PROCESS FOR MELT-SPINNING POLYAMIDES INTO LOW HUMIDITY ATMOSPHERE

Filed May 17, 1957
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Application May 17, 1957, Serial No. 659,984

Claims priority, application Italy May 18, 1956

2 Claims. (Cl. 18—54)

The present invention relates to a process and apparatus for the melt-spinning of synthetic linear polymers. In particular, it is useful for the spinning of polyamides, of hexamethyleneamine terephthalate polyamide (Nylon 66) and of poly-caprolactam (Nylon 6 or Perlon) and the polymer of amino-adamicanoic acid (Nylon 11 or Rislan).

According to conventional processes, these polymers are brought to the state of a melt in a special melter from which they are extruded through spinnerets in the shape of filaments. The filaments extruded are reeled on bobbins at a distance of some meters above the plane of the spinnerets. Special contrivances are necessary to obtain regular winding up of the thread on the bobbin, which requirement has utmost practical importance.

According to conventional methods, since the filaments of this kind absorb a lowly moisture when left on bobbins in any room even if provided with humidity controls, and consequently the windings swell and become irregular, it becomes hardly possible to unwind them, the filaments are humidified, in practice by steaming, prior to their reaching the reeling machine, by making them pass, after extrusion and cooling, through a vertical steaming tube. Whereafter the thread received the so-called sizing or finishing which consists in the application to the thread by means of suitable sizing rolls, of an emulsion of vegetable or mineral oils in water, with or without the addition of softening compounds, that is, of agents capable of lowering the surface tension of water (such as sulfonated oils). A great number of types of sizing are obtainable in the trade and are known to the skilled in the art.

The aforesaid process, although universally followed, affords however still some inconvenience. In fact the steaming of the filaments, while it prevents them from swelling on the bobbins by absorbing moisture from the reeling room (which is understood here to be the ambient in which the reeling machine finds itself), makes the filaments little sensitive to the variations of the quantity of sizing applied thereto, so that it becomes difficult to adjust and control the application of said sizing and accurate and burdensome analytical methods must be resorted to for keeping the sizing content of the thread within predetermined limits. This is firstly very burdensome and moreover it does not always suffice to prevent the threads from getting too little or too much sizing, with the consequence of irregular stretching effects and anomalies in subsequent textile treatments.

It has been found now, in a quite unexpected and surprising way, that it is possible to obtain much better results if eliminating the steaming or other forms of thread humidification, provided a diametrically opposed operation is carried out, on the contrary of what had been deemed necessary so far, namely of slightly heating of the space within which the thread previously extruded and cooled down, moves prior to reaching the sizing rolls and the reeling machine. This space is heated at a temperature higher than the temperature of the reeling room and the relative humidity thereof is not higher than that of the reeling room. It has also been found that there exists an optimum temperature interval within which the greatest regularity of the threads is attained, in particular if polyamides are treated.

The invention will be better understood with reference to the accompanying drawings constituted by one single diagrammatical figure illustrating the apparatus interposed between an extruding spinneret and a reeling machine, according to the invention.

In the drawing, the reference numeral 10 indicates the spinneret and numeral 11 indicates the thread, which may be formed by one single filament (mono-filament) or by a group of fibrils or even by a plurality of monofilaments or groups of fibrils, according to the particular spinneret employed. On leaving the spinneret the thread passes first of all through a blowing tube or box indicated diagrammatically with numeral 12 and whereinto the air coming from a mouth 13 is blown through gauges 14 and 15, from one to the other over the thread.

Subsequently the thread passes into a tube which will be called herein “accompanying tube,” which is placed in the position in which according to conventional methods the steaming tube is placed. That tube is indicated with numeral 16. It is preferably cylindrical, provided with a jacket 17 for circulating therein a heating fluid, preferably hot water, which enters at 18 and leaves at 19. Of course, other heating means might be used, and the means indicated herein is merely the most economical and easy one. The thread enters the tube 16 from top through the orifice 20 and leaves it from bottom through another orifice 21. This latter orifice has very small diameter so that the thread which moves at high speed downwards takes as little air as possible along with it into the reeling room. The means for circulating hot water or other fluid in the jacket 17 are not indicated because they are of obvious kind. After leaving the tube 16, the thread passes through the sizing device diagrammatically indicated at 22, as comprising a roll 23 dipping in a basin 24 and a roll 25 wherein the thread glides, and therefrom to the reeling machine diagrammatically indicated at 26 as comprising guide rolls 27 and 28, where it is reeled on a bobbin 29. The room in which the bobbin 29 is operated, is called herein the “reeling room.”

By way of examples of embodiment, the treatment of yarns of a polymer of aminoundecanoic acid and of a polymer of hexamethylene diamine adipate will be described hereinafter.

A thread is extruded of aminoundecanoic acid polymer destined to have after 2500 stretching a count of 30 den./10 filaments. On the bobbin 29, the count will be, therefore, 75 den. The speed of spinning is 1000 meters per minute, that is, a very high speed. The term "spinning speed" is understood herein to designate the speed with which the thread is wound up on the bobbin (reeling). The definition is necessary because the thread when leaving the spinneret, has a greater diameter than on the bobbin and, consequently, a lower speed. The spinneret is provided with 10 bobbins of 200 micron diameter.

When leaving the spinneret, in the box 12, over a vertical path of about 1 metre, the thread is subjected to blowing with air at 25° C. 30 cubic meters of air with 20-25% relative humidity are employed. The accompanying tube 16 is 2.5 meters long. The reeling room has a temperature of 20° C. and is conditioned at 50-55% of relative humidity.

The speed of spinning being 1000 meters per minute and the tube being 2.5 meters long, the calculated time of passage is between 1/4 and 1/3 of a second. In the same way, a nylon thread of equal final count and number of filaments is treated, which however undergoes
400% stretching and has on the bobbin a count of 130 den.

Spinning is carried out while heating the accompanying tube by means of water circulation at diverse temperatures. The results are tabulated in the following table, for the two types of threads considered, where the left column gives the temperature of the water circulating in the jacket and the two right columns give the winding-up characteristics for the two types of threads, evaluated from the point of view of regularity.

<table>
<thead>
<tr>
<th>Temperature of accompanying tube, °C.</th>
<th>Polymer of amino-undecanoic acid</th>
<th>Polymer of hexamethylene diamine adipate</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>irregular</td>
<td>irregular, Do</td>
</tr>
<tr>
<td>30</td>
<td>do</td>
<td>fairly irregular, Do</td>
</tr>
<tr>
<td>40</td>
<td>fairly irregular</td>
<td>regular, Do</td>
</tr>
<tr>
<td>50</td>
<td>Do</td>
<td>regular, Do</td>
</tr>
<tr>
<td>60-80</td>
<td>do</td>
<td>Do</td>
</tr>
</tbody>
</table>

It can be seen that the effect of heating in the tube is insensible in practice until above 30° C, that is, in the absence of heating or with only faint heating, no satisfactory reeling is attained without steaming. If however 40° C. are attained, reeling becomes fairly regular and is regular at temperatures above 50° C. All those temperatures are suitable, therefore, for carrying out the invention. However, the best conditions for carrying out sizing conveniently and in controllable manner, are obtained if the accompanying tube has temperatures between 40 and 60° C, since if operation is carried out at more than 60° C, the thread becomes insensible to the variations of finishing in emulsion.

The invention may be embodied in many ways departing from the details of the example hereinbefore described, since the invention is characterized solely by the suppression of steaming and by the introduction of a moderate heating subsequent to the blowing of the thread when leaving the spinneret, which heating has never been proposed or carried out and the usefulness of which, as well as the technical effect of which, was absolutely unpredictable and unexpected.

We claim:

1. A process for the melt-spinning of yarns of synthetic linear polymers produced from the group consisting of aminoundecanoic acid and hexamethylene diamine adipate, comprising directing a stream of a cooling gas onto the thread immediately after the same issues from the spinneret and subsequently, but prior to applying sizing to the thread, passing the thread through a space heated at a temperature between 40°-60° C, for a fraction of a second without humidifying the thread, the temperature of the room in which the thread is to be wound up being less than the space temperature, the humidity of said heated space being not higher than that of said winding room.

2. The process of claim 1 in which the winding room has a temperature of 20° C. and is conditioned at 50-55% relative humidity.

References Cited in the file of this patent

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