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PROCESS OF DRAWING MELT SPUN POLYESTER YARNS

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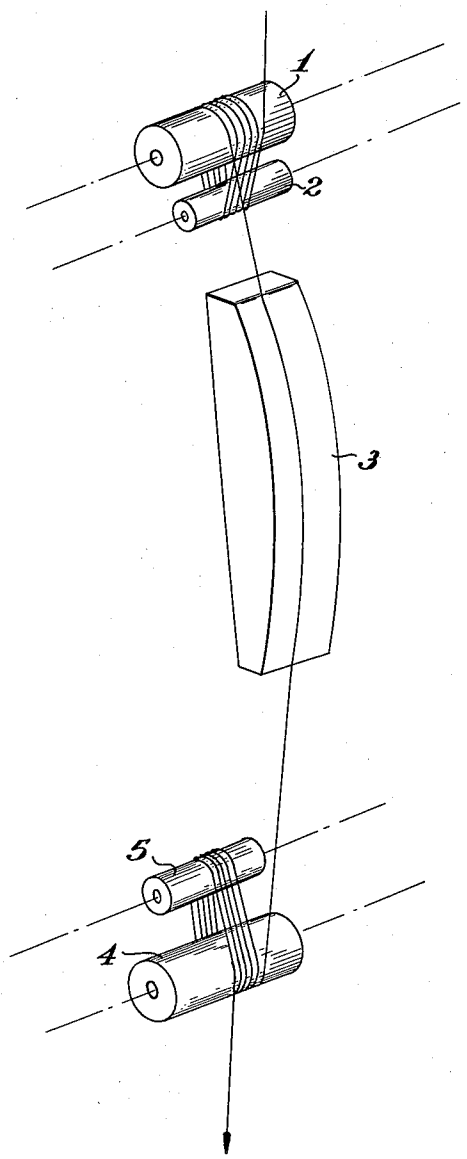

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PROCESS OF DRAWING MELT SPUN POLYESTER YARNS

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This invention relates to a process for treating synthetic yarns and filaments, hereinafter referred to as yarns, and in particular it relates to an improved process for drawing filaments and yarns of melt spun thermoplastic polymers.

It is well known that in order to produce useful textile yarns from, for example, melt spun polyesters such as polyethylene terephthalate, the melt spun yarns have to be stretched and heated. This is done usually by feeding the spun yarn from a supply package over to sets of rollers in turn, the second set having a greater peripheral speed than the first. The yarn is heated between the sets of rollers by passing it, for example, around a heated pin and/or over a heated plate, through heated liquids or vapours or close to a source of radiant heat.

After drawing, the yarn is either collected on to bobbins or crimped and cut to provide staple fibres.

One of the most frequently used and popular drawing processes of the prior art comprises a set of feed rolls, a heated pin and a hot plate, a set of draw rolls and a ring and traveller winding system. By this process it has been possible to manufacture useful textile yarns with a tenacity of 4–5 grams/denier. Yarns with a usefully higher tenacity of over 6 grams per denier can be produced by a modification to the above process whereby the spun yarn is fed around a heated pin to a draw roll and thence over a heated plate to a second draw roll with a peripheral speed greater than that of the first draw roll. The overall draw ratio between the feed roll and the second draw roll required to give the desired properties may be of the order of 6:1 and the intermediate draw ratio of about 4:1. In the first type of process referred to above which is usually known as the pin/plate process the draw ratio is about 4:1 and it is used to produce medium tenacity continuous filament yarns with deniers up to about 200 or staple fibres, for apparel purposes.

The second process, known as "two stage draw" is used primarily for industrial outlets such as ropes or tyre cords manufactured as continuous filament yarns with deniers in the range 250–10,000. The higher tenacity yarns may also be produced by a single stage pin/plate drawing process by increasing the draw ratio and heating the yarn further by increasing the arc of contact around the pin. To give the desired properties a draw ratio of up to 5:1 may be required.

The processes outlined above, however, tend to suffer some disadvantages. For example, with medium tenacity continuous filament yarns of about 70 denier the draw speed is limited under the most favourable conditions to about 1500 feet per minute because above this speed, denier variations are introduced which give rise to stripiness in dyed fabrics made from such yarns.

In the production of the higher tenacity yarns of, for example, polyethylene terephthalate the two stage drawing process tends to cause lapping on the final draw roll when the draw ratio is high enough to give a tenacity of over 7 grams per denier, and with both processes the hot pin surface wears away rapidly causing broken filaments within the yarn, unless the draw speed is limited. For example, 1000 denier yarn with a tenacity of about 7.5 grams per denier can be produced only at about 500 ft. per minute even using a yarn preheater plate, followed by two hot pins and a hot plate.

In the production of high tenacity polypropylene yarns of about 1000 drawn denier the process requires at least two and preferably four hot pins followed by a hot plate, and the wear on the pin surfaces is excessive.

It is the object of our present invention to provide a drawing process which overcomes the aforementioned disadvantages and permits the production of medium and high tenacity melt spun yarns of improved quality at a greatly increased rate.

According to our invention we provide an improved process for producing drawn melt spun yarns by drawing said melt spun yarns around a set of feed rolls and a set of draw rolls rotating at a higher peripheral speed than the feed rolls characterised in that at least one feed roll is heated and a heating zone is provided between the feed rolls and draw rolls.

The heating zone located after the feed roll may comprise any suitable device and we have found that a heated metal plate is very suitable.

In a preferred version of our process there is provided one feed roll only and this is associated with a skewed idler roll so that two or more turns of yarn may be wound around it.

The drawing illustrates one preferred form of the equipment for carrying out the process of our invention. Melt spun yarn from a suitable source (not shown) is led to and around a heated feed roll **1** and an associated skewed idler roll **2**. From these rolls the yarn is passed over a heated metal plate **3** to a second set of draw and skewed idler rolls **4** and **5**. The draw roll **4** is rotated at a higher speed than the feed roll **1** in order that the yarn may be stretched. From the draw roll **4** the yarn is passed to a suitable collecting means (not shown). Means (not shown) for measuring and controlling the temperatures of the heated roll **1** and the heated plate **3** are also incorporated.

Using the process of our invention we have been able to produce medium tenacity yarns, i.e. yarns with a tenacity not greater than 6 grams per denier, at much higher draw speeds than has previously been possible and also with greatly improved quality.

The process of our invention may be used for producing drawn melt spun yarns of high tenacity, from suitable polyesters. By high tenacity we mean yarns with a tenacity greater than 6 grams per denier. We have found that for the production of such yarns with a denier range of 20 to 500 the feed roll temperature should be within the range 75° C. to 90° C. and the heating zone temperature should be within the range of 160° to 200° C.

For the optimum yarn drawing conditions we prefer that the feed roll temperature should be between 80° C. and 85° C. and the temperature of the heating zone should be between 185° C. and 195° C.

For the production of high tenacity polyester yarns in the denier range 500 to 2000 the temperature of the heated feed roll should be within the range 60° C.–75° C. and preferably within the range 65° C. to 70° C. The temperature of the heating zone should be within the range 160° C.–200° C. and preferably within the range 185° C. to 190° C.

High tenacity polyester yarns as described above may suitably be made from polyethylene terephthalates.

Drawn yarns of comparatively low denier, i.e. about 20, may be scuccessfully drawn by the process of our invention at speeds up to 3000 ft. per minute. With yarns of higher denier the improvement in quality and speed of drawing is particularly noticeable using yarns of low denier per filament. Thus a drawn yarn of 140 denier with 120 filaments may be drawn by the process of our invention at speeds up to 1500 ft. per minute whereas a similar yarn drawn over a pin plate system could not be drawn at speeds greater than 600 ft./min.

In the production of medium tenacity polyester yarns as hereinbefore described we have found that the temperature of the heated feed roll should be within the range 90° C.–100° C. and the temperature of the heating zone should be within the range 160° C.–180° C. and preferably the temperature of the heating zone should be within the range 170–175° C.

The process of our invention is also suitable for producing high tenacity yarns from stereo regular polyolefines within the denier range 20 to 2000 and as with the polyester yarns the precise conditions vary slightly with yarn denier. Thus, in the production of high tenacity yarns of stereo regular polyolefines within the denier range 20 to 500 the temperature of the heated feed roll should be within the range 75° C. to 90° C. and the temperature of the heating zone should be within the range 135° C.–145° C.

For the optimum conditions we prefer that the feed roll temperatures should be within the range 80° C. to 85° C. For the production of high tenacity yarns from stereo regular polyolefines of a denier within the range 500–2000 the temperature of the heating zone should be within the range 135° C. to 145° C. For optimum drawing conditions we prefer that the feed roll should be heated within the range 65° C. to 75° C. and the heating zone should be within the range 135° C. to 145° C.

Any suitable stereo regular polyolefine may be used and we have found that isotactic polypropylene is very suitable.

The process of our present invention may be used to make filaments from any suitable synthetic polymers. Among the most important are polyesters and copolyesters such as the condensation products of ethylene glycol with terephthalic acid, ethylene glycol with a mixture of terephthalic/5 (sodium sulpho) isophthalic acids, ethylene glycol with a mixture of terephthalic acid and isophthalic acids, ethylene glycol with terephthalic acid and another dibasic acid such as sebacic or adipic acid, present in small amounts, polyesters of terephthalic acid with a glycol other than ethylene glycol, polyolefines such as stereo regular polypropylene and polyamides such as poly hexamethylene adipamide.

The following examples illustrate but do not limit our invention.

Example 1

A 4000 denier spun yarn of birefringence 5.2×10^{-3} and intrinsic viscosity of 0.72 was drawn at a draw ratio of 4.63:1 around a pin at 100° C. and over a plate at 200° C. at a speed of 500 ft. per minute to give a yarn of 7.5 grams per denier. At draw speeds greater than this lapping occurred on the draw roll and at a draw speed of 1000 ft. per minute it was not possible to operate the process because of severe lapping.

The same yarn when similarly treated except that it was passed over a driven feed roll heated to 65° C. instead of the pin, was drawn at 1300 ft. per minute with virtually no lapping to give identical physical properties.

Example 2

A 70 denier medium tenacity yarn when produced by drawing on a pin/plate system and woven into a fabric and dyed showed a pronounced stripiness when the wind up speed was above 1500 ft. per minute.

A similar yarn when drawn over a heated driven feed roll at 95° C. and a hot plate at 170° C. was wound up at 2500 ft. per minute and the resulting fabric was free of stripes.

Example 3

A spun yarn of polyethylene terephthalate with a denier of 5,600 was drawn around a hot pin at 110° C. and over a hot plate at 185° C. at a speed of 500 ft. per minute to give a yarn with a tenacity of 7.5 gm./denier. Draw speeds greater than this could only be achieved in a conventional manner (without very heavy lapping) by using a preheater plate at 75° C., two hot pins at 110° C. and a hot plate at 185° C. However, by using a hot driven feed roll at 70° C. followed by a hot plate at 185° C. a draw speed of 1000 ft./min. could readily be achieved without serious lapping.

Example 4

A polypropylene yarn of spun denier about 8000 was drawn over a system involving 4 hot pins, the first two at 85° C. and the second and third at 90° C. and 95° C. respectively and a hot plate at 145° C. at a speed of 500 ft./min. to give a yarn with a tenacity of 8.4 gm./denier and an extension of 20.4%. Using a single driven hot feed roll at 75° C. followed by a hot plate at 145° C. a drawn yarn with a tenacity of 9.09 gm./denier and an extension of 20.4% was obtained.

Example 5

Spun yarn with a denier of 1100 was drawn around a driven hot feed roll at 80° C. and over a hot plate at 185° C. at a draw speed of 1300 ft./min. to give a yarn with a tenacity of 7.6 gm./denier. Using the pin/plate drawing sequence yarn of a similar denier was drawn to a tenacity of 6.8 gm./denier at a speed of only about 600 ft./min. The number of laps per pound produced by the yarn drawn over the pin and plate was three times greater than that drawn over the heated feed roll.

Example 6

A melt spun yarn of polyethylene terephthalate of approximately 130 denier was drawn at a draw ratio of 3.3:1 over a pin/plate system at a maximum speed of 2000 ft. per minute to give a good quality stripe free medium tenacity yarn with trouble free running. At speeds greater than this, bad lapping on the hot pin and draw rolls occurred. The same yarn when drawn using a heated feed roll at 98° C. and a plate at 175° C. gave a good quality yarn at a speed of 2800 ft. per minute.

Example 7

Using a pin/plate drawing process a good quality 70 denier 1.2 d.p.f. yarn of polyethylene terephthalate was drawn from spun yarn of 230 denier at a speed of 1000 feet per minute. At draw speeds greater than this, loopy yarn of poor quality was produced.

Using the process of our invention with a heated roll temperature of 93° C. and a hot plate temperature of 168° C. it was possible to make good quality 70 denier 1.2 d.p.f. yarn at speeds up to 1500 feet per minute.

Example 8

Using a pin/plate drawing process we have not been able to produce good quality yarns of 140 denier with a d.p.f. less than 1.5 from melt spun yarns of polyethylene terephthalate. However, a melt spun polyethylene terephthalate yarn of 460 denier was drawn over a heated feed roll at 95° C. and a heated plate at 173° C. at a speed of 1100 feet per minute to give good quality drawn yarn of 140 denier and 1.3 d.p.f.

What we claim is:

1. In a process for producing drawn melt spun polyester yarns of a drawn denier between 20 and 2000 and tenacity greater than 6 grams per denier which process includes drawing the yarn around a set of feed rolls and a set of draw rolls, the improvement comprising heating at least one feed roll to between 60° C. and 90° C., providing a heating zone of between 160° C. and 200° C. between the feed rolls and the draw rolls and providing a skewed idler roll for each heated feed roll.

2. A process for producing drawn melt spun polyester yarns of a tenacity less than 6 grams per denier which process includes drawing the yarn around a set of feed rolls and a set of draw rolls, the improvement comprising heating at least one feed roll to between 90° C. and 100° C., providing a heating zone of between 160° C.

and 180° C. between the feed rolls and the draw rolls and providing a skewed idler roll for each heated feed roll.

3. A process according to claim 1 for producing melt spun yarns of stereoregular polyolefines of a drawn denier between 50 and 2000 wherein the temperature of the feed roll is between 60° C. and 90° C. and the temperature of the heating zone is between 135° C. and 145° C.

4. A process according to claim 1 wherein the melt spun yarns are composed of fibers selected from the group consisting of polyesters, stereoregular polyolefines and polyamides.

5. A process according to claim 4 wherein the fiber is polyethylene terephthalate.

6. A process according to claim 4 wherein the fiber is isotactic polypropylene.

7. A process for producing melt spun yarns of a drawn denier between 20 and 2000, the fibers of which are selected from the group consisting of polyesters having ester linkages as an integral part of the main chain, stereoregular polyolefines and polyamides comprising: feeding the yarn with a feed roll and an associated skewed idler roll, said feed roll being heated to a temperature of 60° C.–100° C.; heating the yarn in a heating zone which is maintained at a temperature of 135° C.–200° C.; and drawing off the yarn with a draw roll which is rotated at a greater speed than the feed roll.

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