) is sealed off.

16. Apparatus according to Claim 15, characterized in that the sealed-off part (5) is situated directly underneath the spinnerette (2).

35 17. Apparatus according to Claim 15, characterized in that the sealed-off part is situated at a distance of 200 to 300 mm from the spinnerette.

18. Apparatus according to one or more of Claims 1 to 17, characterized in that the convergence element (6) is



THIS SHEET HAS BEEN
REPLACED



situated at a distance of 400 to 2,200 mm from the spinnerette (2) but at least about 100 mm below the porous tube (4).

19. Apparatus according to one or more of Claims 1 to 5 18, characterized in that the convergence element (6) is a conventional spin finish applicator.

20. Apparatus according to one or more of Claims 1 to 10 19, characterized in that the wind-up means (8) is situated about 2,000 to 4,000 mm underneath the spinnerette (2).

21. Apparatus according to one or more of Claims 1 to 20, characterized in that a means (7) for entangling the filaments is disposed upstream of the wind-up.

22. Apparatus according to one or more of Claims 1 to 15 21, characterized in that disposed upstream of the spinnerette there is a line for feeding the polymer melt from an extruder to the spinnerette, in which line there is disposed at least one static mixer.

23. Apparatus according to Claim 22, characterized in 20 that static mixers are disposed within the melt line at one or more locations between extruder and spinnerette.

24. Apparatus according to Claim 22 or 23, characterized in that the static mixers are disposed directly upstream of a filter packet situated upstream of the 25 spinnerette.

25. Use of the apparatus according to one or more of Claims 1 to 24 for manufacturing filament yarns at wind-up speeds of up to 10,000 m/min.

26. Use according to Claim 25, wherein the filament 30 yarns comprise polyethylene terephthalate, polyamide, nylon-6, nylon-6,6, copolymers thereof or mixtures thereof.

27. Use of the apparatus according to one or more of Claims 1 to 24 for manufacturing polyester filament yarns 35 at wind-up speeds of up to 10,000 m/min.

28. Use of the apparatus according to one or more of Claims 1 to 24 for manufacturing polyester yarns at wind-up speeds of 5,000 to 8,000 m/min.

29. Use of the apparatus according to one or more of



THIS SHEET HAS BEEN
REPLACED



Claims 1 to 24 for manufacturing polyester yarns at wind-up speeds of 2,000 to 5,000 m/min.

30. Use of the apparatus according to one or more of Claims 1 to 24 for manufacturing filament yarns at wind-up speeds of 2,000 to 8,000 m/min with filament linear densities of 0.1 to 6 dtex.
- 5

This Sheet Has Been Replaced



THIS SHEET HAS BEEN
REPLACED

Apparatus for high speed spinning multifilament yarns and use thereof

Akzo nv, Arnhem

Abstract:

Apparatus and use thereof for melt spinning multifilament yarns from fibre-forming polymers at wind-up speeds of at least 2,000 m/min, comprising a spinnerette (2), a cooling means (4) for solidifying the filaments, a convergence element (6) for the filaments and a wind-up means (8) and having, at least between the spinnerette (2) and the convergence element (6), an essentially vertical spinline (A-A), characterized in that the cooling means is a porous tube (4) which is open in the spinning direction and concentric relative to the spinline (A-A) and neither upstream nor downstream of which are there any further means for charging and/or discharging a cooling medium.

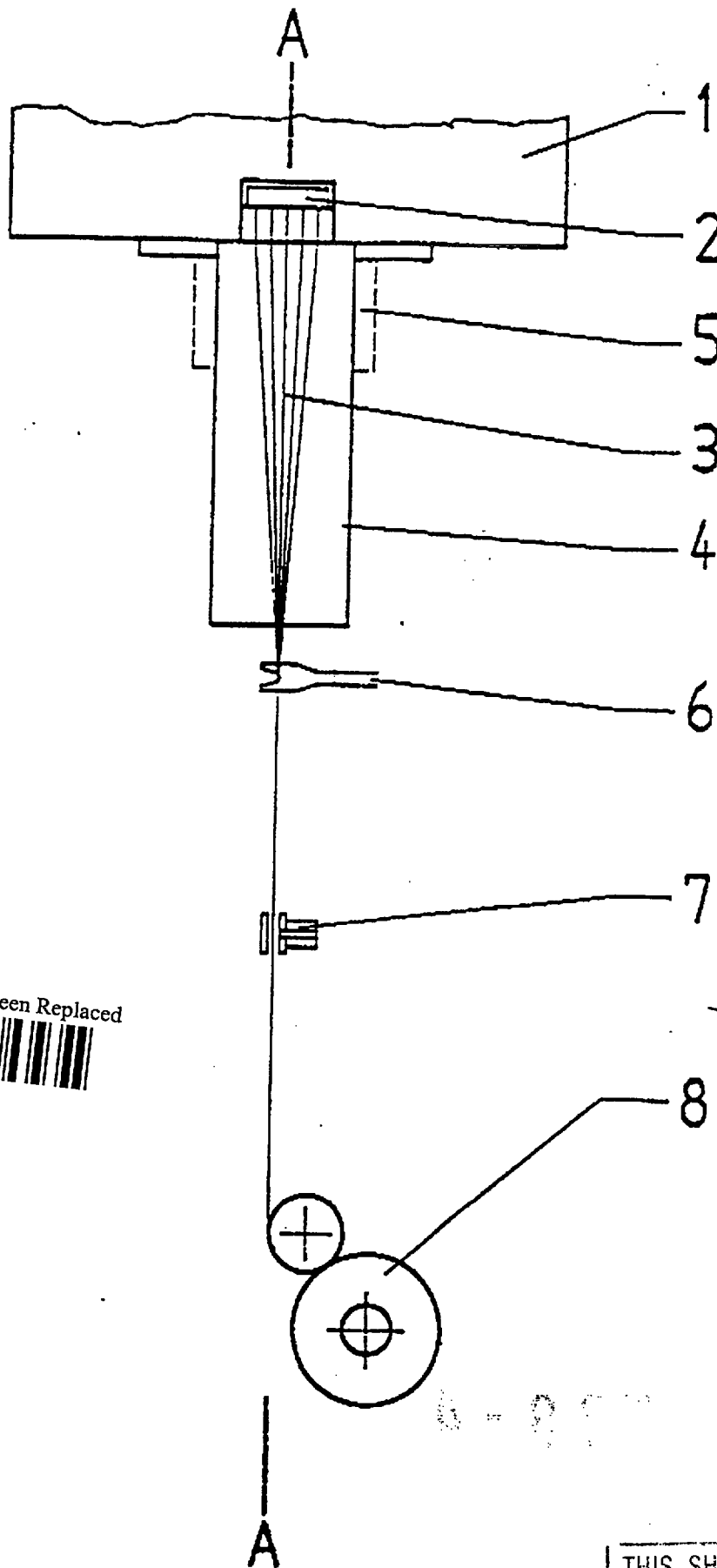
Figure

This Sheet Has Been Replaced



THIS SHEET HAS BEEN
REPLACED

1/1



This Sheet Has Been Replaced



THIS SHEET HAS BEEN
REPLACED



Apparatus for high speed spinning multifilament yarns and use thereof

Akzo nv, Arnhem

Description:

The present invention relates to apparatus for high speed spinning multifilament yarns from fibre-forming polymers at wind-up speeds of at least 2,000 m/min, comprising a spinnerette, a cooling means for solidifying the filaments, a convergence element for the filaments and a wind-up means and having, at least between the spinnerette and the first convergence element, an essentially vertical spinline. The invention also concerns the use of this apparatus for manufacturing polyester filament yarns.

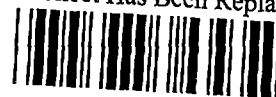
In the manufacture of multifilament yarns from fibre-forming polymers the economics are crucially affected by the wind-up speed. Wind-up speeds of 3,500 to about 5,000 m/min are common today, while wind-up speeds of more than 5,000 m/min to about 12,000 m/min are also known. At these high wind-up speeds, in particular at wind-up speeds above 5,000 m/min, it is known from prior art manufacturing processes that the design of the apparatus used plays an ever greater part, whereas purely process features are increasingly less significant.

For instance, EP-A-56 963 describes a process for manufacturing a polyester fibre using a wind-up speed of at least 5,000 m/min wherein the extruded filaments are initially guided through a heating zone at least 50 mm in length and then directly into a suction means before they are wound up. As is discernible from the drawing, the apparatus described for carrying out this process has a notably simple design.

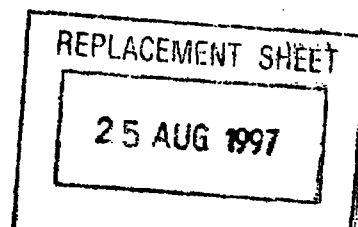
Further simplification of this known apparatus is revealed in EP-A-95 712, wherein the heating zone is initially followed by a cooling means for solidifying filaments and then by a convergence element for the filaments, after which the multifilament yarn is wound

REPLACEMENT SHEET

25 AUG 1997

**Claims:**

1. Apparatus for melt spinning multifilament yarns from fibre-forming polymers at wind-up speeds of at least 2,000 m/min, comprising a spinnerette (2), a cooling means (4) for solidifying the filaments, a convergence element (6) for the filaments and a wind-up means (8) and having, at least between the spinnerette (2) and the first convergence element (6), an essentially vertical spinline (A-A), characterized in that the cooling means is a porous tube (4) which is open in the spinning direction and concentric relative to the spinline (A-A) and neither upstream nor downstream of which are there any further means for charging and/or discharging a cooling medium.
2. Apparatus according to Claim 1, characterized in that the spinline is essentially vertical between spinnerette (2) and wind-up (8).
3. Apparatus according to Claim 1 or 2, characterized in that the porous tube (4) forming the cooling means has a length of 200 to 1,800 mm.
4. Apparatus according to one or more of Claims 1 to 3, characterized in that the porous tube exhibits a pressure drop of about 3 to 150 Pa when air flows through its walls at a speed of 1 m/s.
5. Apparatus according to one or more of Claims 1 to 4, characterized in that the porous tube (4) is a cylinder whose inner cross-section has at least approximately the same geometrical shape as the outer contour of the filament bundle (3).
6. Apparatus according to one or more of Claims 1 to 5, characterized in that the porous tube (4) comprises a metal sieve with or without a perforated metal sheet support.
7. Apparatus according to Claim 6, characterized in

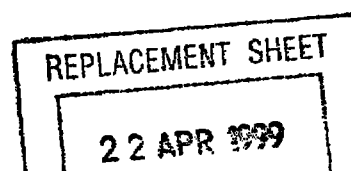


The invention relates to a device for the melt spinning of multifilament fibres from fibre-forming polymers according to the pre-characterizing clause of Claim 1, as is known, for example, from DE-A-1 914 556. The invention also relates to the use of this device to manufacture polyester filament yarns.

In the manufacture of multifilament fibres from fibre-forming polymers, the winding speed of the multifilament fibres is a substantial factor for reasons of economy. Winding speeds of 3500 up to approx. 5000 m/min are common nowadays, and winding speeds of more than 5000 m/min up to approx. 12,000 m/min are also known. At these high winding speeds, particularly at winding speeds above 5000 m/min, it has emerged from the manufacturing processes that have become known in the past that the structure of the device used for manufacture plays an increasingly important role whereas process technology features are increasingly fading into the background.

EP-A-56 963, for example, describes a process for the manufacture of a polyester fibre with a winding speed of at least 5000 m/min in which the extruded filaments are initially guided through a heating zone with a length of at least 50 mm and then directly into an extraction device before they are wound. As can be seen from the illustration, the device for implementing the known process that is described is distinguished by simple construction.

A further simplification of this known device emerges from EP-A-95 712, in which first a cooling device for solidifying the fibres and then a combining device for the filaments is arranged under the heating zone, after which the multifilament yarn is wound. Substantial components of this device are the heating zone under the spinneret, the place where the filaments are packed and the winding speed of 7000 m/min and more. A similar device is described in



22 APR 1999

EP-A-117 215 in which the distance between nozzle and winder is quoted as a substantial feature in addition to the place where the filaments are combined.

Although the devices described in the past mention that a cooling device is required in order to solidify the fibres there are no indications about the construction of the cooling device.

As regards the structure of the cooling device, EP-A-244 216 states that the cooling air should be supplied radially from the outside inwards via a wire mesh cylinder under controlled conditions. In this device a considerable reduction of the outlet cross-section of the wire mesh cylinder, which merges into a narrow pipe, is also required, which means that a great deal of outlay is associated with starting spinning.

In WO 90/02222 the filament fibres are spun in a closed spinning chamber. Insofar as this spinning chamber is used as a cooling device, the cooling air is extracted via an injector. The injector must first be removed to start spinning, which makes starting very complicated.

For spinning speeds of 1000 m/min it is also known that the cooling device is a porous pipe open in the spinning direction, which is arranged concentrically with respect to the spinning line, and no further devices supplying and/or removing a cooling medium are connected up- and/or downstream of the porous pipe (DE-A-19 14 556).

A further melt spinning device was known from CH-A-467 348 in which two porous pipes were placed one above the other.

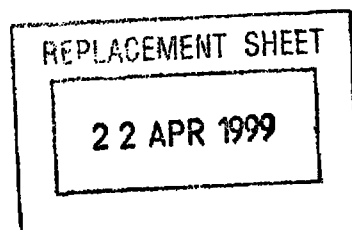
The very age of DE-A-19 14 556 and CH-A-467 348 indicates that the person skilled in the art has not considered the

usability of these known devices for higher spinning speeds.

The object of the invention is to provide a device of the above-mentioned kind which has an uncomplicated structure and is suitable for the manufacture of multifilament fibres from fibre-forming polymers with winding speeds of at least 2000 m/min, particularly at least 5000 m/min, and in which starting spinning can also be effected in a simple manner, and whose use to manufacture multifilament fibres is particularly versatile.

In a device for the melt spinning of multifilament fibres from fibre-forming polymers with a spinneret, a cooling device for solidifying the fibres and a combining device for the filaments, a substantially vertical spinning line being provided at least between nozzle and first combining device and the cooling device being a porous pipe open in spinning direction, which pipe is arranged concentrically with respect to the spinning line, and no further devices supplying and/or removing a cooling medium being connected up- and/or downstream of the porous pipe, this object is achieved in that the device also has a winder for winding speeds of at least 2000 m/min and that the porous pipe has a porosity which brings about a pressure loss of 3 to 150 Pa at a throughflow speed of air of 1 m/s.

It has in fact been found that the manufacture of multifilament fibres is particularly successful particularly at very high winding speeds if there is no active supply of a cooling medium. Surprisingly it is entirely sufficient to connect a porous pipe open in the spinning direction downstream of the spinneret without the need to provide further structures on the pipe for supplying a cooling medium and/or for sealing off with



respect to the surroundings. It is even entirely sufficient for the air surrounding the porous pipe to be at ambient temperature, so that the device according to the invention operates particularly economically. In addition to the features of the cooling device used in the device according to the invention which have already been described, the only further requirement is for the porous pipe to be arranged concentrically with respect to the spinning line. A length of 200 to 1800 mm has proved to be favourable for the porous pipe.

Virtually all spinnable polymers can be processed into multifilament yarns with a spinning device of this kind. In particular, polyethylene terephthalate, polyamide, polyamide 6, polyamide 6,6, their copolymers and mixtures of these polymers are most suitable for spinning with the device according to the invention.

Because of the simple design of the cooling device of the device according to the invention it is also very simple to adapt the length of the pipe to an optimal spinning procedure in each case. For this purpose it is only necessary to provide a set of porous pipes of different lengths in the range from 200 to 1800 mm, the lengths of the individual pipes differing from each other by approx. 100 mm in each case, for example. To simplify further, the porous pipe can, however, also be designed like a telescope. To manufacture FOY yarns which are wound at a speed of 5000 to 10,000 m/min, a length of the porous pipe of 200 to 1200 mm is particularly suitable, whereas for POY yarns which are usually wound at 2000 to 5000 m/min, a porous pipe with a length of 900 to 1800 mm should be used. To manufacture thicker filaments or filament yarns with a higher overall count a porous pipe with a length in the upper range of the lengths quoted should be used.

REPLACEMENT SHEET

22 APR 1999

It is entirely sufficient for the porous pipe to have a constant cross-section in its longitudinal direction, which means that preparing the device to start spinning is particularly simple because the filaments pass through the pipe zone in free fall and can be gathered up under the pipe. Other pipe shapes, such as pipes in the shape of a truncated cone, can, however, also be considered.

Because of the high speed of the fibres the cooling air required to solidify the fibres is drawn through the porous pipe by the fibres themselves. There is no need to prepare the cooling air. The standard atmosphere in the region of the device according to the invention is sufficient, particularly for polyester filament yarns, so that the operators can work at the device according to the invention in a comfortable atmosphere. Compared with the known devices the device according to the invention requires less space because no channels for supplying conditioned air are required. There is less waste when starting spinning. The device is also distinguished by a particularly low energy requirement as there is no need to prepare the cooling air and no further devices influencing the temperature of the fibres are required up to the winder.

At very high spinning speeds in particular it is of advantage if the spinning line runs substantially vertically between nozzle and winder.

In the device according to the invention it has proved particularly appropriate for the porous pipe to be cylindrically configured, it being possible for the cross-section of the cylinder to have virtually all common geometrical shapes such as circle, ellipse, octagon or hexagon. It is particularly favourable if the internal cross-section of the porous pipe has at least approximately the same geometrical shape as the external contour of the

REPLACEMENT SHEET

22 APR 1999

filament package. This achieves a particularly uniform solidification of the individual filaments. In this case it is appropriate to select the distance between external contour of the filament package and the internal wall of the porous pipe at the inlet cross-section in such a way that contact with the pipe wall is avoided at all costs. Distances between filament package contour and pipe wall of 5 to 40 mm have proved satisfactory; a shorter distance, such as 5 to 20 mm, should be maintained in the case of shorter porous pipes and a longer distance, such as 20 to 30 mm, optionally up to 40 mm, in the case of longer pipes.

When selecting the material for the porous pipe the only factor to be borne in mind is that the porous pipe can be fixed directly to the spinneret and does not therefore yet soften at the temperatures prevailing in the spinneret. Metals in particular, and particularly steel, are suitable for this. As a minimum the porous pipe should adjoin the spinneret, the spinning head and/or a cooling delay device connected between spinneret and porous pipe in such a way that in the region of the porous pipe air can only enter via the pore system of the porous pipe and that uncontrolled inflow of cooling medium into the region beneath the spinneret is effectively prevented.

In the simplest case the porosity of the pipes can be assured by means of perforated pipes, but also by means of sintered metals. In principle all those porous pipes whose porosity brings about a pressure loss of approx. 3 to 150 Pa at a throughflow speed of air of 1 m/s are suitable, a pressure loss in the region of 10 Pa at the air speed quoted having proved favourable. It has, however, proved particularly satisfactory if the porous pipe is formed from a metal sieve, a 60 mesh metal sieve being the most suitable. A further pipe made of perforated plate can be

22 APR 1999

arranged inside the metal sieve pipe to stabilize the metal sieve.

The porous pipe can be directly connected to the spinneret. A device which is up to 300 mm long and impedes the cooling of the filaments and which the porous pipe adjoins can, however, also be connected between the spinneret and the porous pipe.

Filament cooling can be impeded, for example, in that the device which impedes the cooling comprises a hot air stream surrounding the filaments. This achieves a particularly uniform delayed cooling of the filaments. Favourable results are achieved if the hot air jacket has a temperature which approximately corresponds to the temperature of the spinneret.

The hot air jacket can be particularly favourably effected if the spinneret is a multiple spinneret in the centre of which the extrusion of the melt is provided and in which one or more openings are provided concentrically about the centre, through which openings a hot air stream, which surrounds the filaments, emerges. In this case it is particularly favourable if the opening arranged concentrically about the centre is an annular gap. The use of such spinnerets for the delayed cooling of the filaments is known per se from DE-OS 39 41 824 and EP-A- 0 455 897.

The filament cooling can also be impeded in a particularly simple way in that the device which impedes the cooling of the filaments is a heated, particularly an unheated, pipe.

The device which impedes the cooling of the filaments is particularly simple when an up to 300 mm long section of that part of the porous pipe facing the spinneret is

LAST SHEET

22 APR 1999

22 APR 1999

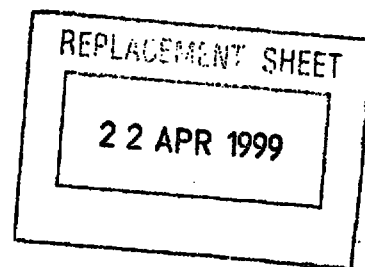
covered. The covered section is preferably arranged directly underneath the spinneret.

By impeding the filament cooling, a delayed cooling of the filaments is achieved, and this promotes a trouble-free spinning procedure particularly in the case of low individual counts.

To manufacture thicker filaments and/or where longer porous pipes are used it has, however, proved satisfactory if the cover of the porous pipe is arranged at a distance of 200 to 300 mm from the spinneret.

The device according to the invention has proved particularly satisfactory when the combining device is arranged at a distance of 400 to 2200 mm from the spinneret but at least approximately 100 mm underneath the porous pipe. In the simplest case the combining device can be a yarn guide. It is, however, particularly appropriate if the combining device is a per se known preparation application device.

In the device according to the invention, particularly large distances between spinneret and winder of up to 9000 mm, for example, can also be achieved in practice. The device according to the invention has proved to be particularly satisfactory when the winder is arranged approximately 2000 to 4000 mm underneath the spinneret. At spinning speeds of 6000 m/min and more for the manufacture of FOY yarns, a distance of 2000 to 3500 mm, preferably 2400 mm, between spinneret and winder has proved to be the best and at spinning speeds of 2000 to 5000 for the manufacture of POY yarns, a distance of 2500 to 3500 mm, preferably 3000 mm; this distance should be increased to up to 4000 mm for the manufacture of yarns with an individual count of more than 3 dtex and/or an overall



count of more than 100 dtex. A device of this kind is distinguished in particular by a low structural height, which means that the operators have to work on one level only. This means lower costs for buildings, therefore, where the device according to the invention is installed new. The device according to the invention is particularly distinguished by a very low susceptibility to faults.

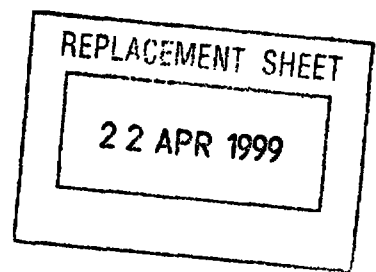
In most cases a device for entangling the filaments is arranged upstream of the winder.

A further reduction of spinning faults is achieved in that a melt line for conveying the polymer melt from an extruder to the spinneret is connected upstream of the spinneret, in which line at least one static mixer is arranged. This also has a favourable influence on the uniformity properties of the spun filament yarns.

It is of advantage if the static mixers are arranged at one or more points in the melt line between extruder and spinneret.

It has proved particularly favourable if the static mixers are arranged directly upstream of a filter pack connected upstream of the spinneret. Preferably, in the case of the filter pack connected upstream of the spinneret, care should be taken to ensure that the most intensive possible filtration is assured.

When the device according to the invention is used to manufacture polyester filament yarns, the polyester filament yarns being wound at speeds of up to 10,000 m/min, the yarns achieved in this way have a low coefficient of variation, low values for shrinkage at the boil and hot air shrinkage and can be particularly easily dyed and deep-dyed. The use of the device according to the invention to



manufacture polyester yarns at winding speeds of 6000 to 8000 m/min has proved particularly favourable. As already stated, the use of the device has also proved particularly favourable for the manufacture of filament yarns from polyethylene terephthalate, polyamide, polyamide 6, polyamide 6,6, their copolymers or mixtures of these polymers. The device is also outstandingly suitable when used to manufacture filament yarns, the filament yarns being wound at speeds of 2000 to 8000 m/min, after which the filaments of the filament yarns have an individual count of 0.1 to 5 dtex. It is also possible to manufacture microfibres whose individual counts are in the range from approx. 0.1 to 1.5 dtex particularly favourably using the device according to the invention although it is advisable to select a lower winding speed and machine height, the lower the individual count of the filaments of the filament yarns is intended to be.

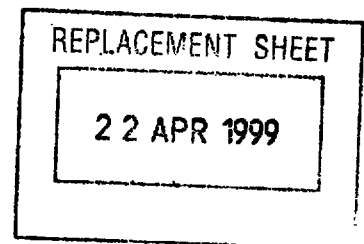
The device according to the invention is also suitable for manufacturing POY yarns. The use of the device according to the invention is therefore also preferred for the manufacture of polyester yarns, the polyester yarns being wound at speeds of 2000 to 5000 m/min.

The device according to the invention will be described in greater detail with the aid of the drawing.

A spinneret 2 is incorporated in a spinning head 1. Several filaments 3, which are taken up by a porous pipe 4 directly underneath the spinneret, are extruded from the spinneret 2. On leaving the porous pipe 4 the filaments are combined into a yarn via the combining device 6 - a yarn guide in the case illustrated. An air entangling unit 7 can be incorporated upstream of the winder 8 in order to keep the filaments together in the yarn in a more satisfactory manner. Parallel plate nozzles which are

favourably operated with blowing pressures of 1.5 to 8 bar are particularly suitable for the air entangling unit 7; the higher the spinning speed that is set, the higher the pressure should be selected. Fibre monitoring systems such as thread-end monitors and fibre cutters can also be provided along the spinning line A-A, although these are not illustrated.

The use of the device will be described in greater detail below with the aid of the examples which follow, the substantial features of the device according to the invention, the process conditions maintained and the properties of the yarns obtained being initially summarized in a table.



T a b l e

Polymer	A	B	C	D	E	F
rel. viscosity	PET 1.640	PET 1.640	PET 1.638	PET 1.636	PET 1.639	PET 1.633
Moisture content of granules	50 [10 ⁻³ % H ₂ O]	5	50	13	6	5

Dryer temperature [°C]	150	150	150	150	170	150
Moisture content of granules after drying	4	3-4	3-4	4	4	4
rel. viscosity	1.642	1.640	1.642	1.646	1.659	1.641

12

Extruder						
Temperature zone 1 [°C]	305	305	305	300	305	320
Temperature zone 2 [°C]	310	300	305	295	300	315
Temperature zone 3 [°C]	295	290	296	290	292	300
Temperature zone 4 [°C]	290	290	292	290	290	295
Temperature, head [°C]	290	294	300	290	291	292
Pressure [bar]	140	155	160	130-200	180	150
Melt temperature, extruder [°C]	287	291	292	285	293	298

REPLACEMENT SHEET

22 APR 1999

Table continuation sheet 1

	A	B	C	D	E	F
Spinning pack pressure [bar]	90	185	130	170	205	175
Spinneret						
Spinneret diameter [mm]	36/200	24/250	36/200	36/Y	24/250	24/250
Spinneret temperature [°C]	80	80	80	80	80	80
Throughput [g/min]	284	296	301	302	293	294.5
rel. melt viscosity	40.7	34.8	32.6	31.2	53.6	61.2
	1.625	1.601	1.574	1.599	1.622	1.595
Length of cooling delay [mm]	0	0	50	0	100	50
Porous pipe (sieve on perforated plate) [mesh]	60	60	60	60	60	60
Length of porous pipe [mm]	1400	700	500	500	700	800
Diameter of porous pipe [mm]	80	80	80	80	80	80
Combining unit and preparation device	pin 10 mm dia.	pin 10 mm dia.	pin 10 mm dia.	pin 10 mm dia.	pin 10 mm dia.	pin 10 mm dia.
Distance between spinneret and preparation device [mm]	1995	900	880	920	1000	1020
Quantity taken up [%]	0.42	0.60	0.66	0.70	0.50	0.50
Entangling nozzle pressure [bar]	1.5	6	4	3.5	6	7.0
Winding speed [m/min]	3500	7000	6500	6250	7000	8000
Winding tension [cN]	20-21	13-14	14-15	18	14-16	22

Table continuation sheet 2

	A	B	C	D	E	F
Yarn data						
Uster CV 100	0.71	1.06	0.01	1.43	1.18	0.9-1.0
Spinning breaks	-	18.8	5.7	9.4	7.1	-
Filament number	36	24	36	36	24	24
Overall count	115.9	49.7	50.6	50.0	75.2	76.5
Elongation at break	102.8	31.5	36.0	36.0	37.7	23.5
Strength	27.3	32.0	33.5	33.8	36.9	30.0
Shrinkage at the boil	39.4	2.6	2.8	2.8	2.5	2.5
Hot air shrinkage	42.7	3.3	3.6	3.6	3.3	3.4
Double refraction	0.0544	0.114	0.115		0.113	0.102
Density	1.3485	1.339	1.387	1.384	1.401	1.383
Opening length	9.4	6.0	5.0	5.16	6.6	7.6
Coefficient of variation [%]	52.3	64	10.5	12.6	32.0	37.0
Dye absorption uniformity		8.5	7.7	8.0	8.0	8.0
Dye streakiness		8.0	8.3	8.0	8.0	8.0
Pinholes		6.0	6.0	6.0	6.0	6.0

REPLACEMENT SHEET

22 APR 1999

22 APR 1999

The following is intended to aid comprehension of the table.

In Experiment D a spinneret with 36 holes, which Y-profile for a triangular cross-section which corresponds to a diameter of approx. 250 μm , was used.

The moisture content of the granules was determined by heating a sample in vacuo to 200 °C and reading off the vapour pressure that was establishing. The moisture content of the granules can be determined by means of a calibration curve.

The relative solution viscosity was measured in a standard Ubbelohde viscometer, a 1% solution in n-cresol having first been prepared. The measurement took place at 25 °C. The throughput time of the solution on the one hand and the throughput time of the solvent on the other hand are measured in the same viscometer, the relative viscosity being calculated as the ratio of the two throughput times.

A parallel plate nozzle was used as the entangling nozzle, the distance between plates being 1.2 mm and the diameter of the air supply running at a right angle being 1.1 mm.

The values for Uster CV 100 were determined by means of an Uster Tester II-C as values for the count uniformity. The measurement was carried out at 20 °C and 65% relative atmospheric humidity. The test speed was 100 m/min for 2.5 min.

Strandlets with a yarn length of 10 mm were reeled to measure the hot air shrinkage. After an hour's relaxation time at 20 °C ambient temperature and 65% relative humidity the initial length is determined under 0.5 cN/tex load. Hot air is then applied in the oven at 190 °C for 15

22 APR 1999

minutes. After an hour's conditioning time at 20 °C and 65% relative humidity the strandlet length is measured. The change in the yarn length is related to the initial value.

The opening length was measured using the Rothschild Entanglement tester. The test is carried out at 20 °C and 25% relative humidity. In the count range tested, between 50 and 200 dtex, the initial tension is 10 cN and the release force of the needle (trip level) 20 cN.

To determine the dye absorption uniformity, the stocking tubes produced from the yarns are washed in a solution comprising water and detergent at a temperature of 30 to 35 °. The stocking tubes are then drawn over steam boards and introduced with a frame into a steam cupboard pre-heated to 110 °C for fixing. The residence time is 10 min. Dyeing then takes place in a solution of water, 60% acetic acid and the dye Foron blue E-BL. The residence time in the dye liquor is approx. 50 min at temperatures of approx. 125 °. Finally, the stocking tubes are dried and visually evaluated according to specified standards. Marks between 1 and 10 are awarded for dye absorption uniformity, a mark of 10 denoting very good. Marks between 1 and 10 are also awarded in respect of dye streakiness, a mark of 10 again denoting particularly uniform goods. In respect of pinholes (thick spots in the yarn) a mark between 1 and 6 is awarded, a mark of 6 denoting no pinholes at all.

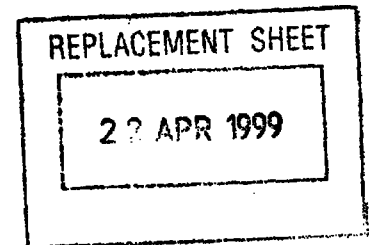
As can be seen from the above Table, when the device according to the invention is used yarns are obtained which are distinguished by very good uniformity (Uster CV 100) and a dye absorption uniformity and streakiness assessed as good.

22 APR 1999

CLAIMS

1. Device for the melt spinning of multifilament fibres from fibre-forming polymers with a spinneret (2), a cooling device (4) for solidifying the fibres and a combining device (6) for the filaments, a substantially vertical spinning line (A-A) being provided at least between nozzle (2) and first combining device (6) and the cooling device being a porous pipe (4) open in the spinning direction, which pipe is arranged concentrically with respect to the spinning line (A-A), and no further devices supplying and/or removing a cooling medium being connected up- and/or downstream of the porous pipe (4), characterized in that the device also has a winder (8) for winding speeds of at least 2000 m/min, and that the porous pipe has a porosity which brings about a pressure loss of 3 to 150 Pa at a throughflow speed of air of 1 m/s.
2. Device according to Claim 1, characterized in that the spinning line runs substantially vertically between nozzle (2) and winder (8).
3. Device according to Claim 1 or 2, characterized in that the porous pipe (4) forming the cooling device has a length of 200 to 1800 mm.
4. Device according to one of Claims 1 to 3, characterized in that the porous pipe (4) is cylindrically configured, its internal cross-section having at least approximately the same geometrical shape as the external contour of the filament package (3).
5. Device according to one of Claims 1 to 4, characterized in that the porous pipe (4) is formed





from a metal sieve which is optionally supported by a perforated plate.

6. Device according to Claim 5, characterized in that the metal sieve is a 60 mesh sieve.
7. Device according to one of Claims 1 to 6, characterized in that the porous pipe (4) is directly connected to the spinneret (2).
8. Device according to one of Claims 1 to 6, characterized in that a device which is up to 300 mm long and impedes the cooling of the filaments and which the porous pipe (4) adjoins, is arranged directly underneath the spinneret (2).
9. Device according to Claim 8, characterized in that the device which impedes the cooling of the filaments comprises a hot air stream surrounding the filaments.
10. Device according to Claim 9, characterized in that the spinneret is a multiple spinneret in the centre of which the extrusion of the melt is provided and in which one or more openings are provided concentrically about the centre, through which openings a hot air stream, which surrounds the filaments, emerges.
11. Device according to Claim 10, characterized in that the opening arranged concentrically about the centre is an annular gap.
12. Device according to Claim 8, characterized in that the device which impedes the cooling of the filaments comprises a heated pipe.



22 APR 1999

13. Device according to Claim 8, characterized in that the device which impedes the cooling of the filaments comprises an unheated pipe.
14. Device according to one of Claims 1 to 7, characterized in that an up to 300 mm long section (5) of that part of the porous pipe (4) facing the spinneret (2) is covered in order to impede the filament cooling.
15. Device according to Claim 14, characterized in that the covered section (5) is arranged directly underneath the spinneret (2).
16. Device according to Claim 14, characterized in that the covered section is arranged at a distance of 200 to 300 mm from the spinneret.
17. Device according to one of Claims 1 to 16, characterized in that the combining device (6) is arranged at a distance of 400 to 2200 mm from the spinneret (2), but at least approximately 100 mm underneath the porous pipe (4).
18. Device according to one of Claims 1 to 17, characterized in that the combining device (6) is a per se known preparation application device.
19. Device according to one of Claims 1 to 18, characterized in that the winder (8) is arranged approximately 2000 to 4000 mm underneath the spinneret (2).
20. Device according to one of Claims 1 to 19, characterized in that a device (7) for entangling the filaments is arranged upstream of the winder (8).



22 APR 1999

21. Device according to one of Claims 1 to 20, characterized in that a melt line for conveying the polymer melt from an extruder to the spinneret is connected upstream of the spinneret, in which line at least one static mixer is arranged.
22. Device according to Claim 21, characterized in that static mixers are arranged at one or more points in the melt line between extruder and spinneret.
23. Device according to Claim 21 or 22, characterized in that the static mixers are arranged directly upstream of a filter pack connected upstream of the spinneret.
24. Use of the device according to one of Claims 1 to 23 to manufacture filament yarns, the filament yarns being wound at speeds of up to 10,000 m/min.
25. Use according to Claim 24, the filament yarns comprising polyethylene terephthalate, polyamide, polyamide 6, polyamide 6,6, their copolymers or mixtures thereof.
26. Use of the device according to one of Claims 1 to 23 to manufacture polyester filament yarns, the polyester filament yarns being wound at speeds of up to 10,000 m/min.
27. Use of the device according to one of Claims 1 to 23 to manufacture polyester yarns, the polyester yarns being wound at speeds of 5000 to 8000 m/min.
28. Use of the device according to one of Claims 1 to 23 to manufacture polyester yarns, the polyester yarns being wound at speeds of 2000 to 5000 m/min.



29. Use of the device according to one of Claims 1 to 23 to manufacture filament yarns, the filament yarns being wound at speeds of 2000 to 8000 m/min, after which the filaments of the filament yarns have an individual count of 0.1 to 6 dtex.



REPLACEMENT SHEET

22 APR 1999