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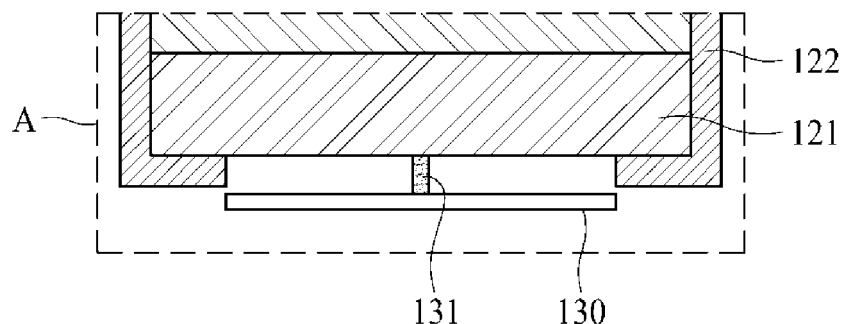
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(54) **HIGH-STRENGTH POLYETHYLENE TEREPHTHALATE YARN AND METHOD FOR PRODUCING THE SAME**

(57) Disclosed are a PET fiber having an intrinsic viscosity of 1.1 dl/g or higher and a tensile strength of 10 g/d or higher, and a manufacturing method therefor. A manufacturing method according to the present invention includes the steps of: melting a polyethylene terephthalate chip having an intrinsic viscosity of 1.4 to 1.7 dl/g to prepare a spinning melt; discharging the spinning melt

through a nozzle of a spinning pack; heating the spinning melt just before being discharged from the nozzle by means of a heat source of 300 to 500 °C located immediately below the nozzle; converging a plurality of filaments formed by the discharging to form a multifilament; and drawing the multifilament, wherein a temperature of the spinning pack is maintained at 280 to 305 °C.

【FIG. 2】



Description**[Technical Field]**

5 **[0001]** The present invention relates to a polyethylene terephthalate yarn and a method for producing the same, and more particularly to a polyethylene terephthalate yarn having higher strength than a conventional polyethylene terephthalate yarn and a method for producing the same.

[Background Art]

10 **[0002]** Research is continuously conducted to improve the mechanical properties (e.g., strength, elongation, etc.) of industrial polyethylene terephthalate (hereinafter referred to as 'PET') yarns used in the manufacture of tire cords, air bags, etc.

15 **[0003]** In general, the method of producing a PET yarn includes a spinning process of forming a multifilament and a process of drawing the multifilament at a predetermined draw ratio, wherein the spinning process includes melting a PET chip, discharging the PET melt through a nozzle of a spinning pack, and converging the filaments in a solidified state formed through cooling after the PET melt is discharged through the nozzle, thereby forming a multifilament.

20 **[0004]** Since industrial PET yarn is generally required to have excellent dimensional stability (i.e., low elongation at a specified load (EASL) and low dry heat shrinkage), for example, it is necessary to produce a PET yarn through high-speed spinning of 1500 m/min or more. That is, the dimensional stability can be improved by increasing the degree of fiber orientation before the drawing process.

25 **[0005]** However, since the spinning speed and the draw ratio have a trade-off relationship, increasing the spinning speed ultimately limits the draw ratio that can be applied in the drawing step. That is, if the spinning speed is increased to 1500 m/min or more in order to improve the dimensional stability of the PET yarn, the draw ratio that can be applied in the drawing step is ultimately lowered to 2.0 or less. The lower the draw ratio, the lower the strength of the PET yarn.

30 **[0006]** Therefore, in order to produce PET yarns having higher strength than conventional PET yarns while having excellent dimensional stability, there is a need for a method for increasing the strength of PET yarns by controlling process factor(s) other than the draw ratio.

[DETAILED DESCRIPTION OF THE PRESENT DISCLOSURE]**[Technical Problem]**

35 **[0007]** Accordingly, the present invention relates to a PET yarn capable of preventing problems caused by the limitations and disadvantages of the related art as described above, and to a method for producing the same.

40 **[0008]** One aspect of the present invention provides a PET yarn having high strength compared to the existing PET yarn while having excellent dimensional stability.

45 **[0009]** Another aspect of the present invention provides a method for producing a PET yarn having high strength compared to the existing PET yarn while having excellent dimensional stability.

50 **[0010]** In addition to the aspects of the present invention mentioned above, additional features and advantages of the present invention will be described below, or from such description will be clearly understood by those skilled in the art.

[Technical Solution]

55 **[0011]** In accordance with one aspect of the present invention as described above, a PET yarn including 100 to 500 filaments each having fineness of 2 to 5 denier is provided, wherein the PET yarn has an intrinsic viscosity of 1.1 dl/g or more and a tensile strength of 10 g/d or more.

60 **[0012]** The PET yarn may have an intrinsic viscosity of 1.1 to 1.25 dl/g and a tensile strength of 10 to 10.6 g/d.

65 **[0013]** The PET yarn may have elongation of 3 to 6 % at a 4.5 g/d load and dry heat shrinkage of 7 to 12 %.

70 **[0014]** The PET yarn may have elongation at break of 13 to 14 %.

75 **[0015]** The PET yarn may have elongation at break of 13.4 to 13.9 %.

80 **[0016]** In accordance with another aspect of the present invention, a method for producing a PET yarn is provided, including the steps of: melting a polyethylene terephthalate chip having an intrinsic viscosity of 1.4 to 1.7 dl/g to prepare a spinning melt; discharging the spinning melt through a nozzle of a spinning pack; heating the spinning melt just before discharging it from the nozzle by means of a heat source of 300 to 500 °C located immediately below the nozzle; converging a plurality of filaments formed by the discharging to form a multifilament; and drawing the multifilament, wherein a temperature of the spinning pack is maintained at 280 to 305 °C.

85 **[0017]** In the method for producing a PET yarn, a speed after drawing of 4000 to 6200 m/min and a draw ratio of 1.9

to 2.5 may be applied.

[0018] The distance between the nozzle and the heat source may be 5 to 50 mm.

[0019] The temperature of the heat source may be higher than the temperature of the spinning pack.

[0020] The heat source may include a hot wire.

5 [0021] The heat source may include a plurality of hot wires, and the hot wires may be respectively arranged between the filaments so as to not hinder the movement of the filaments.

[0022] The hot wires may be arranged at equal intervals.

[0023] Each of the hot wires may be arranged to be parallel to the lower surface of the nozzle.

[0024] The draw ratio in the drawing step may be 1.9 to 2.5.

10 [0025] The discharging step may be performed under a discharge pressure of 2400 psi or less.

[0026] The general description of the present invention as described above is intended only to illustrate or explain the present invention, and is not intended to limit the scope of the present invention.

[ADVANTAGEOUS EFFECTS]

15 [0027] According to the present invention, by using a PET chip having a relatively high intrinsic viscosity (I.V.), and minimizing thermal decomposition of the polymer during the spinning process and a decrease in intrinsic viscosity (I.V. drop) resulting therefrom, it is possible to produce a PET yarn having a relatively high intrinsic viscosity (I.V.) of 1.1 dl/g or more and a relatively high tensile strength of 10 g/d or more.

20 [0028] In addition, despite the use of PET chips with a relatively high intrinsic viscosity (I.V.), and despite the application of a relatively low spinning temperature to minimize intrinsic viscosity drop (I.V. drop), by providing high-temperature heat energy from immediately below a spinneret, it is possible to prevent an increase in the discharge pressure due to a decrease in the fluidity of the PET melt, and thus prevent the occurrence of a leakage phenomenon in the spinning pack and damage to the spinning pack due to the increase in the discharge pressure.

25 [0029] Further, according to the present invention, the uniformity of mechanical properties of a large number of filaments constituting the polyester yarn can be improved.

[BRIEF DESCRIPTION OF THE DRAWINGS]

30 [0030] The accompanying figures, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this application, illustrate embodiment(s) of the invention, and together with the description serve to explain the principle of the invention.

35 FIG. 1 schematically illustrates an apparatus for producing a PET yarn according to one embodiment of the present invention.

FIG. 2 is an enlarged view of a portion A in FIG. 1.

[DETAILED DESCRIPTION OF THE EMBODIMENTS]

40 [0031] The present inventors found that the intrinsic viscosity (I.V.) of PET yarn is closely related to the strength of PET yarn. That is, as the intrinsic viscosity (I.V.) of the PET yarn increases, the strength of the PET yarn increases. Therefore, in order to produce a PET yarn having higher strength than a conventional PET yarn, it is required to produce a PET yarn having a higher intrinsic viscosity (I.V.) than the conventional PET yarn.

45 [0032] In order to produce a PET yarn having a higher intrinsic viscosity (I.V.) than a conventional PET yarn, (i) the spinning melt should be prepared using a PET chip having a higher intrinsic viscosity (I.V.) than the intrinsic viscosity (I.V.) of PET chips used in a conventional PET yarn manufacturing method, and (ii) thermal decomposition of polymers and a drop in intrinsic viscosity (I.V. drop) resulting therefrom should be minimized by applying a spinning temperature that is lower than the spinning temperature (i.e., the temperature of the spinning pack) that has been applied to a conventional PET yarn manufacturing method.

50 [0033] However, the higher the intrinsic viscosity (I.V.) of the PET chip and the lower the spinning temperature, the lower the fluidity of the spinning melt is. The low fluidity of the spinning melt increases the discharge pressure and thus increases the risk of leakage at the spinning pack and damage to the spinning pack.

55 [0034] According to the present invention, in order to produce a PET yarn having a relatively high intrinsic viscosity (I.V.) of 1.1 dl/g or more and relatively high strength of 10 g/d or more, despite using PET chips with a relatively high intrinsic viscosity (I.V.) of 1.4 to 1.7 dl/g and applying a relatively low spinning temperature of 280 to 305 °C, it is possible to prevent the occurrence of a leakage phenomenon in the spinning pack and the damage to the spinning pack by providing high-temperature thermal energy from immediately below the spinneret.

[0035] Hereinafter, referring to FIGS. 1 and 2, the method for producing a PET yarn according to one embodiment of

the present invention will be described in more detail.

[0036] An apparatus according to one embodiment of the present invention includes an extruder 110, a spinning pack 120, a heat source 130, a cooling unit 140, a converging unit 150, a drawing unit 160, and a winder 170.

[0037] The spinning pack 120 includes main parts such as a filter, a distribution plate, a nozzle 121, and the like, and a pack body 122 surrounding the main parts. The heat source 130 may be fixed to the nozzle 121 via a bolt 131. Alternatively, the heat source 130 may be fixed to a spin block (not shown) surrounding the spinning pack 120.

[0038] First, the PET chip is put into an extruder 110, and then melted to form a spinning melt (that is, a PET melt), and the spinning melt is extruded into a spinning pack 120.

[0039] As described above, the PET chip used in the present invention has an intrinsic viscosity (I.V.) of 1.4 to 1.7 dl/g that is higher than the intrinsic viscosity (I.V.) (less than 1.4 dl/g) of the PET chip that has been previously used.

[0040] Since it is required that high-speed spinning to enhance the orientation of PET yarn is performed, if the intrinsic viscosity (I.V.) of the PET chip is less than 1.4 dl/g, it is impossible to produce a PET yarn having an intrinsic viscosity (I.V.) of 1.1 dl/g or more, and as a result, it is also impossible to produce PET yarns having a tensile strength of 10 g/d or more.

[0041] On the other hand, if the intrinsic viscosity (I.V.) of the PET chip exceeds 1.7 dl/g, the fluidity of the spinning melt is excessively low to the extent that a high discharge pressure outside the allowable range (2400 psi or less) is required (even if the method of the present invention is applied).

[0042] The spinning melt delivered from the extruder 110 to the spinning pack 120 is discharged through holes in the nozzle 121. The nozzle 121 may have 100 to 500 holes, and L/D, which is a ratio of the length L and the diameter D of each hole, may be 2 to 5.

[0043] According to the present invention, when the spinning process is performed, the spinning temperature, that is, the temperature of the spinning pack 120 (more specifically, the temperature of the pack body 122) is maintained at 280 to 305 °C. In general, the temperature of the spinning pack 120 may be measured via a temperature sensor installed in a spinning block surrounding the spinning pack 120.

[0044] If the spinning temperature is less than 280 °C, not only is the uniformity of the spinning melt lowered, but the fluidity of the spinning melt is excessively low to the extent that a high discharge pressure outside the allowable range is required.

[0045] On the other hand, if the spinning temperature exceeds 305 °C, rapid thermal decomposition of the polymer occur which causes a sudden drop in intrinsic viscosity (I.V. drop). As a result, it becomes impossible to produce PET yarns having a high tensile strength of 10 g/d or more.

[0046] That is, according to the present invention, by applying a spinning temperature of 280 to 305 °C which is much lower than the spinning temperature of 310 to 320 °C that has been applied to a conventional PET yarn manufacturing method, thermal decomposition of polymers during the spinning process and a drop in intrinsic viscosity (I.V. drop) resulting therefrom can be minimized.

[0047] Meanwhile, as described above, the higher the intrinsic viscosity (I.V.) of the PET chip and the lower the spinning temperature, the more the fluidity of the spinning melt is lowered. The low fluidity of the spinning melt increases the discharge pressure and thus increases the risk of a leakage phenomenon in the spinning pack 120 and damage to the spinning pack 120.

[0048] In order to solve the above-mentioned problems, according to the present invention, the spinning melt just before being discharged from the nozzle 121 is heated by a heat source 130 located immediately below the nozzle 121.

[0049] The most important factor for determining the discharge pressure is the fluidity of the spinning melt just before being discharged from the nozzle 121. Therefore, if the spinning melt is heated only momentarily before being discharged from the nozzle 121, its fluidity can be instantaneously increased immediately before discharge without causing serious thermal decomposition of the polymer, and as a result, an increase in the discharge pressure can be minimized. Therefore, according to the present invention, the spinning process is performed at a discharge pressure of 2400 psi or less, preferably 2350 psi or less, and more preferably 2320 psi or less.

[0050] As a result, according to the present invention, despite using PET chips with a relatively high intrinsic viscosity (I.V.) of 1.4 to 1.7 dl/g and applying a relatively low spinning temperatures of 280 to 305 °C, it is possible to prevent the occurrence of the leakage phenomenon in the spinning pack and the damage to the spinning pack due to an increase in the discharge pressure.

[0051] In order to properly heat the spinning melt just before the discharge, the distance between the nozzle 121 and the heat source 130 may be 5 to 50 mm.

[0052] According to one embodiment of the present invention, the temperature of the heat source 130 is higher than the temperature of the spinning pack 120. For example, the temperature of the heat source 130 may be 300 to 500 °C, preferably 320 to 490 °C, and more preferably 350 to 480 °C.

[0053] The heat source 130 may include a hot wire. For example, the heat source 130 may include a plurality of hot wires, and the hot wires may be arranged between the filaments 10 so that the spinning melt does not hinder the movement of the plurality of semi-solid filaments 10 formed while being discharged from the holes of the nozzle 121.

[0054] In order to uniformly heat the spinning melt just before the discharge, the hot wires may be arranged at equal intervals and each of the hot wires may be arranged so as to be parallel to the bottom surface of the nozzle 121.

[0055] In addition, since the filaments 10 are uniformly spaced apart from the hot wires at a predetermined distance (for example, 3 to 10 mm), uniformity of physical properties between the filaments 10 may be ensured.

[0056] According to the present invention, unlike the conventional cylindrical heating hood for delaying cooling of the spinning melt discharged from the nozzle 121, a plurality of hot wires constituting the heat source 130 are arranged at equal intervals immediately below the nozzle 121, and instantaneously heat the spinning melt just before being discharged from the nozzle 121. Thus, despite using PET chips with a relatively high intrinsic viscosity (I.V.) PET chip of 1.4 to 1.7 dl/g and applying a relatively low spinning temperature of 280 to 305 °C, it is possible to prevent the occurrence of the leakage phenomenon in the spinning pack and the damage to the spinning pack due to an increase in the discharge pressure.

[0057] A plurality of semi-solid filaments 10 formed as the spinning melt is discharged from the holes of the nozzle 121 are completely solidified while passing through the cooling unit 140. In order to control the cooling process, cooling air of an appropriate temperature and speed is blown into the filaments 10. The cooling behavior of the filaments 10 has a great influence on the final physical properties of the fiber.

[0058] Subsequently, the completely solidified filaments 10 are converged by the converging unit 150 to form a multifilament 20. An emulsion may be applied to the multifilament 20 at the converging unit 150. That is, the step of forming the multifilament (20) and the step of applying the emulsion can be performed simultaneously. The application of the emulsion may be performed using a MO (Metered Oiling) or RO (Roller Oiling) method.

[0059] The multifilament 20 formed through the converging step is drawn in the drawing unit 160. The drawing unit 160 may include first to fifth godet rollers 161, 162, 163, 164, and 165.

[0060] The first godet roller 161 determines the spinning speed and the spinning draft ratio.

[0061] Drawing of the multifilament 20 is performed between a first godet roller 161 and a fourth godet roller 164. That is, a draw ratio is determined by a ratio of the speed of the fourth godet roller 164 to the speed of the first godet roller 161.

[0062] Between the fourth godet roller 164 and the fifth godet roller 165 is a relaxation section, and by imparting some relaxation to the multifilament 20 drawn by the first to fourth godet rollers 161, 162, 163, and 164, it is possible to prevent (i) excessive shrinkage of the multifilament 20, (ii) distortion of the winder 170, and (iii) instability of unwinding, which may be caused by contraction forces immediately after drawing.

[0063] According to one embodiment of the present invention, the spinning speed (i.e., the speed of the first godet roller 161) is 1500 to 3300 m/min, the speed after drawing (i.e., the speed of the fourth godet roller 164) is 4000 to 6200 m/min, and the draw ratio is 1.9 to 2.5. PET yarns having high dimensional stability according to the present invention produced at spinning speeds of 1500 to 3300 m/min and speeds after drawing of 4000 to 6200 m/min have elongation of 3 to 6 % at 4.5 g/d load and dry heat shrinkage of 7 to 12 %.

[0064] Optionally, at least one of the second to fourth godet rollers 162, 163, and 164 may be provided with a heating means to perform heat treatment/heat fixing of the drawn multifilament 20. For example, by adjusting the number of windings on the fourth godet roller 164, the amount of time that the multifilament 20 stays in the fourth godet roller 164 can be adjusted, which allows for appropriate heat treatment/heat fixing for the drawn yarn.

[0065] The drawn and heat-treated multifilament 20 is wound by a winder 170 to thereby complete the PET yarn.

[0066] The PET yarn of the present invention includes 100 to 500 filaments each having fineness of 2 to 5 denier, and it has a relatively high intrinsic viscosity (I.V.) of 1.1 dl/g or more and a relatively high tensile strength of 10 g/d or more as mentioned above. According to one embodiment of the present invention, the PET yarn has elongation at break of 13 to 14 %.

[0067] The high strength PET yarn of the present invention can be applied to various industrial applications such as tire cords, air bags, and the like.

[0068] Hereinafter, the present invention will be described in detail by way of examples and comparative examples. However, the following examples are shown to help the understanding of the present invention, but the spirit or scope of the present invention should not be limited thereto.

Example 1

[0069] The spinning melt obtained through the melting of a PET chip having an intrinsic viscosity (I.V.) of 1.7 dl/g was discharged through 250 holes ($L/D = 2.1/0.7$) of the nozzle of the spinning pack. At this time, the temperature of the spinning pack, that is, the spinning temperature, was about 295 °C. In addition, the spinning melt just before being discharged from the holes of the nozzle was heated with hot wires at 450 °C located 10 mm away from the nozzle immediately below the nozzle. A plurality of semi-solid filaments formed as the spinning melt was discharged from the holes of the nozzle were completely solidified while passing through the cooling unit. The drawing step, the heat treatment step, and the winding step were sequentially performed on the plurality of filaments formed by converging the filaments, and thereby, a PET yarn containing 250 filaments each having fineness of 4 denier (total fineness: 1000 denier) was

obtained. A discharge pressure of 2101 psi was applied, the speed after drawing was 5800 m/min, and the drawing ratio was 2.0.

Example 2

[0070] A PET yarn was obtained in the same manner as in Example 1, except that the spinning temperature and the temperature of the hot wire were 299 °C and 420 °C, respectively, and the spinning process was performed under a discharge pressure of 2181 psi.

Example 3

[0071] A PET yarn was obtained in the same manner as in Example 1, except that the spinning temperature and the temperature of the hot wire were 304 °C and 380 °C, respectively, and the spinning process was performed under a discharge pressure of 2312 psi.

Example 4

[0072] A PET yarn was obtained in the same manner as in Example 1, except that PET chips with an intrinsic viscosity (I.V.) of 1.4 dl/g were used for the production of the spinning melt, the spinning temperature and the temperature of the hot wire were 298 °C and 380 °C, respectively, and the spinning process was performed under a discharge pressure of 2160 psi.

Comparative Example 1

[0073] The same method as in Example 1 was applied, except that the spinning temperature was 310 °C, heating by the hot wire was omitted, and a discharge pressure of 2930 psi was applied. However, an excessively high discharge pressure caused a leakage of the spinning melt in the spinning pack, and thus winding was impossible.

Comparative Example 2

[0074] A PET yarn was obtained in the same manner as in Example 1, except that a PET chip with an intrinsic viscosity (I.V.) of 1.4 dl/g was used for the preparation of the spinning melt, the spinning temperature was 306 °C, heating by the hot wire was omitted, and a discharge pressure of 2370 psi was applied.

Comparative Example 3

[0075] A PET yarn was obtained in the same manner as in Example 1, except that a PET chip with an intrinsic viscosity (I.V.) of 1.21 dl/g was used for the preparation of the spinning melt, the spinning temperature was 299 °C, heating by the hot wire was omitted, and a discharge pressure of 1910 psi was applied.

Comparative Example 4

[0076] A PET yarn was obtained in the same manner as in Example 1, except that a PET chip with an intrinsic viscosity (I.V.) of 1.21 dl/g was used for the preparation of the spinning melt, the spinning temperature and the temperature of the hot wires were 292 °C and 380 °C, respectively, and the spinning process was performed under a discharge pressure of 1850 psi.

[0077] The PET yarns of the examples and comparative examples were measured for intrinsic viscosity (I.V.), tensile strength, elongation at break, elongation at 4.5 g/d load (EASL@4.5 g/d), and dry heat shrinkage by the following method, respectively. (In the case of Comparative Example 1 where winding was impossible, the I.V. of the dropped solidified sample was measured, and tensile strength, elongation at break, EASL@4.5 g/d, and dry heat shrinkage of the yarn were not measurable). The results are shown in Table 1 below.

*Intrinsic viscosity of PET yarn (I.V.)

[0078] The intrinsic viscosity (I.V.) (dl/g) of each PET yarn was measured by a capillary viscometer according to Test Method ASTM D4603-96. The solvent used was a mixture of phenol/1,1,2,2-tetrachloroethane (60/40 wt%).

*Tensile strength, EASL@4.5 g/d, and elongation at break of PET yarn

[0079] In accordance with Test Method ASTM D885, the tensile strength (g/d) and elongation at break (%) of PET yarns were measured using a universal tensile tester (Instron Engineering Corp, Canton, Mass) (initial load: 0.05 gf/d, sample length: 250 mm, tensile speed: 300 mm/min), and EASL@4.5 g/d of PET yarn was measured.

*Dry heat shrinkage of PET yarn

[0080] The initial length (L1) of the specimen and the length (L2) of the specimen after 2 minutes in an oven at 177 °C were respectively measured in accordance with Test Method ASTM D885, and then the dry heat shrinkage (%) of the PET yarn was calculated by the following Equation.

$$\text{Equation: Dry Heat Shrinkage (\%)} = [(L1-L2)/L1] \times 100$$

[Table 1]

	Process condition					PET yarn				
	PET chip I.V. (dl/g)	Spinning temperature (°C)	Hot wire temperature (°C)	Speed after drawing (m/min)	Disc harg e pressure (psi)	I.V. (dl/g)	Tensile strength (g/d)	EASL@ 4.5g/d (%)	Dry heat shrinkage (%)	Elongation at break (%)
Example 1	1.7	295	450	5800	2101	1.25	10.6	4.4	9.9	13.4
Example 2	1.7	299	420	5800	2181	1.23	10.3	4.3	9.8	13.8
Example 3	1.7	304	380	5800	2312	1.19	10.2	4.4	9.7	13.7
Example 4	1.4	298	380	5800	2160	1.11	10.0	4.5	9.5	13.9
Comparative Example 1	1.7	310	-	5800	2930	1.12 (I.V. of dropped solidified sample)	-	-	-	-
Comparative Example 2	1.4	306	-	5800	2370	1.03	9.3	4.6	10.3	12.9
Comparative Example 3	1.21	299	-	5800	1910	0.93	9.0	4.6	10.6	13.1
Comparative Example 4	1.21	292	380	5800	1850	0.95	9.2	4.5	9.5	13.0

[0081] In Examples 1 to 4, by using PET chips with a relatively high intrinsic viscosity (I.V.) of 1.4 to 1.7 dl/g, and applying a relatively low spinning temperature of 295 to 304 °C to minimize the thermal decomposition of the polymer, PET yarns with high intrinsic viscosity (I.V.) of 1.11 to 1.25 dl/g, high tensile strength of 10.0 to 10.6 g/d, and elongation at break of 13.4 to 13.9 % could be obtained.

[0082] In contrast, when PET chips with an intrinsic viscosity (I.V.) of less than 1.4 dl/g were used as in Comparative Examples 3 and 4, although low spinning temperatures of 299 °C or 292 °C were applied and thus the thermal decomposition of the polymer would be less than that of Examples 1 to 4, the intrinsic viscosity (I.V.) and tensile strength of PET yarns did not reach 1.1 dl/g and 10 g/d, respectively.

[0083] Further, as in Comparative Example 2, PET chips having a relatively high intrinsic viscosity (I.V.) of 1.4 dl/g were used, but even when a high spinning temperature of 306 °C was applied and thermal decomposition of the polymer

occurred, the intrinsic viscosity (I.V.) and tensile strength of PET yarns did not reach 1.1 dl/g and 10 g/d, respectively.

[0084] On the other hand, in Examples 1 to 4, despite using PET chips with a relatively high intrinsic viscosity (I.V.) of 1.4 to 1.7 dl/g and applying a relatively low spinning temperature of 295 to 304 °C, the spinning melt was heated just before discharging with a hot wire of 380 to 450 °C, and thereby, a spinning process and drawing process (speed after drawing: 5800 mm) under a discharge pressure of 2101 to 2312 psi, that is, an allowable discharge pressure (i.e., 2400 psi or less/min), could be performed.

[0085] On the contrary, in the case of Comparative Example 1 in which PET chips having an intrinsic viscosity (I.V.) of 1.7 dl/g were used as in Examples 1 to 3, despite the application of a spinning temperature of 310 °C that was higher than the spinning temperature in Examples 1 to 3, heating by the hot wire was omitted, and thus a high discharge pressure (i.e., 2930 psi) outside the allowable range was required, and as a result, leakage of the spinning melt in the spinning pack was caused, and winding of the yarn was impossible.

[0086] Therefore, in order to perform the spinning process with a PET chip having an intrinsic viscosity (I.V.) of 1.7 dl/g without heating by a hot wire, it can be seen that it is required to reduce the discharge pressure by applying a spinning temperature much higher than 310 °C.

[0087] However, even when a spinning temperature of 310 °C was applied, significant thermal decomposition of the polymer occurred, and thus the I.V. reduction of about 0.58 dl/g (I.V. of PET chips - I.V. of dropped solid samples) occurred. Considering the above, it was obvious that when the spinning temperature of much higher than 310 °C was applied, the I.V. drop exceeding 0.6 dl/g was caused, and thus the intrinsic viscosity (I.V.) and tensile strength of the PET yarn did not reach 1.1 dl/g and 10 g/d, respectively.

Claims

1. A polyethylene terephthalate yarn comprising
100 to 500 filaments each having fineness of 2 to 5 denier,
wherein the PET yarn has an intrinsic viscosity of 1.1 dl/g or more and a tensile strength of 10 g/d or more.
2. The polyethylene terephthalate yarn of claim 1, wherein the PET yarn has an intrinsic viscosity of 1.1 to 1.25 dl/g and a tensile strength of 10 to 10.6 g/d.
3. The polyethylene terephthalate yarn of claim 1, wherein the PET yarn has elongation of 3 to 6% at a 4.5 g/d load and dry heat shrinkage of 7 to 12 %.
4. The polyethylene terephthalate yarn of claim 1, wherein the PET yarn has elongation at break of 13 to 14 %.
5. The polyethylene terephthalate yarn of claim 4, wherein the PET yarn has elongation at break of 13.4 to 13.9 %.
6. A method for producing a polyethylene terephthalate yarn comprising the steps of:
melting a polyethylene terephthalate chip having an intrinsic viscosity of 1.4 to 1.7 dl/g to prepare a spinning melt;
discharging the spinning melt through a nozzle of a spinning pack;
heating the spinning melt just before being discharged from the nozzle by means of a heat source of 300 to 500 °C located immediately below the nozzle;
converging a plurality of filaments formed by the discharging to form a multifilament; and
drawing the multifilament,
wherein a temperature of the spinning pack is maintained at 280 to 305 °C.
7. The method for producing a polyethylene terephthalate yarn according to claim 6, wherein a speed after drawing of 4000 to 6200 m/min and a draw ratio of 1.9 to 2.5 are applied.
8. The method for producing a polyethylene terephthalate yarn according to claim 6, wherein the distance between the nozzle and the heat source is 5 to 50 mm.
9. The method for producing a polyethylene terephthalate yarn according to claim 8, wherein the temperature of the heat source is higher than the temperature of the spinning pack.
10. The method for producing a polyethylene terephthalate yarn according to claim 9, wherein the heat source includes a hot wire.

EP 3 686 326 A1

11. The method for producing a polyethylene terephthalate yarn according to claim 9, wherein the heat source includes a plurality of hot wires, and the hot wires are respectively arranged between the filaments so as to not hinder the movement of the filaments.

5 12. The method for producing a polyethylene terephthalate yarn according to claim 11, wherein the hot wires are arranged at equal intervals, and each of the hot wires is arranged to be parallel to the lower surface of the nozzle.

10 13. The method for producing a polyethylene terephthalate yarn according to claim 6, wherein the discharging step is performed under a discharge pressure of 2400 psi or less.

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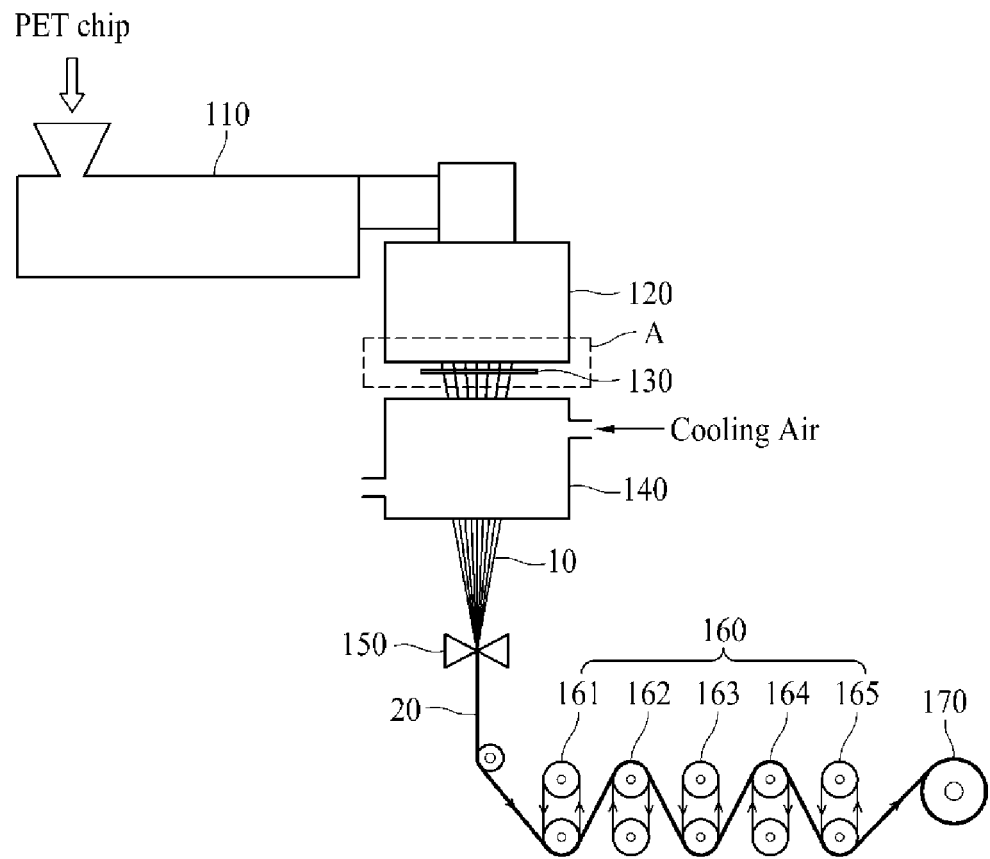
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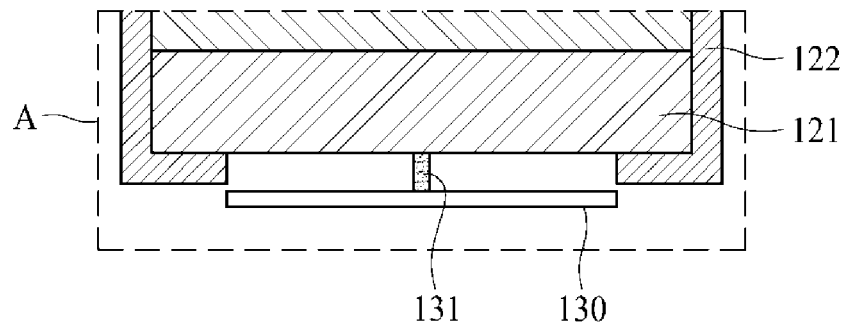
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【FIG. 1】



【FIG. 2】



INTERNATIONAL SEARCH REPORT

International application No.

PCT/KR2018/010211

A. CLASSIFICATION OF SUBJECT MATTER <i>D01F 6/62(2006.01)i, D01D 5/084(2006.01)i, D01D 5/098(2006.01)i</i> According to International Patent Classification (IPC) or to both national classification and IPC																		
B. FIELDS SEARCHED																		
Minimum documentation searched (classification system followed by classification symbols) D01F 6/62; B60C 9/00; D02G 3/44; D03D 1/02; D01D 5/084; D01D 5/098																		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Korean Utility models and applications for Utility models: IPC as above Japanese Utility models and applications for Utility models: IPC as above																		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) eKOMPASS (KIPO internal) & Keywords: polyethylene terephthalate, yarn, fineness, intrinsic viscosity, tensile strength, melting, radiation, elongation																		
C. DOCUMENTS CONSIDERED TO BE RELEVANT																		
<table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>A</td> <td>KR 10-2011-0070396 A (KOLON INDUSTRIES, INC.) 24 June 2011 See paragraphs [0082], [0083], [0116]; and claims 1-3, 6, 8, 10, 11.</td> <td>1-13</td> </tr> <tr> <td>A</td> <td>KR 10-2011-0078414 A (HYOSUNG CORPORATION) 07 July 2011 See the entire document.</td> <td>1-13</td> </tr> <tr> <td>A</td> <td>KR 10-1295697 B1 (HYOSUNG CORPORATION) 20 August 2013 See the entire document.</td> <td>1-13</td> </tr> <tr> <td>A</td> <td>JP 08-134716 A (UNITIKA LTD.) 28 May 1996 See the entire document.</td> <td>1-13</td> </tr> <tr> <td>A</td> <td>US 5033523 A (BUYALOS, E. J. et al.) 23 July 1991 See the entire document.</td> <td>1-13</td> </tr> </tbody> </table>	Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	A	KR 10-2011-0070396 A (KOLON INDUSTRIES, INC.) 24 June 2011 See paragraphs [0082], [0083], [0116]; and claims 1-3, 6, 8, 10, 11.	1-13	A	KR 10-2011-0078414 A (HYOSUNG CORPORATION) 07 July 2011 See the entire document.	1-13	A	KR 10-1295697 B1 (HYOSUNG CORPORATION) 20 August 2013 See the entire document.	1-13	A	JP 08-134716 A (UNITIKA LTD.) 28 May 1996 See the entire document.	1-13	A	US 5033523 A (BUYALOS, E. J. et al.) 23 July 1991 See the entire document.	1-13
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☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.																		
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Date of the actual completion of the international search 04 JANUARY 2019 (04.01.2019)	Date of mailing of the international search report 04 JANUARY 2019 (04.01.2019)																	
Name and mailing address of the ISA/KR  Korean Intellectual Property Office Government Complex Daejeon Building 4, 189, Cheongsu-ro, Seo-gu, Daejeon, 35208, Republic of Korea Facsimile No. +82-42-481-8578	Authorized officer Telephone No.																	

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/KR2018/010211

Patent document cited in search report	Publication date	Patent family member	Publication date
KR 10-2011-0070396 A	24/06/2011	CN 102656299 A	05/09/2012
		CN 102656299 B	11/06/2014
		EP 2513359 A2	24/10/2012
		EP 2513359 B1	18/07/2018
		JP 2013-513738 A	22/04/2013
		JP 5486094 B2	07/05/2014
		KR 10-1575837 B1	22/12/2015
		US 2012-0289114 A1	15/11/2012
		US 9617664 B2	11/04/2017
		WO 2011-074920 A2	23/06/2011
		WO 2011-074920 A3	24/11/2011
KR 10-2011-0078414 A	07/07/2011	KR 10-1551421 B1	09/09/2015
KR 10-1295697 B1	20/08/2013	CA 2783546 A1	30/06/2011
		CA 2783546 C	22/12/2015
		CN 102713031 A	03/10/2012
		CN 102713031 B	17/09/2014
		EP 2518195 A2	31/10/2012
		EP 2518195 B1	31/10/2018
		JP 2013-514465 A	25/04/2013
		KR 10-1295696 B1	14/08/2013
		KR 10-2011-0073992 A	30/06/2011
		KR 10-2011-0076140 A	06/07/2011
		MX 2012007451 A	15/10/2012
		US 2012-0263401 A1	18/10/2012
		WO 2011-078513 A2	30/06/2011
		WO 2011-078513 A3	10/11/2011
JP 08-134716 A	28/05/1996	JP 3459478 B2	20/10/2003
US 5033523 A	23/07/1991	CA 2002165 A1	08/06/1990
		CA 2002165 C	12/09/2000
		CN 1043164 A	20/06/1990
		EP 0447402 A1	25/09/1991
		EP 0447402 B1	18/08/1993
		EP 0447402 B2	27/09/2000
		JP 04-502181 A	16/04/1992
		JP 2904522 B2	14/06/1999
		KR 10-0140228 B1	01/07/1998
		US 4867936 A	19/09/1989
		US 4975326 A	04/12/1990
		WO 90-06383 A1	14/06/1990

Form PCT/ISA/210 (patent family annex) (January 2015)