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CRIMPING PROCESS

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This invention relates to a process for crimping, specifically, drawn nylon 6 yarn carrying a lubricant finish thereon, said process being of the type wherein the yarn is forced into a pressure crimping zone. My process is especially suitable for use with heavy denier multi-filament yarns having denier of say 1000–5000 and filament count of say about 50–250.

Crimpers of the general type employed in my process are well-known, being disclosed for example in U.S.P. 2,734,228 of February 14, 1956 to W. D. Hay for "Crimping Apparatus"; U.S.P. 2,763,898 of September 25, 1956 to C. W. Sammons et al. for "Treatment of Textile Fibers"; U.S.P. 2,865,080 of December 23, 1958 to R. A. A. Hentschel for "Method and Apparatus for Crimping and Relaxing Filaments" and U.S.P. 2,888,733 of June 2, 1959 to Harry Wegener for "Process for the Fixation of Pressure Crimped Synthetic Fibers." When used upon heavy denier yarns, however, especially simultaneously upon several ends of such yarns, the prior art crimpers tend to be unsatisfactory with respect to uniformity of crimp frequency obtained therewith.

I have found that important factors in obtaining uniform crimp frequency in a stuffer box crimper of the type above discussed are the moisture content of the yarn entering the crimping chamber, and the temperature of the entering yarn. My process described below provides excellent control over these moisture and yarn temperature factors.

My process comprises contacting a drawn nylon 6 yarn carrying a lubricant finish thereon with dry steam in a steaming zone prior to introduction of the yarn into the crimping chamber, said dry steam being at or slightly above saturation temperature and pressure. To establish the desired temperature and moisture content of the steam used for treating the yarn, I have found it is important to maintain the steam initially at a temperature of at least about 103° C. and not above about 130° C. and at a superatmospheric pressure constant within about 2 ounces per square inch, just before the steaming zone. Thereby temperature variations both in this steam under pressure and in the steam within the steaming zone can be maintained within about 1° C.

Further in accordance with my invention, the yarn thus treated with steam is fed at moisture content of about 2–3% by weight into the crimping chamber and receives no supply of heat and no setting agent other than said steam. Moreover, in accordance with my invention the yarn in the crimping zone is at a temperature between about 60° C. and about 90° C. The desired temperature and moisture content of the yarn will usually be obtained using steam as above specified within a short contact time of the order of about 1 second. The yarn temperature resulting from this contact may be close to that of the steam itself, but in general the yarn will cool in the crimping chamber as the result of heat losses therefrom, thus reaching the desired temperature range of about 60°–90° C.

While I do not intend to be bound by any mere theories of the operation of my process, I believe that use of dry rather than wet steam is important because drops of moisture on the yarn will result in random removal of lubricating finish therefrom thus causing random variation in the friction between the yarn and the crimping chamber, with consequent variation in the pressure within the crimping chamber. Such pressure variations result in variations in crimping frequency. Moreover, drops of water on the yarn will tend to produce random localized cooling and this cooling will affect the nature of the crimp at the cooled spot. Apparently the crimping frequency is sensitive to yarn pressure and also to moisture content and temperature of the yarn. Maintenance of a yarn temperature in the main body of the crimping chamber between about 60° C. and about 90° C. apparently is desirable to limit crimping action to the zone immediately adjacent the inlet nip of the feed rolls. A moisture content of the entering yarn of about 2–3% by weight, with the entering yarn at temperature near that of the steam employed, say about 95° C.–100° C., appears to represent a favorable combination of conditions for obtaining a uniform crimp frequency of about 10–15 crimps per inch in a heavy denier drawn nylon 6 yarn.

Preferred operating conditions in my process involve maintaining the temperature of the steam while under pressure, just before the steam enters the steaming zone, in the range between about 105° C. and about 110° C. and the pressure of this steam in the range between about 3 and about 5 p.s.i.g., and maintaining the steam in the steaming zone at about atmospheric pressure and at about 101° C. These conditions can be established by generating steam at say 15 p.s.i.g. and then reducing the pressure on this steam through an automatically controlled valve while maintaining back pressure by use of an orifice with a very small opening just ahead of the inlet to the steaming zone. To compensate for heat losses in the piping carrying the steam under pressure, a superheater is desirably provided having means for automatically controlling the steam temperature within about 1° C. For best control the steam temperature and steam pressure should be sensed as near as possible to the orifice which creates the back pressure.

The steam leaving the orifice suitably enters a tube serving as steaming zone, at the bottom thereof and about at a mid-point. Desirably the steam tube is tilted away from the crimper so as to drain any condensate without allowing the condensate to contact the yarn. Desirably also a blower is provided at the exit from the steam tube to withdraw the steam before it can contact the crimper feed rolls and condense thereon. Under the preferred conditions above outlined I find the crimps formed in the yarn include both sharp V-bends and round bends.

A particularly suitable crimper of the stuffing box type for use in my process is described in detail in my copending application Serial No. 26,876 filed simultaneously herewith, wherein a sensitive switch is actuated by motion of the gate of the crimper to stop the feed rolls when the yarn volume in the crimping chamber reaches a predetermined point, and the opposite motion of the gate is limited by a stop bar or the like.

The examples, data for which is set out in the table below, represent specific embodiments of the best mode contemplated by me for carrying out my invention but are intended to be illustrative only, and the invention is not to be considered as limited to all details of the examples.

In the below examples the nylon 6 yarn employed was of 2100 denier and 112 filament count and had from 0 to 1/2Z twist per inch. It was produced generally in conventional manner by melt spinning, applying a lubricating oil emulsion finish to the spun filament, drawing the filament on a draw twister over a snubbing pin and a heated block and taking up on a pirn. Six ends of this yarn were threaded through eye holes in the inlet and outlet of a steam tube about 29" long. The steam was initially maintained at back pressures constant within 2

ounces per square inch ranging between 3 and 5 p.s.i.g, and at temperatures, corresponding to said pressures, constant within 1° C. and ranging from 104° C. to 109° C. The steam was withdrawn from the tube by pipes and a blower, to avoid condensation on the crimper feed rolls.

This steam had saturation temperature of about 101° C. corresponding to saturation pressure of about 1½ p.s.i.g. The steam outlets from the steam tube were small enough to maintain the steam under slight superatmospheric pressure therein. The steam when allowed to issue into the air from the steam tube did not condense to a fog until it had cooled slightly in the air. The temperature of the steam tube was 101° C.±1° C.

The six yarn ends were withdrawn to the crimper as a flat ribbon from the steam tube. The rate of yarn feed to the crimper in feet per minute varied from 730 to 770; the weight on the crimper gate was 1 pound; the maximum movement of the gate was 3/16"; and the rate of winding up the crimped yarn varied from 560–570 feet per minute, being adjusted to take up the yarn slightly slower (on a weight basis) than the yarn was fed whereby the switch periodically stopped the feed rolls momentarily. The temperature of the yarn entering the crimper was about that of the steam tube, say about 95°–100° C. and may have risen just beyond the nip rolls; but in the main body of the crimping chamber the yarn was about 70° C. and its moisture content entering the crimper was about 2.5% by weight.

	Steam Input at Orifice		Average [a] Crimp Frequency	Average [b] Percent Crimp
	p.s.i.g.	° C.		
Ex. 1	3	104.0	10.6	21.9
Ex. 2	3½	105.0	10.6	21.8
Ex. 3	4	106.0	10.2	26.8
Ex. 4	4½	108.0	10.5	25.2
Ex. 5	5	109.0	10.2	27.8

[a] Average 30 tests, crimps per inch.
[b] Average 18 tests (crimped length/straight length) × 100.

The control of crimp frequencies obtained in the above examples was excellent, the range being between 10 and 11 crimps per inch in all tests. Yarn with these controlled crimp frequencies shows good uniformity in dyeing, important in most commercial applications.

I claim:

1. A process of crimping drawn nylon 6 yarn carrying a lubricant finish thereon by forcing the yarn into a pressure crimping zone, which process comprises contacting said yarn with dry steam in a steaming zone prior to introduction of the yarn into the crimping zone, said dry steam being at about its saturation temperature and pressure and being maintained just before said steaming zone at higher temperature of at least about 103° C. and not above about 130° C. and at a superatmospheric pressure constant within about 2 ounces per square inch, the temperature variations in this steam under pressure and in the steam in the steaming zone being maintained within about 1° C.; and feeding said yarn with moisture content of about 2–3% by weight into a crimping zone; said dry steam being the sole source of heat and the sole setting agent applied to the yarn and said yarn being at a temperature in the main body of the crimping zone between about 60° C. and about 90° C. and at higher temperature at the entrance thereto than in the main body.

2. Process as defined in claim 1 wherein the temperature of the steam under pressure just before inlet to the steaming zone is maintained in the range between about 105° C. and about 110° C.; the pressure of this steam is in the range between about 3 and about 5 p.s.i.g.; the steam in the steaming zone is at about atmospheric pressure and at about 101° C.; and the contact time of the yarn with the steam is of the order of one second.

References Cited in the file of this patent

UNITED STATES PATENTS

2,734,228 Hay ---------- Feb. 14, 1956
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