METHOD TO PRODUCE SPUN-DRAWN POLYCAPROLACTAM YARN
HAVING IMPROVED RESISTANCE TO OZONE FADING
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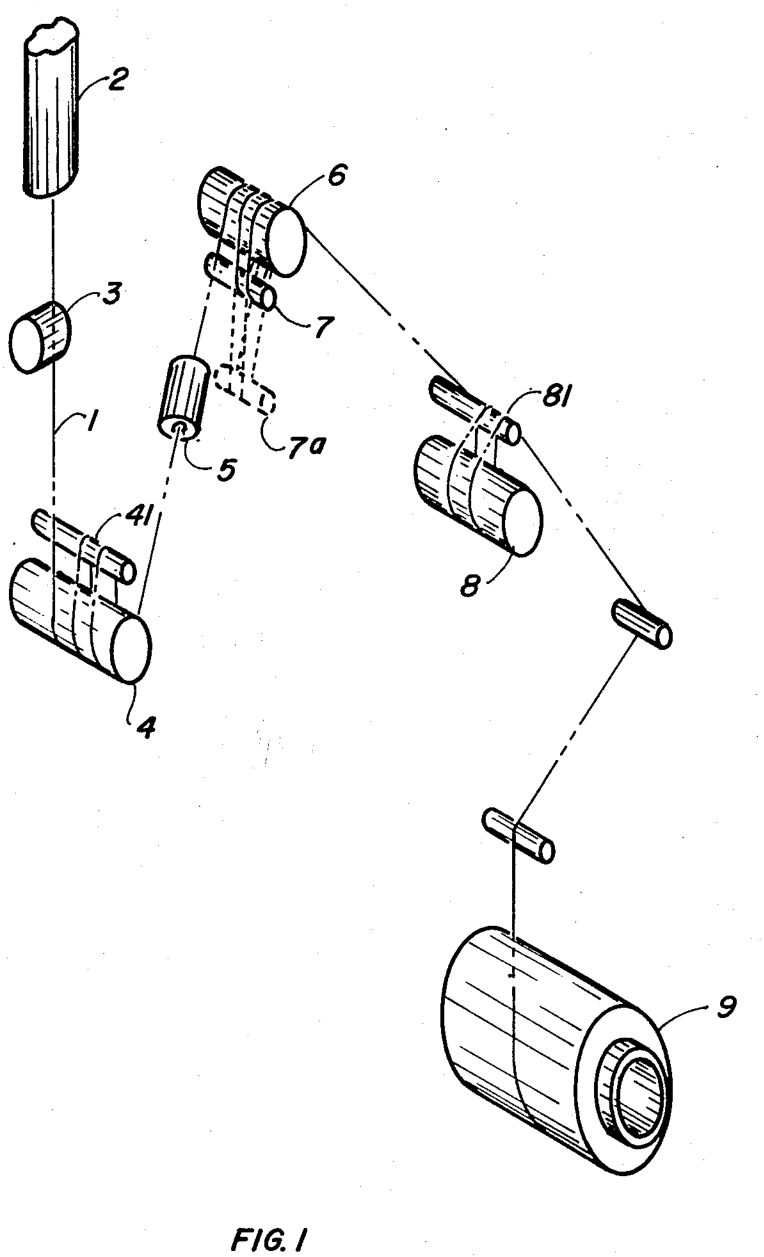

FIG. 1

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METHOD TO PRODUCE SPUN-DRAWN POLYCAPROLACTAM YARN HAVING IMPROVED RESISTANCE TO OZONE FADING

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ABSTRACT OF THE DISCLOSURE

A continuous process and its product for spinning and drawing polycaproamide filaments is disclosed. The method is the coupled or continuous process of extruding filaments, cooling and applying finish, then immediately drawing the filaments. The improved resistance to ozone fading is accomplished by feeding the filaments after the finish applying step with a heated feed roll through an air cooling jet to a cooled draw roll and withdrawing filaments to a second draw roll, then winding the filaments into a package.

BACKGROUND OF THE INVENTION

Coupled or continuous process spin-draw yarn, such as that processed by the methods disclosed in U.S. Pats. 3,489,832 and 3,414,646 or Canadian Pat. 784,611, has been found to be deficient in resistance to ozone fading, an important characteristic, especially when the yarn is used to make carpets. For purposes of this discussion, this fading, caused by exposure to ozone in the atmosphere, is measured by ΔE values determined by reading differences in fading between control and test specimens with a Hunter Lab D–25 Color Difference Meter, after exposure to ozone in an ozone generator for a standard time. The standard time varies with each test and is determined by the time necessary to reach ΔE=2.0 on a standard control sample, so that any variation in ozone exposure is compensated. All samples ared yed with disperse olive dye No. 1 as follows. The samples are subjected to a non-ionic scour of 2.0 percent (OWF) tri-sodium phosphate and 0.5 percent (OWF) of a non-ionic surfactant (Triton X–100) by Rhom & Haas. Scour is carried out at 160° F. for 30 minutes. Then the samples are dyed with 0.807 percent (OWF) Celliton Fast Pink RF (GAF) (CI Disperse Red 4), 0.465 percent (OWF) Celliton Fast Yellow (GAF) (CI Disperse Yellow 3), and 0.069 percent (OWF) Celliton Fast Blue FFRN (GAF) (CI Disperse Blue 3) in the presence of the above scour additives. The scour and the dyeing take place at 40:1 liquor ratio. The dye bath is brought to 200° F. at a rate of 4° per minute and maintained at 200° F. for one hour. The fabric is removed from dye bath, cooled, and tumble dryed. Samples are then ready for ΔE determination procedures.

SUMMARY OF THE INVENTION

It has been found that ozone fading of continuous spun-drawn yarn can be reduced by preparing uniformly oriented polycaproamide filaments by extruding a molten synthetic linear polycaproamide from a spinnerette to form filaments, quenching the filaments to provide a solid structure, applying finish, then immediately feeding the filaments with a heated feed roll through an air-cooling jet to a draw roll and withdrawing the filaments to a second draw roll, and finally winding the filaments into a package. The preferred temperature on the heated feed roll is from about 80° to about 120° C. The feed roll can be provided with a step roll and the draw roll can be provided with a lowered separator roll. The draw roll can be cooled by blowing ambient air across it. The draw ratio between the feed roll and the draw roll should be from about 1.01 to about 2.17. Yarn temperature should be maintained by blowing room temperature air through the air cooling jet to obtain a temperature after the jet of from about 50 to about 70° C. when the yarn has been heated to a temperature from about 80 to about 95° C. by the heated feed roll. The total draw ratio across the feed roll to the second draw roll should be from about 2 to about 5, preferably from 3.5 to about 4.6.

Resistance to ozone fading was significantly improved by (1) heating the yarn on the feed roll and (2) maintaining a high draw ratio by air cooling the yarn on the second roll. In this way fading was reduced from a ΔE value of more than 4.5 to a level of 2.5.

By only increasing feed roll temperature, ozone fading was significantly reduced. By increasing feed roll temperature, draw ratio was reduced. Without use of the air jet, maximum draw was found to be 3.7 at 80° C. temperature on the feed roll. With the use of an air cooling jet in the first stage and air cooling on the draw roll, the draw ratio was increased to 4.1 with 120° C. temperature on the feed roll. Higher total draw ratios were obtained with the first stage draw ratios above 5 percent. First stage draw ratios up to 2.0 did not adversely affect resistance to ozone fading.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a schematic diagram of the apparatus used for the method and to make the produce of this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The apparatus used for this invention is shown in FIG. 1. Yarn **1** leaves quench stack **2** below a spinnerette not shown. Yarn **1** then passes over finish roll **3** and on to feed roll **4** equipped with separator roll **41**. Air cooling jet **5** causes ambient temperature air to impinge upon the yarn as it is drawn between feed roll **4** and draw roll **6**. Separator **7** for draw roll **6** can be in normal position as shown, or in the lower separator roll position as shown by **7A**. Final draw step takes place between draw roll **6** and second draw roll **8** having separator roll **81**. Yarn **1** then passes to winder **9**. Table I shows successful operating conditions and yarn properties for three runs on a system having a step roll on the feed roll achieving a 1.09 draw ratio at 42 lbs./hr. output at 2250 denier, 140 filaments, Y cross-section yarn having a modification ratio greater than 3. Conventional finish achieving about a 7 percent pickup was used. Draw roll **6** was air cooled by blowing ambient across it, and the second draw roll was maintained at a temperature of 130° C. Other operating conditions and results are given in the table below. UTS means ultimate tensile strength, UE means ultimate elongation and TM means tensile modulus.

TABLE I

1st stage draw	Total draw ratio	Denier	UTS	UE	TM	Dye sorption	ΔE
1.03	3.9	2,273	4.3	51.8	17	0.38	3.2
1.03	4.0	2,293	4.6	50.9	16	0.36	2.5
1.2	4.1	2,284	4.6	53.7	17	0.37	3.0

Table II shows, in the first line of data, a run where no air jet was used. Note that the ΔE value is between 1.5 and 2.2 units higher than the runs using the air jet; this amounts to an improvement of over 30% to about 47% in resistance to ozone fading based on the original 4.7 ΔE value. Table II data is based on runs all using comparable feeder yarn.

Yarn having an ultimate elongation of from 25 to 60%, and ultimate tensile strength from 4.0 to 7.5 was also prepared but are not shown here.

TABLE II

Draw ratio		Feed roll temp., °C.	Draw roll	Air jet	Yarn temp., °C.				Ozone fade, E
First stage	Total				Before jet	After jet	Next to last wrap	Last wrap	
1.03	3.50	120	No cooling	No	80	76	70	82	4.7
1.03	3.90	120	Cooling	Yes	80	69	49	68	3.2
2.00	4.20	80	Lowered, no cool	Yes	85	60	66	94	2.6
1.90	4.40	80	do	Yes	85	60	66	95	2.8
2.00	3.90	90	do	Yes					2.5
1.90	4.60	80	do	Yes					2.7

We claim:

1. In a continuous process for spinning and drawing polycaproamide polymer filaments comprising extruding said filaments from a spinnerette, cooling, applying finish, then immediately drawing said filaments, the improvement comprising consecutively

(a) feeding said filaments, after said step of applying finish, with a feed roll heated to between about 80 and 120° C., said filaments maintained at temperature from about 80 to about 95° C., through an air cooling jet, said air cooling jet cooling said filaments to a temperature to about 50 to about 70° C., to an ambient-air cooled first draw roll, said draw ratio from said feed roll to said first draw roll being from about 1.01 to about 2.17, and

(b) withdrawing said filaments to a second draw roll so that the overall draw ratio is from about 3.5 to about 4.6, and finally,

(c) winding said filaments into a package,

whereby uniformly oriented polycaproamide yarn having improved resistance to ozone fading as characterized by ΔE values of less than 3.3, and substantially no loss of uniformity, ultimate tensile strength, or ultimte elongation is formed.

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