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MELT SPINNING PROCESS

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This invention relates to the preparation of artificial fibers. More specifically, it relates to a process for treating the spinneret outer face in the preparation of artificial fibers by the melt spinning process and to the treated spinneret produced thereby.

It is an object of the present invention to provide an improved process for the production of artificial filaments and fibers and particularly for the melt spinning of fusible filament forming polymers.

A further object is to provide a process for melt spinning which lessens the tendency for bending, flicking and dripping of the extruded liquid.

A still further object is to provide a novel and improved spinneret particularly for use in the melt spinning of synthetic fibers.

These and other objects will become apparent in the course of the following specification and claims.

In the preparation of certain types of filaments and fibers from polymeric material, e. g., the polymers, particularly the condensation polymers, described in U. S. Patent Nos. 2,071,250, 2,071,251, 2,071,253, 2,130,948 and 2,190,770 it is the practice of the art to melt the prepared polymer and extrude it through an orifice. This process is commonly referred to as "spinning." The device which provides the extrusion orifice or orifices is known as the "spinneret." Normally, this device is of metal construction. Within the broad scope of the present invention, the material of its construction is not limited to metal, nor to particular structure and dimensions. However, metal spinnerets are preferred. An example of one form of metal spinneret is shown in U. S. Patent No. 2,341,555 which, inter alia, describes the spinneret as composed of nickel-free, chromium steel (see also U. S. Patent No. 2,362,277).

In normal melt spinning, the spinneret is suspended so as to permit the hot extruded liquid to fall downward, the extruded streams being cooled and solidified into the filament form during this descent. Among the problems encountered in this process have been bending, flicking and dripping. Flicking is an obvious and repeated deviation of the liquid stream near the face of the spinneret from its normal path of descent. This phenomenon may occur at regular or irregular intervals. At times an oscillating effect is observed. When the liquid stream is permanently deflected from its normal path of descent, it is said to have undergone bending. Where the liquid stream has flicked or bent to such an extent that it touches and wets the spinneret face, fouling occurs, the continuous liquid stream is broken and the liquid thereafter drips from the orifice. This is known as dripping.

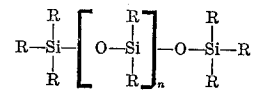
The flicking, bending and dripping of the extruded liquid is normally corrected by wiping the outer face of the spinneret with a brass rod. If these difficulties are not corrected, not only is production interrupted, but variations in the filaments result which cause streaks and rings in the fabrics produced therefrom. It is, therefore, the practice to wipe the outer face of all spinnerets with

a brass rod at scheduled intervals to avoid these problems as far as is practical.

In accordance with the present invention, it has been discovered that the use of a spinneret upon the outer face of which a film of a silicone fluid is maintained permits melt spinning with considerable reduction of the flicking, bending or dripping tendencies. As a result the periods between wipings can be increased considerably and filament uniformity can be more satisfactorily controlled than was previously possible.

Silicone fluids which have been found particularly useful in the present invention are the liquid, hydrocarbon-substituted, polymerized siloxanes commonly referred to as polyorganosiloxanes. These materials are well-known and are more fully described in the book "An Introduction to the Chemistry of the Silicones" by E. G. Rochow (John Wiley and Sons, Inc., New York, 2nd ed., 1951).

Among the useful representations of the silicones is the following:



wherein the R's represent the same or different hydrocarbon radical such as the members of the class consisting of the alkyl, aryl, alkylaryl and aralkyl radicals and n is a number greater than 1. Mixtures of varying chain length are suitable. The orientation and nature of the various hydrocarbon substituents in the molecular structure has not been found to be of critical importance provided the siloxane chain is of sufficient length to be a liquid and not cross-linked to such an extent as to cause gelling and/or resinification. Within these limits the physical properties may vary widely. The liquid should have a low volatility to avoid flashing off at the high spinneret temperatures, a low enough viscosity to permit rapid spreading at the spinneret temperature, and sufficient heat stability to avoid such problems as decomposition and polymerization. The polyalkylsiloxanes such as the polymethylsiloxanes with viscosities between 50 and 1000 centistokes at 25° C., have been found particularly useful. Such materials are available on the open market from the Dow Corning Corporation of Midland, Michigan, and the General Electric Company of Pittsfield, Massachusetts.

The method of applying the liquid silicone film to the outer face of the spinneret is not critical. It may be accomplished by wiping, spraying, wicking or dipping. Where a spray has been employed it has been found advantageous to use a vibrator type gun which does not deliver a strong blast. It is not necessary that the liquid film be present when the extrusion is commenced. However, it must be applied prior to the time at which bending, flicking or dripping is to be expected based on previous experience. This period will vary depending upon the nature of the material being extruded, the orifice diameter, the velocity of extrusion and the like. It is a matter simply determined by one skilled in the art. Normally, the silicone film is established either prior to spinning or immediately after extrusion has commenced.

The amount of silicone employed is not important as long as sufficient is present to provide a liquid coating upon the spinneret outer face. Due to the low surface tension and excellent spreading characteristics of these fluids, this coating may be obtained using only a very minor quantity of silicone. Usually a drop or two is effective over several hours of operation.

The wiping schedule of a spinneret wetted with liquid silicone, as described herein, has been found to permit an operating period between wipings two to ten times greater than was previously possible in similar spinning operations. While such spinnerets have been found particu-

larly effective in the spinning of polyamide filaments, since in its case non-uniformity of filaments is particularly noticeable in the finished product, they offer considerable advantage in the spinning of other synthetic polymers which are subject to similar difficulties and which are extruded at temperatures ranging from about 175° to 350° C. In every instance, the increased period between wipings represents a saving in the labor cost of the final product.

The wetted spinneret of the present invention is particularly adaptable to continuous processes since it is not necessary to take it out of operation over long periods of time to treat it, nor is it necessary to interrupt extrusion during the application of the silicone fluid. Since the silicone is in a liquid form it is convenient to apply and presents no fume problem. It can be employed on present conventional equipment with little or no modification.

The following example illustrates one method of carrying out the invention, but it is given merely by way of illustration and not by way of limitation.

Example

A conventional melt spinning assembly, ordinarily used to spin linear polyamides is set up. This apparatus is equipped with a spinneret of the design as shown in U. S. Patent No. 2,341,555, fabricated from a nickel-free steel containing 18% chromium as taught in U. S. Patent No. 2,362,277, having a 2" diameter outer face and ten extrusion orifices, each of 0.0088" diameter. The outer face of the spinneret is sprayed with 0.1 cc. of polymethylsiloxane having a viscosity of 100 centistokes at 25° C. Molten linear polyhexamethylene adipamide is then fed to the spinneret assembly at a temperature of 290° C. and under pressure of about 2500 p. s. i. The extruded melt is spun at a rate of at least 1100 yards per minute into a 100 denier, 10 filament yarn which is a typical 30 denier hosiery yarn after drawing. The outer face of the spinneret is sprayed with 0.1 cc. silicone as described above, at the end of each four hours. The average time lapse from the start of the operation to the first observed flicking filament is about 24 hours. By wiping the spinneret every 12 hours during such operation, flicking filaments are eliminated for all practical purposes.

A control run, under identical conditions, but without the silicone oil coating, gives flicking filaments in less than 4 hours on the average.

The elimination of flicking filaments greatly improves the uniformity of the fiber. As a result, fewer streaks and rings are observed in dyed knit tubing made from yarn produced in accordance with the present invention than was possible in the previous process even where the period between wiping was as low as 4 hours.

It has been found that a solid silicone coating produced by the polymerization of silicone on the spinneret, or by whatever other manner obtained, has no beneficial effect in retarding or preventing bending, flicking or dripping of filaments in the spinning process. It is essential that the silicone be a liquid and that the liquid film be maintained on the spinneret face. Nevertheless, the incidental formation of polymerized silicone gel or solid upon the spinneret face due to the heat and/or the presence of oxygen has no deleterious effect as long as liquid silicone is also present.

While the invention has been described with respect to melt spinning, it is intended to cover, in all its novel and useful aspects, dry spinning and the like and all other forms of spinning in which the benefits of the invention can be realized.

While particular mention has been made of nickel-free chromium steel as the spinneret material, the invention is applicable to other chromium steels, including those which contain nickel, and also to spinnerets made of other metals and even non-metals to which the invention can be applied with benefit.

It is understood that minor amounts of the conventional oxidation inhibitors, polymerization inhibitors and the like may be present in the treating fluid. Many other modifications will be apparent to those skilled in the art without a departure from the inventive concept.

What is claimed is:

1. In the process of melt spinning artificial filaments and fibers by extrusion through a spinneret, the step which comprises maintaining a liquid film of polyorgano siloxane on the outer face of the spinneret during the spinning operation.

2. The process as defined in claim 1 wherein the polyorgano siloxane has a viscosity of 50 to 1000 centistokes at 25° C.

3. The process as defined in claim 2 wherein the process is for the spinning of polyamide filaments.

4. The process as defined in claim 3 wherein the extruded material is linear polyhexamethylene adipamide.

5. The process as defined in claim 3 wherein the polyorgano siloxane is polymethyl siloxane.

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