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PATENT SPECIFICATION

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DRAWINGS ATTACHED

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(54) IMPROVEMENTS IN OR RELATING TO THE PRODUCTION OF BULKED YARNS

(71) We, IMPERIAL CHEMICAL INDUSTRIES LIMITED, of Imperial Chemical House, Millbank, London, S.W.1. A British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention concerns improvements in or relating to the production of bulked yarns, particularly such yarns in which the bulk is induced by the false twist crimping process.

Bulking by false twist crimping is now a well-established industry, with the majority of interest concentrated in polyamide and polyester multifilament yarns owing to the readiness with which these materials may be set in a desired deformed state.

Circumstances are such that in many instances the yarn producers make special feed-stock yarns for use in the sundry false twist crimping processes. For instance, in some cases it is desirable to employ as feed-stock a yarn which has not been fully drawn according to the conditions normally appertaining to yarn of its kind. At the other end of the false twist crimping process, the crimped yarn is often further processed in order to modify its bulk and stretch characteristics to fit the fabric or other use requirements for which the yarn is intended.

Thus, post-treatments are carried out, either continuously on the crimped yarn as it travels towards the wind-up on the crimping machine, or batch-wise after the yarn has been wound or skined.

Whilst it has been previously proposed to combine the producer's step of drawing the feed-stock yarns, that is, to further orient the molecules of the filaments, and the processor's step of false twist crimping, historical circumstances in the way the trade is fragmented have told against the establishment of such a combined process in practice.

It has now been found that very considerable and surprising process and product advantages arise when a particular post-treat-

ment involving a controlled amount of over-feed of the crimped yarn on to the take-up package of the false twist crimping machine, is provided with a feed-stock of synthetic polymeric yarn in a drawable state, and the conditions of false twist crimping are such as to draw the yarn.

The main advantage, particularly in polyester yarns, is that of dyeing uniformity, compared with similar yarn produced from previously drawn yarn. It is possible, although the Applicants do not wish to be bound by the theory, that this improvement is due to the lower rate at which drawing takes place when in the context of false twist crimping, and the concomitant increased time for heating the yarn, compared with ordinary drawing processes.

Subsidiary advantages are that of increased bulk for a given drawable feed-stock, and that of the ability to produce a variety of different bulk effects from a common feed-stock by the simple expedient of altering the draw ratio applied between the feed rolls and draw rolls (take-out rolls) of the false twist crimping machine.

The invention therefore comprises a process for producing a bulked synthetic polymeric yarn in which yarn in a drawable state is fed by feed rolls via heating means and false twist means to draw rolls which are rotated at a peripheral speed higher than that of the feed rolls by an amount equivalent to the desired draw ratio of the yarn, the yarn in its passage to the false twist means being heated in such manner that the drawing zone occurs during an early stage of heating and the setting of the twist occurs at a later stage of heating with incomplete snubbing of twist taking place in the drawing zone and subsequently heating the crimped yarn when in a controlled longitudinally contracted condition.

Thus, drawing takes place in or on the heating means, preferably within the first few inches of contact with a single conduction type of heater depending upon such variables as yarn denier and speed and heater tem-

perature, with the yarn drawing at a visible neck at that point, the neck being so located by virtue of the heating-up of the drawable yarn.

- 5 In these circumstances, drawing takes place very uniformly and very completely, normally at draw ratios lower than standard for the yarn in question. No snubbing-pin need be used, e.g. as described in U.K. Specification 10 890,053 which has the effect of substantially preventing twist inserted by the flange of the draw roll from passing back to the feed rolls. Thus, in the present invention some of the twist inserted by the false twist means runs 15 back through the drawing zone until arrested by the feed rolls, i.e. there is incomplete snubbing of the twist in the drawing zone.

- Normally the feed rolls are unheated, but under some circumstances depending upon the 20 final yarn characteristics that are desired, they may be heated.

- The yarn feed-stock can be provided in a drawable state either directly from a continuous supply thereof, e.g. a melt-spinning 25 machine, or in the form of a wound package of drawable yarn which will be mounted on a creel in place of the conventional package of so-called "raw", or producer's yarn, i.e. yarn in a drawn state, but without any subsequent 30 processing other than optionally a small amount of twist or intermingling to effect coherence.

- The temperature of the heating means, which may comprise one or more heaters, will 35 depend on the nature of the polymeric yarn, and on the process throughput; but in general it can be said that lower temperatures will be required, for a given throughput, and a given degree of bulk to be attained, than in the case 40 of a like process utilizing a drawn yarn as feed-stock, provided that the lower draw ratio is employed.

- The stabilizing process can be one involving heating the yarn on the run whilst it is travelling to a wind-up; or one involving heat treatment 45 of the package as wound up, e.g. by steam, followed by, or combined with, dyeing, or one involving a combination of the above two heating processes.

- 50 Preferably, the drawn yarn is allowed to contract longitudinally by at least 10% between the draw rolls and the wind-up means.

- The invention has found its main application to date in the production of bulked yarns 55 of synthetic linear polyesters, such as polyethylene terephthalate, owing chiefly to the commercial emphasis on the use of this polymeric yarn in bulked yarns of the kind in question. However, it may be useful in the 60 production of bulked yarns of other polymeric material, as for instance, synthetic linear polyamides, for example, nylon 6 and nylon 66.

- The invention will now be described by reference to some exemplary processes utilizing 65 ing drawable multifilament yarn of poly-

ethylene terephthalate, having an as-spun total denier of 540 and 30 filaments.

EXAMPLE I

The drawable yarn was drawn and false twist crimped on a machine calculated to insert 70 55 turns per inch "S" twist by a false twist spindle (or friction bush) rotating at 300,000 r.p.m., and having a single 2 foot long tracked, arcuate contact-heater. Drawing took place at 75 a neck at the start (i.e. upstream end) of the heater, the draw ratio having been set by fixing the speed ratio of the feed and the draw rolls (take-out rolls) of the machine. The crimped yarn was positively forwarded to a cheese-type 80 wind-up, the traverse guide of which was so adjusted in reciprocating rate during the wind that a constant wind ratio was maintained in winding a soft yarn package. The yarn linear speed at the draw rolls was 230 feet/minute, and the surface speed of the wind-up was 195 85 feet/minute, corresponding to a mechanical overfeed (i.e. the overfeed set on the machine, as between the draw roll and wind-up package surface speeds) of 15%. In these conditions, the amount of linear contraction of the crimped yarn was 11%. The yarn package 90 was steamed for 20 minutes at 25 p.s.i.; and subsequently this yarn was coned, with the application of an oil, and then knitted as two-fold in 24 gauge fully-fashioned panels for comparison with "control" yarns which had 95 been processed commercially, using drawn 150 denier/30 filament polyethylene terephthalate yarn as feed-stock.

Various heater temperatures between 140°C 100 and 200°C were utilized in successive trials, to assess the effect of heater temperature on final fabric appearance; and, similarly, different draw ratios, between 2.9 and 3.65 (the "standard" draw ratio for this yarn) were 105 tried.

It was established that the yarns according to the invention provided greater fabric bulk than those of the "control"; and that fabric bulk decreased with reduction in processing 110 temperature and increase in draw ratio. In fact, at the "standard" draw ratio of 3.65, acceptable fabric bulk and handle were only attainable at 180°C heater temperature; and consequently such a high draw ratio is not 115 normally desirable, and neither is it desirable on the score of rather excessive filamentation that takes place.

EXAMPLE II

Comparison of fabric dyeing properties was 120 made between bulked yarns produced according to the invention and those produced in the present conventional manner from drawn yarn feed-stock. Both sets of yarns were derived from the same spinning batch. 125

The respective processing conditions were as follows:—

Condition	Process according to the invention	Conventional process
Spindle speed	150,000 r.p.m.	150,000 r.p.m.
Twist	55 t.p.i.	55 t.p.i.
Heater Temp.	185°C	193°C
Mechanical (set) overfeed	13.5%	15%
Draw ratio	3.2	—
Overfeed to twist zone	—	0%

Under these conditions the amount of twist running back through the drawing zone was 10.5 turns per inch.

Both sets of yarns were steam set on the wind-up packages for 20 minutes at 27 p.s.i.

After coning, the respective yarns were knitted into panels and into circular fabrics (12 feeder), which were dyed, at 100°C., Cypress Green and were then visually compared for dyeing uniformity. It was found by assessment of the panels that the bulked yarn according to the invention evinced no short-term dyeing variations due to within-package variability, which were present in the conventional yarn; and far less between-package variations. Also, in the assessment of the circular fabrics, it was found that stripiness and short-term variations were markedly less for the yarn of the invention than for the conventional yarn.

A suitable apparatus for carrying out the invention as specified in Examples I and II will now be described.

The apparatus is diagrammatically illustrated in the accompanying drawing and comprises a positive-feed false twist crimping machine having a supply package creel 1, a feed roll 2 (of low inertia) and a draw roll 3 both driven from a single motor through chains and sprockets via a Kopp (registered trade mark) variator (not shown) by means of which the relative speeds of the rolls (and hence the set draw ratio) can readily be changed, a magnetically-mounted false twist spindle 4 belt-driven by a motor and Kopp variator (not shown), capable of prolonged running at 300,000 r.p.m., a twin-track 2 foot arcuate contact heater 5 having its temperature controlled by a proportional controller (not shown) and conventional yarn wind-up means 6. Yarn passes through the machine from bottom to top thereof.

Both the feed and draw rollers are provided with separator rolls 7 (i.e. rolls closely aligned to the main rolls and adapted to keep separate a plurality of yarn wraps taken around both rolls together), and with nip rolls 8 on weighted

arms (not shown), which latter are lowered on to the draw roll and feed roll, respectively in that order, at start-up.

Swing-arm thread-guide means are also provided by means of which the threadline can be either held in contact with the heater track along its length or held in closely spaced relationship thereto.

The reason for this is that it is important with certain polymeric materials, as for instance polyethylene terephthalate, that the yarn should not make contact with the heater (at full processing temperature) until the process is running correctly, i.e. until drawing and twisting are taking place. On the other hand, drawing will not take place correctly unless the yarn is heated to a moderate temperature.

This matter is highlighted by polyester yarns (in contradistinction, say, to polyamide yarns) which will yield and rupture too readily if heated under tension in the drawable state above their second order transition temperature (90°C.—100°C.). The above technique affords the possibility of starting-up the process for such yarns with the threadline close to the heater so that the drawable yarn may be moderately heated by radiation therefrom; and, as soon as drawing is observed to be occurring, which will be almost immediately, the threadline may then be transferred to make contact with the heater, the first part of which (desirably the bottom) being at a lower temperature than the main part due to heat losses. It has been found that the threadline should not be closer than $\frac{1}{4}$ inch from the heater during start-up, or else melting of the drawable polyethylene terephthalate may still occur.

Similarly, if the post-treatment of the crimped yarn is to be a continuous one performed by heating the yarn under controlled conditions of contraction prior to wind-up, the heater for this purpose will be provided with means for holding the threadline out of contact with the heating means, e.g. a similar tracked contact heater, until drawn, crimped yarn is being produced.

WHAT WE CLAIM IS:—

1. A process for producing a bulked synthetic polymeric yarn in which yarn in a drawable state is fed by feed rolls via heating means and false twist means to draw rolls which are rotated at a peripheral speed higher than that of the feed rolls by an amount equivalent to the desired draw ratio of the yarn, the yarn in its passage to the false twist means being heated in such manner that the drawing zone occurs during an early stage of heating and the setting of the twist occurs at a later stage of heating with incomplete snubbing of twist taking place in the drawing zone and subsequently heating the crimped yarn when in a controlled longitudinally contracted condition.
2. A process according to claim 1 in which the yarn is heated prior to the false twist means by passage over an arcuate contact heater with the drawing zone of the yarn located at the upstream end thereof.
3. A process according to claims 1 or 2 in which the yarn is heated prior to the false twist means by passage over a single contact heater.
4. A process according to claims 1, 2 or 3 in which the feed rolls are heated.
5. A process according to any one of claims 1—4 in which the drawable yarn is derived from a synthetic polyamide.
6. A process according to claim 5 in which the drawable yarn is derived from polyhexamethylene adipamide.
7. A process according to any one of claims 1—4 in which the drawable yarn is derived from a synthetic polyester.
8. A process according to claim 7 in which

the drawable yarn is derived from polyethylene terephthalate.

9. A process according to claim 8 in which the polyethylene terephthalate yarn is drawn to a draw ratio of substantially 3.2.

10. A process according to any one of the preceding claims in which the yarn is allowed to contract by at least 10% after the draw rolls.

11. A process according to any one of the preceding claims in which the yarn while in a controlled longitudinally contracted condition is subjected to heating between the draw rolls and a wind-up means.

12. A process according to any one of claims 1—10 in which the yarn after winding-up while in a controlled longitudinally contracted condition is subjected to heating.

13. A process according to claim 12 in which the yarn package is subjected to steaming.

14. A process according to any one of claims 1—10 in which the yarn while in a controlled longitudinally contracted condition is subjected to a combination of heating as claimed in claims 11 and 12.

15. A process according to any one of claims 11—14 in which the heating is followed by or combined with a dyeing process.

16. A process for producing a bulked synthetic polymeric yarn substantially as described herein.

17. A bulked synthetic polymeric yarn when produced according to any one of the preceding claims.

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