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[54] FILAMENT QUENCHING APPARATUS AND PROCESS

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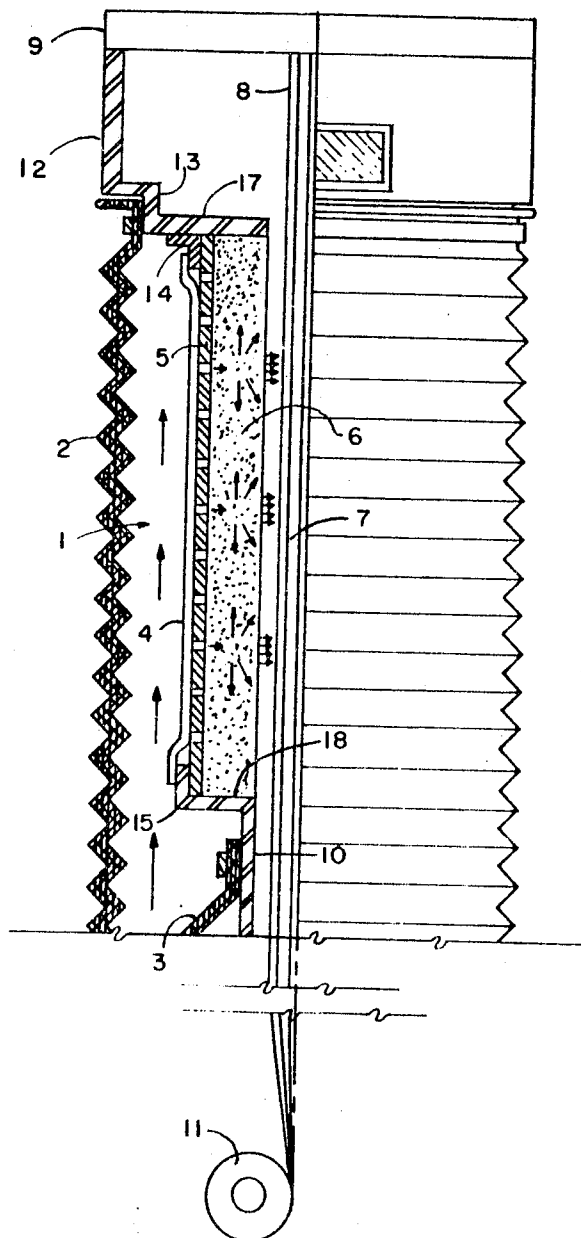
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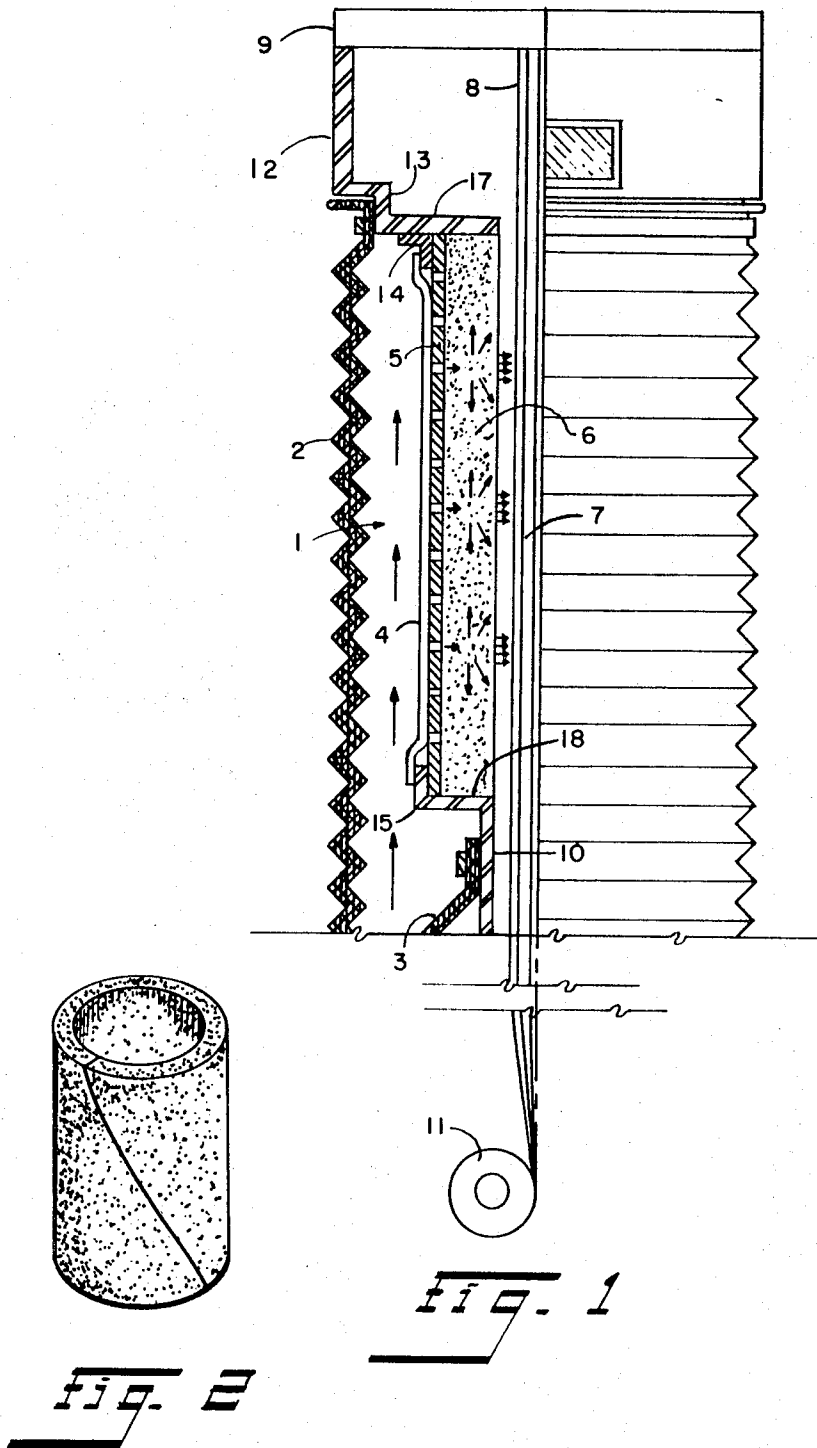
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ABSTRACT: An apparatus and process for producing a substantially nonturbulent stream of cooling gas for quenching a melt extruded filament which comprises a quenching chamber, wherein a melt extruded filament is passed therethrough, and a gas entry chamber, the gas entry chamber being provided with means for introducing a cooling gas. The quenching chamber and the gas entry chamber are separated from each other by a porous, multicellular, polymeric foam diffuser which is capable of diffusing gas entering from the gas entry chamber and permitting the diffused gas to pass therethrough into the quenching chamber as a substantially nonturbulent stream of gas thereby quenching the melt extruded filament and producing greater cross-sectional uniformity in the filament.





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FILAMENT QUENCHING APPARATUS AND PROCESS

BACKGROUND OF THE INVENTION

This invention relates to an apparatus and process for the production of a substantially nonturbulent stream of quenching gas for quenching one or more synthetic filaments produced by a melt spinning process.

In a typical melt spinning process, one or more filaments extrudes from one or more spinnerettes and passes into a quenching chamber. The quenching chamber comprises one or more walls which can be a perforated plate, screen or both which separates the quenching chamber from an adjoining gas entry chamber which is in communication with a cooling gas supply system. The synthetic polymer extruding from the spinnerette is a viscous liquid at an elevated temperature. Cooling of this liquid takes place in the quenching chamber where a cooling gas, which is usually air, is contacted with the filaments. The cooling gas enters the quenching chamber from the gas entry chamber through the perforated plate or plates in a direction substantially perpendicular to the filaments. The filaments pass through the quenching chamber in a direction substantially parallel to the perforated plate or plates separating the gas entry chamber from the quenching chamber. The use of the perforated plate or plates is necessary to reduce cooling gas turbulence because the filaments are highly vulnerable to cooling gas turbulence since they are in the liquid phase at entry into the quenching chamber. Turbulence in the cooling gas stream detracts from the uniformity, the orientation capacity, and the strength of the filaments. When two or more perforated plates are used, the volume between the inner and outer perforated plates serves as a plenum chamber to further disperse the cooling gas and reduce its turbulence. The perforated plates therefore serve the purpose of further dispersing and reducing the turbulence of the cooling gas supplied to the quenching chamber so that the extruded filaments have more uniform properties throughout their whole length.

The prior art also teaches that the turbulence of the gas stream in the quenching chamber can be reduced by using a number of screen layers of the same or different mesh lying against each other in place of or in addition to the perforated plate or plates. The mesh in the direction of gas flow can be the same of successively larger or smaller. Great care has to be exercised to construct such a number of screen layers and this method is extremely expensive.

The apparatus and process described above is adequate for low filament extrusion rates; however, in keeping with the competitive demands of the modern textile industry, higher filament extrusion rates are now required and effective quenching of the filaments is a problem using the conventional apparatus and process described above. For example, when the above-described apparatus is used with a high filament extrusion rate and a relatively low cooling gas rate which will produce filaments having an acceptable Percent Uster and drawing performance, the filaments are wound on the takeup package at a relatively high temperature and excessive package growth may occur with certain polymers which produces a loose, sloughing and unacceptable fiber package. On the other hand, when the cooling gas rate is increased to a point where an acceptable fiber package can be produced, the resulting filaments have an unacceptably high Percent Uster with accompanying high wraps and breaks upon drawing or subsequent processing.

A typical perforated plate which has been used in the prior art has under 50 percent open area which consists of small diameter holes spaced at regular centers. A check of the cooling gas velocity through the perforations has shown that the gas turbulence in the quenching chamber is caused by a jetting action of the gas through the perforations. This jetting action causes turbulence in the quenching chamber and produces filaments having nonuniform cross section.

It has now been discovered that a substantially nonturbulent stream of cooling gas can be produced for quenching a melt extruded filament by separating the gas entry chamber and the

quenching chamber with a porous, multicellular, polymeric foam diffuser which is capable of diffusing the cooling gas entering from the gas entry chamber. The porous, multicellular polymeric foam diffuser diffuses the cooling gas and permits it to pass therethrough into the quenching chamber as a substantially nonturbulent stream of gas thereby quenching the melt extruded filament and producing a filament having a more uniform cross section, a significantly improved Percent Uster and a significantly improved drawing performance at high filament extrusion rates.

SUMMARY OF THE INVENTION

In accordance with the present invention, there is provided an apparatus for producing a substantially nonturbulent stream of cooling gas for quenching a melt extruded filament which comprises a quenching chamber wherein a melt extruded filament is passed therethrough and a gas entry chamber, said gas entry chamber being provided with means for introducing a cooling gas. The quenching chamber and the gas entry chamber are separated from each other by a porous, multicellular, polymeric foam diffuser which is capable of diffusing within said diffuser gas entering from the gas entry chamber and permitting said diffused gas to pass therethrough said diffuser into said quenching chamber as a substantially nonturbulent stream of gas thereby quenching the melt extruded filament and producing greater cross-sectional uniformity in said filament at a high filament extrusion rate. The greater cross-sectional uniformity in the filament results in a filament having a more uniform cross section, a significantly improved Percent Uster and a significantly improved drawing performance.

The term porous, multicellular polymeric foam diffuser used to define the present invention is to be understood to mean that a sufficient number of the foam cells are interconnected to an extent that the foam is considered to be open-celled and is capable of diffusing gas in accordance with the present invention.

Accordingly, using the above-described apparatus, there is provided, in accordance with the present invention, a process for quenching a melt extruded filament which comprises introducing a cooling gas into a gas entry zone and passing the gas from the gas entry zone into a porous, multicellular, polymeric foam diffusion zone. The gas is diffused within the porous, multicellular, polymeric foam diffusion zone and the diffused gas is permitted to pass therethrough the diffusion zone into a quenching zone as a substantially nonturbulent stream of gas. A melt extruded filament is passed through the quenching zone and is quenched in the quenching zone by the substantially nonturbulent stream of cooling gas thereby producing greater cross-sectional uniformity in the filament.

The porous, multicellular, polymeric foam diffuser used in the present invention can have a foam thickness, generally perpendicular to the axis of the quenching chamber or apparatus, of about $\frac{1}{4}$ to 4, preferably about $\frac{1}{2}$ to 2, inches and can have a length, generally parallel to the axis of the quenching chamber or apparatus, of about 6 to 72, preferably about 6 to 24, inches. The width of the porous, multicellular, polymeric foam diffuser is determined by the configuration of the filaments in the quenching chamber. The porous, multicellular, polymeric foam can have about 50 to 200, preferably about 75 to 150, cells per lineal inch and a cellular void volume of about 50 to 97, preferably about 75 to 97, percent of the total volume of the porous, multicellular polymeric foam. Accordingly, the polymer volume of the porous, multicellular, polymeric foam can be about 3 to 50, preferably about 3 to 25, percent of the total volume of the porous, multicellular, polymeric foam. The bulk density of the porous, multicellular, polymeric foam can range from about 1 to 10, preferably about 1.4 to 6, lb. per cu. ft. The porous, multicellular, polymeric foam diffuser can be made from flexible or rigid foam.

The range of gas velocity flow through the porous, multicellular, polymeric foam diffuser can be about 30 to 120, preferably about 40 to 90, SCFM per sq. ft. at a pressure differential across the porous, multicellular, polymeric foam of about 0.15 to 4, preferably about 0.2 to 2, inches of water. The humidity of the entering gas can be established at any given desired humidity level and a suitable humidity range can be from about 40 to 95 percent relative humidity at 20° C.

The porous, multicellular, polymeric foam diffuser can be a foamed synthetic polymer such as a polyurethane foam, a vinyl foam, which can be produced from a vinyl such as polyvinyl chloride or polyvinyl acetate, and the like. Accordingly, the porous, multicellular, polymeric foam diffuser can be a natural or synthetic foam rubber such as acrylic, neoprene, polybutadiene, nitrile, butadiene-acrylonitrile, butadiene-styrene, polyisobutylene, polyisoprene, vinyl pyridine, silicone, and the like.

A particularly advantageous aspect of the porous, multicellular, polymeric foam diffuser used in the present invention is its ability to diffuse cooling gas in three dimensions thereby producing the substantially non turbulent stream of cooling gas.

In a preferred embodiment of the present invention, the porous, multicellular, polymeric foam diffuser is a porous, multicellular polyurethane foam. Polyurethane foams suitable for use in the present invention can be produced by reacting an organic compound having reactive hydrogen atoms and a stoichiometric excess of an organic polyfunctional isocyanate with water in the presence of a suitable catalyst and foam stabilizing agent. When water reacts with the excess isocyanate groups not previously reacted, carbon dioxide is formed which is entrapped in the reaction mixture and thereby causes it to foam. An auxiliary blowing agent, such as a volatile fluorocarbon, may also be employed. The polyurethane foam can be produced by the prepolymer method wherein the organic compound having reactive hydrogen atoms is first reacted with the organic polyfunctional isocyanate or by the one-shot method wherein the reactants are simultaneously mixed together and reacted. The preparation of suitable polyurethane foams is typically described in U.S. Pat. Nos. 3,171,820 at columns 1 through 20 and 3,198,757 at columns 1 through 6. Suitable polyurethane foams useful in this invention include those of the polyester and polyether type. A particularly useful type of polyurethane foam is reticulated polyester foam or reticulated polyether foam.

In some cases, it may be desirable to provide a means for producing an additional pressure drop across the porous, multicellular polymeric foam diffuser. Such an additional pressure drop can be provided by covering the gas intake surface of the porous, multicellular, polymeric foam diffuser with a cooling gas distribution means such as a woven or nonwoven felt material which can be produced from a natural or synthetic fiber. Suitable fibers include cotton, wool, polyamides, polyesters and the like. Suitable felt materials can have a total weight of between about 10 to 40, preferably about 15 to 30, oz. per sq. yard. When such a felt material is used, the pressure drop across it is usually about 0.5 to 2 inches of water.

The scope of the present invention includes the use of the porous, multicellular, polymeric foam diffuser to diffuse cooling gas in cross current quenching wherein the cooling gas is passed across the extruded filament in a direction substantially perpendicular to the filament and is then exhausted; cocurrent quenching wherein the cooling gas is passed into the quenching chamber and travels in a direction substantially parallel to the filament downward through the quenching chamber into and through a cooling stack; inflow quenching wherein the cooling gas is passed into the quenching chamber and travels in a direction substantially parallel to the filament downward through the quenching chamber and is then exhausted after passing therethrough the quenching chamber; and the like.

The apparatus and process of the present invention can be used to quench synthetic filaments such as a polyamide,

polyester, polyolefin, polysulfone, polyphenyloxide, polycarbonate, polyacrylonitrile and the like or polymer blends thereof.

Suitable polyamides include, for example, those prepared by condensation of hexamethylene diamine and adipic acid, condensation of hexamethylene diamine and sebacic acid known as nylon 6,6 and nylon 6,10, respectively condensation of bis(para-aminocyclohexyl)methane and dodacanedioic acid, or by polymerization of 6-caprolactam, 7-aminoheptanoic acid, 8-caprylactam, 9-aminopelargonic acid, 11-aminoundecanoic acid, and 12-dodecalactam, known as nylon 6, nylon 7, nylon 8, nylon 9, nylon 11, and nylon 12, respectively.

Suitable polyesters can be prepared in general by condensation reactions between dicarboxylic acids or their derivatives and compounds containing two hydroxyl groups, or materials possessing both an alcohol group and a carboxylic acid group or derivative thereof; or by polymerization of lactones. The preferred polyester is polyethylene terephthalate.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is cross-sectional view showing a fiber melt extrusion apparatus and process illustrating the present invention which uses a porous, multicellular, polymeric foam diffuser to diffuse filament quenching gas.

FIG. 2 is an illustration showing one embodiment of a porous, multicellular, polymeric foam diffuser and a method of fabrication.

Referring now to FIG. 1, a cooling gas, which is preferably air, which is introduced into gas entry chamber 1 by appropriate gas transfer means. Gas entry chamber 1 is formed by outer cylindrical neoprene rubber bellows 2 which surrounds inner cylindrical neoprene rubber bellows 3 in a concentric manner thereby forming an annular gas entry chamber. Cooling gas entering gas entry chamber 1 is passed through filter felt 4 and then through perforated metal cylinder 5 into porous, multicellular, polymeric foam diffuser 6. Perforated metal cylinder 5 distributes the cooling gas entering diffuser 6 into smaller streams. The cooling gas is diffused in diffuser 6 and enters quench chamber 7 as a substantially nonturbulent stream thereby quenching filaments 8 emerging from spinnerette assembly 9. The cooling gas is then passed downward through quench chamber 7 into and through cooling stack 10 and is exited through suitable exit means (not shown).

The filaments extruded through spinnerette assembly 9 and quenched in quench chamber 7 are collected on takeup means 11 and then are drawn into yarn. Spinnerette 9 is surrounded by cylindrical wall 12 which surrounds and encloses the filaments extruding from spinnerette 9. Cylindrical neoprene rubber bellows 2 is connected to inner flange 13 which is positioned near the bottom of cylindrical wall 12 thereby creating the outer extremity of gas entry chamber 1. Perforated metal cylinder 5 is connected to inner flange 14 which is positioned at the bottom of cylindrical wall 12 thereby forming the inner extremity of the upper part of gas entry chamber 1. The bottom of perforated cylinder 5 is connected to outer flange 15 which is positioned at the top of cooling stack 10. Cooling stack 10 serves as a further cooling chamber for the quenched filaments and additional cooling of the filaments takes place within this cylindrical stack.

Inner cylindrical neoprene rubber bellows 3 is connected to the upper part of cooling stack 10 thereby completing the lower inner extremity of gas entry chamber 1. Filter felt 4, which can be a woven or nonwoven felt material, is wrapped around perforated metal cylinder 5 and serves to provide a means for producing an additional pressure drop across diffuser 6 and to filter dust and other undesirable contaminants from the cooling gas prior to its entry into quench chamber 7.

Diffuser 6 is inserted against perforated cylinder 5 and is held in place by flange 17 positioned at the bottom of cylindrical wall 12 and flange 18 positioned at the top of cooling stack 10 thereby completing the filament quenching apparatus of the present invention.

Referring now to FIG. 2, porous, multicellular, polymeric foam diffuser 6 can be cut from porous bulk material or can be fabricated from slab stock. When diffuser 6 is fabricated from slab stock and formed into a cylinder as shown in FIG. 2, a suitable adhesive can be used to join the ends to form diffuser 6. A suitable adhesive for polyurethane foam is a fast-drying nitrile adhesive marketed as Cycleweld K-186 by the Chemical Division of Chrysler Corporation.

PREFERRED EMBODIMENTS

The following examples illustrate the practice and principles of this invention and a mode of carrying out the invention.

EXAMPLE 1

In the operation of the apparatus in FIG. 1, polycapromide was melt extruded at a temperature of 275° C., under a pressure of 2,500 p.s.i.g. through 204-orifice spinnerette assembly 9, each of the orifices having a diameter of 0.022 inch, to produce a 5,500 denier undrawn fiber. The polycapromide was melt extruded through spinnerette 9 at a rate of 45 lbs. per hour.

Cooling air entered gas entry chamber 1 at a temperature of 75° F. and at a rate of 120 SCFM. The air then passed through filter felt 4 (2 layers of 10.5 oz. per sq. yd. cotton felt) and perforated metal cylinder 5 into polyurethane foam diffuser 6. The air was diffused in polyurethane foam diffuser 6 and entered quench chamber 7 as a substantially nonturbulent stream thereby cooling the filaments emerging from spinnerette 9. The cooling air passed downward through quench chamber 7 into cooling stack 10 and was exited through a suitable exit means (not shown). The filaments travelled vertically downward through quench chamber 7 and cooling stack 10. In this manner, the filaments were quenched by means of cocurrent quenching. The polyurethane foam diffuser separating gas entry chamber 1 and quench chamber 7 was cylindrical in shape with an inner diameter of 8-1/2 inches, an outer diameter of 10-1/2 inches, a foam thickness of 1 inch and a length of 8-1/4 inches. The polyurethane foam diffuser was of the polyester type and had 100 cells per lineal inch, a cellular volume of 96 percent of the total volume of the foam and a polymer volume of 4 percent of the total volume of the foam. The rate of gas flow through polyurethane foam diffuser 6 was 0.55 SCFM/sq. in. with a pressure differential across the foam of 0.25 inches of water.

The extruded fiber was collected at about 1,800 feet per minute on takeup means 11 and was then drawn about 4.6 times its extruded length to produce a 1,260 denier yarn. The yarn had a relative viscosity of 55, as determined at a concentration of 11 grams of polymer in 100 ml. of 90 percent formic acid at 25° C. (ASTM-D-789-62T), and a tenacity of about 9.0 grams per denier.

The undrawn filaments produced above were tested for cross-sectional uniformity by measuring the Percent Uster in accordance with ASTM-D-1,425-60T and were found to have an average Percent Uster of 5.5.

Polycapromide was melt extruded and a 5,550 denier undrawn fiber was produced in the same manner as described above except that polyurethane foam diffuser 6 was replaced by a perforated metal cylinder of the prior art which was inserted between perforated metal cylinder 5 and quench chamber 7 to disperse the cooling air stream in quench chamber 7. The undrawn filaments produced were tested for cross-sectional uniformity in the same manner as above and were found to have an average Percent Uster of 15.

A comparison of the average undrawn filament Percent Uster of 5.5 obtained using the apparatus and process of the present invention with the average undrawn filament Percent Uster of 15 obtained using a conventional apparatus and process illustrates the very great improvement in undrawn filament cross-sectional uniformity of the fiber produced in accordance with the apparatus and process of the present invention.

EXAMPLE 2

In the operation of the apparatus in FIG. 1, polycapromide was melt extruded at a temperature of 275° C., under a pressure of 2,000 p.s.i.g. through a 204-orifice spinnerette assembly 9, each of the orifices having a diameter of 0.022 inch, to produce a 5,500 denier undrawn fiber. The polycapromide was melt extruded through spinnerette 9 at a rate of 40 lbs. per hour.

Cooling air entered gas entry chamber 1 at a temperature of 75° F. and at a rate of 105 SCFM. The air 6 passed through filter felt 4 (two layers of 10.5 oz. per sq. yd. cotton felt) and perforated metal cylinder 5 into polyurethane foam diffuser 6. The air was diffused in polyurethane foam diffuser 6 and entered quench chamber 7 as a substantially nonturbulent stream thereby cooling the filaments emerging from spinnerette 9. The cooling air passed downward through quench chamber 7 into cooling stack 10 and was exited through a suitable exit means (not shown). The filaments travelled vertically downward through quench chamber 7 and cooling stack 10. In this manner, the filaments were quenched by means of cocurrent quenching. The polyurethane foam diffuser separating gas entry chamber 1 and quench chamber 7 was cylindrical in shape with an inner diameter of 8-1/2 inches, an outer diameter of 10-1/2 inches, a foam thickness of 1 inch and a length of 8-1/4 inches. The polyurethane foam diffuser was of the polyester type and had 100 cells per lineal inch, a cellular volume of 96 percent of the total volume of the foam and a polymer volume of 4 percent of the total volume of the foam. The rate of gas flow through polyurethane foam diffuser 6 was 0.48 SCFM/sq. in. with a pressure differential across the foam of 0.22 inches of water.

The fiber was collected at about 1600 feet per minute on takeup means 11 and then was drawn about 4.8 times its extruded length to produce a 1260 denier yarn. The yarn had a relative viscosity of 55, as determined at a concentration of 11 grams of polymer in 100 ml. of 90 percent formic acid at 25° C. (ASTM-D-789-62T), and a tenacity of about 8.9 grams per denier.

The undrawn filaments produced above were tested for cross-sectional uniformity by measuring the Percent Uster in accordance with ASTM-D-1425-60T and were found to have an average Percent Uster of 5.3.

Polycapromide was melt extruded and a 1260 denier yarn was produced in the same manner as described above except that polycapromide was melt extruded through spinnerette 9 at a rate of only 32 lbs. per hour, the cooling air rate was reduced from 105 SCFM to 75 SCFM, and polyurethane foam diffuser 6 was replaced by a perforated metal cylinder of the prior art which was inserted between perforated metal cylinder 5 and quench chamber 7 to disperse the cooling air stream in quench chamber 7. The undrawn filaments produced were tested for cross-sectional uniformity in the same manner as above and were found to have an average Percent Uster of 8.5.

A comparison of the average undrawn filament Percent Uster of 5.3 obtained using the apparatus and process of the present invention with the average undrawn filament Percent Uster of 8.5 obtained using a conventional apparatus and process also illustrates the very great improvement in undrawn filament cross-sectional uniformity of the fiber produced in accordance with the apparatus and process of the present invention.

Furthermore, this example illustrates that the apparatus and process of the present invention produces a 25 percent greater undrawn filament extrusion rate without any sacrifice in undrawn filament cross-sectional uniformity and permits higher cooling air rates to be used.

EXAMPLE 3

In the operation of the apparatus in FIG. 1, polycapromide was melt extruded at a temperature of 275° C. through a 204-

orifice spinnerette assembly 9, each of the orifices having a diameter of 0.022 inch, to produce a 5500 denier undrawn fiber. The polycapraamide was melt extruded through spinnerette 9 at various pressures and rates as contained in table I below.

Cooling air entered gas chamber 1 at a temperature of 75° F. and at various rates as contained in table I below and was passed through the filament quenching apparatus in accordance with the present invention in the same manner as in examples 1 and 2.

Polycapraamide was also melt extruded in the same manner as above except that polyurethane foam diffuser 6 was replaced by a perforated metal cylinder of the prior art which was inserted between perforated metal cylinder 5 and quench chamber 7 to disperse the cooling air stream in quench chamber 7.

The results of the above-described fiber extrusions are contained in table I below.

Table I shows that an improvement in undrawn fiber Percent Uster and an improvement in drawn yarn properties is obtained at a relatively low polycapraamide throughput of 32 lb. per hr. using the apparatus and process of the present invention and this improvement in undrawn fiber Percent Uster and an improvement in drawn yarn properties becomes significantly greater as the polycapraamide throughput is increased to a point where, at a polycapraamide throughput of 45 lb. per hr., it was impossible to produce a processable undrawn fiber package using the apparatus and process of the prior art with high extrusion and cooling air rates.

In examples 1, 2, and 3, the relative humidity of the air entering gas chamber 1 was 65 percent at 75° F.

The cooling gas which is used in the present invention can be any inert gas, for example, carbon dioxide, nitrogen and the like, but preferably is air at about room temperature.

TABLE I

	Polycapraamide throughput, lb. per hr.					
	32		40		45	
	Type element					
	Poly-urethane foam	Perforated metal cylinder	Poly-urethane foam	Perforated metal cylinder	Poly-urethane foam	Perforated metal cylinder
Cooling air rate, s.c.f.m.-----	80	75	120	120	120	(1)
Extruder pressure, p.s.i.g.-----	2,000	2,000	2,000	2,000	2,500	(1)
Breaks per pound-----	0.011	0.015	0.011	0.115	0.013	(1)
Wraps per pound*-----	0.081	0.075	0.064	1.880	0.077	(1)
Average percent uster*-----	7.9	8.5	8	13	5.7	(1)

* It was impossible to produce a processable undrawn fiber package using these high extrusion and cooling air rates.

NOTE.—The target fiber physical properties of the above fibers were an ultimate tensile strength of 8.95 gms. per denier and a percent ultimate elongation of 16.2. The above fibers fell within an acceptable range from these target figures.

It is claimed:

1. An apparatus for producing a substantially nonturbulent stream of cooling gas for quenching a melt extruded filament which comprises a quenching chamber, wherein a melt extruded filament is passed therethrough, and a gas entry chamber, said gas entry chamber provided with means for introducing a cooling gas; said quenching chamber and said gas entry chamber being separated from each other by a porous, multicellular, polymeric foam diffuser capable of diffusing within said diffuser a gas entering from said gas entry chamber and said diffuser permitting said diffused gas to pass therethrough into said quenching chamber as a substantially nonturbulent stream of gas thereby quenching the melt extruded filament and producing greater cross-sectional uniformity in said filament.

2. In combination with a spinnerette assembly and a filament take-up means, a filament quenching apparatus which comprises:

- a wall extending from said spinnerette assembly toward said take-up means;
- a porous, multicellular, polymeric foam diffuser in commu-

nication with the lower portion of said wall and extending toward said take-up means;

- means integrating said wall and said diffuser thereby forming a dimensionally stable quenching apparatus;
- means to supply a pressurized cooling gas to said diffuser.

3. The combination of claim 2 including a cooling stack in communication with the lower portion of said diffuser and extending toward said take-up means; means integrating said wall, said diffuser and said cooling stack thereby forming a dimensionally stable quenching apparatus.

4. The combination of claim 2 wherein said porous, multicellular, polymeric foam diffuser has about 50 to 200 cells per lineal inch of foam; a polymer volume of about 3 to 50 percent based on the total foam volume; a foam bulk density of about 1 to 10 lb. per cu. ft.; and said diffuser has a range of gas velocity flow therethrough said foam of about 30 to 120 SCFM per sq. ft. at a pressure differential across said foam of about 0.15 to 4 inches of water.

5. The combination of claim 4 wherein said porous, multicellular, polymeric foam diffuser comprises a synthetic polymeric foam selected from the group consisting of vinyl foam and polyurethane foam.

6. The combination of claim 5 wherein said polyurethane foam is polyether foam.

7. The combination of claim 5 wherein said polyurethane foam is polyether foam.

8. The combination of claim 5 wherein said polyurethane foam is reticulated.

9. The combination of claim 4 wherein said porous, multicellular, polymeric foam diffuser comprises a natural or synthetic foam rubber.

10. The combination of claim 4 wherein said porous, multicellular, polymeric foam diffuser is provided with gas dis-

tribution means to provide an additional pressure drop across said diffuser.

11. A process for quenching a melt extruded filament which comprises introducing a cooling gas into a gas entry zone; passing said gas from said gas entry zone into a porous, multicellular, polymeric foam diffusion zone; diffusing said gas within said diffusion zone and permitting said diffused gas to pass therethrough said diffusion zone into a quenching zone as a substantially nonturbulent stream of gas; passing a melt extruded filament through said quenching zone thereby quenching the melt extruded filament in said quenching zone and producing greater cross-sectional uniformity in said filament.

12. The process of claim 11 wherein the gas is passed through said porous, multicellular, polymeric foam diffusion zone at a gas velocity flow rate of about 30 to 120 SCFM per sq. ft. at a pressure differential across said foam diffusion zone of about 0.15 to 4 inches of water.

13. The process of claim 12 wherein said gas is air.

14. The process of claim 12 wherein said porous, multicellular polymeric foam diffusion zone comprises a porous, mul-

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ticellular, polymeric foam diffuser which has about 50 to 200 cells per lineal inch of foam; a polymer volume of about 3 to 50 percent based on the total foam volume; and a foam bulk density of about 1 to 10 lb. per cu. ft.

15. The process of claim 14 wherein said porous, multicellular, polymeric foam diffuser comprises a synthetic polymeric foam selected from the group consisting of vinyl foam and polyurethane foam.

16. The process of claim 15 wherein said polyurethane foam is polyether foam.

17. The process of claim 15 wherein said polyurethane foam is polyester foam.

18. The process of claim 15 wherein said polyurethane form is reticulated.

19. The process of claim 14 wherein said porous, multicellular, polymeric foam diffuser comprises a natural or synthetic foam rubber.

20. The process of claim 12 wherein said porous, multicellular, polymeric foam diffusion zone is provided with gas dis-

tribution means to provide an additional pressure drop across said diffusion zone.

21. The process of claim 11 wherein said extruded filament is selected from the group consisting of a polyamide, polyester, polyolefin, polysulfone, polyphenyloxide, polycarbonate, polyacrylonitrile and polymer blends thereof.

22. The process of claim 21 wherein the polyamide is polycaproamide.

23. The process of claim 21 wherein the polyester is polyethylene terephthalate.

24. The process of claim 11 wherein said filament is quenched by means of cocurrent quenching.

25. The process of claim 11 wherein said filament is quenched by means of cross-current quenching.

26. The process of claim 11 wherein said filament is quenched by means of inflow quenching.

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