FIG. 5
SLUB YARN PROCESS AND PRODUCT
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ABSTRACT OF THE DISCLOSURE

A process comprising continuously overfeeding a multifilament yarn to an aspirating jet and withdrawing, countercurrent to the aspirating stream, a random slub yarn. The product is characterized with respect to the number, size and length of slubs in a given length of yarn.

This invention relates to the fluid treatment of yarn and more particularly to jet fluid treatment of yarn, preferably continuous filament yarn, to produce a slub yarn. Slub yarns are well known in the art and are characterized by the presence of stable segments of increased cross-section. Such yarns are of interest because of the aesthetic properties they impart to fabrics prepared from them. Because of the desirability that no patterning occur in the fabric, it is preferred that slub size and frequency be of a random distribution.

It is an object of this invention to provide an improved process for producing slub yarns. Another objective is to provide such a process in which slubs are introduced in a random manner and by means of relatively simple equipment. A further object is to provide a novel slubbed yarn that has good weavability. These and other objects and advantages will be apparent from the following detailed disclosure.

In accordance with this invention, a multifilament yarn is fed continuously to the yarn entrance of an aspirating jet device and is withdrawn continuously from the yarn entrance so that the yarn is overfed to the yarn entrance. The jet device is equipped with compressible fluid to form an aspirating fluid stream of sufficient magnitude to pull the yarn into the jet device under tension and form a loop of yarn in the fluid stream. In some unknown and surprising manner, a slub is initiated in the yarn within the jet device and subsequent entanglement in the high velocity stream results in the removal of a slabbed yarn from the jet. Equally surprising is that the size and frequency of the slubs is entirely random. It is believed that a turbulent zone within the jet stream is a desirable feature for slub growth and, at least in the preferred embodiment, may be required for slub initiation.

The preferred process disclosed herein produces novel, continuous, multifilament slab yarn characterized by sections of essentially uniform base yarn and at least about 200 completely random sized and spaced slubs per 1000 yards of yarn; at least about 50% of the slubs having a denier ratio less than 3.0 and at least about 1.1, the remainder having a denier ratio of at least 3.0 and containing at least 1 yarn loop entangled within the yarn mass; at least 70% of the slubs being 0.1 to 1.0 inch in length, the remainder being of greater length and including at least 1 slub having a length of at least 10 times the average slub length and preferably at least 5.0 inches long.

Most slubs formed in this fashion are stable to processing tension, but some pull-out can occur under more strenuous conditions. For this reason, it is desirable to pass the slub yarn through an interlacing jet to increase filament entanglement. Suitable interlacing jets are described in W. Bunting, Jr., et al. U.S. Patent No. 2,985,995, issued May 30, 1961, and jets represented by FIGURES 15, 16 and 17 are preferred types. Slub solidification can also be accomplished by using a torque jet of the type disclosed in Breen et al. U.S. Patent No. 2,997,837, issued Aug. 29, 1961.

The invention will be better understood by reference to the drawings. In these drawings, wherein specific embodiments for practicing the invention are illustrated,

FIGURE 1 is a schematic representation of the process and suitable equipment for manufacturing slabbed, continuous filament yarn in accordance with the invention;
FIGURE 2 is a preferred embodiment of the process and the equipment for manufacturing slub yarn;
FIGURE 3 represents a longitudinal cross-sectional view of a jet device suitable for use in the invention;
FIGURE 4 shows an alternative jet device; and
FIGURE 5 is an enlarged partial longitudinal side view representative of the slub yarn of the present invention.

Referring now to FIGURE 1, a continuous filament yarn 2 from a suitable source, e.g., a spinning cell, contacts guide 4, passes across finish roll 6, where the yarn picks up a small amount of a lubricating fluid, contacts guide 8 and passes to feed rolls 10 and 12. Aspirating jet 14, operating with air supplied through fitting 16, draws in the yarn at point 25 by virtue of the suction created at entrance port 26. Formation of a slub by filament entanglement occurs within the jet device 14 and wind-up roll 20, driving package 22, causes the slub to be removed from the jet 14 at point 27. Preferably the slub yarn is passed through an interlacing jet 18 located as shown by the dotted lines prior to being wound on package 22.

For ease of operation, FIGURE 2 represents a preferred arrangement of essentially the same equipment. Starting the process is facilitated by snubbing pin 32 and the continuity of the operation is improved by roll 21 which may be driven but is preferably an idler roll. Interlace jet 18 is shown between snubbing pin 32 and roll 21 but may, if desired, be located between roll 21 and the wind-up roll 20, as shown by the dotted lines, an arrangement in which the snubbing pin 32 would not be required.

FIGURE 3 shows an aspirating jet suitable for use in the process. Air, under pressure, is supplied through fitting 16 to chamber 13 which completely surrounds inlet section 15. The high velocity flow of air through channel 30 to outlet section 17 creates a reduced pressure at yarn entrance port 26. Air flowing through inlet section 15 combines with the air leaving channel 30 to produce a turbulent zone. If desired, air may be introduced into chamber 13 in a tangential manner so as to produce an air flow with a swirling motion.

FIGURE 4 shows another type of jet device for use in the process. The air, or other compressible fluid, is supplied through tube 33 mounted in body 34. Extending from the other side of the body is a slab formation chamber 35, aligned so that air is jetted into the chamber through entrance 36 and exits from the end. The chamber is of larger diameter to form a turbulent zone. The turbulence can be increased, if desired, by introducing additional fluid sidewise into the chamber through fitting 37 (depicted in dotted lines). Yarn passageway 38 is provided through the body perpendicular to the axis of the chamber. Yarn enters opening 39 and exits from opening 40 after looping into the chamber through entrance 36 which is provided with yarn guide 41 to smooth passage of the yarn. The operation is similar to that of the previous jet device in that the yarn is pulled into the slab formation chamber by a stream of air and then leaves by the same entrance 36 after slubs have formed.
As described above, yarn is fed to the entrance port of the jet device at a higher linear speed than it is withdrawn from the jet. This difference in speed, or overfeed, is a significant factor in determining the character of the resulting product. As used herein, the percent of overfeed is calculated from the formula:

\[
\text{Percent overfeed} = \frac{\text{feed speed} - \text{windup speed}}{\text{windup speed}} \times 100
\]

Slub yarns can be produced with as little as about 3% overfeed and at least as high as 33% overfeed. It is believed that overfeeds as high as 100% can be used but would probably require some reduction in speed. Overfeed rates of about 3-20% are preferred because of improved performance and ease of conversion of the resulting yarn into fabric. The variation in slub size and frequency of such yarns gives woven fabrics which have a very pleasing appearance. In general, the higher overfeed levels tend to produce larger slubs. Neither the feed speed nor the withdrawal speed need be constant, it being essential only that the yarn be fed continuously so that at any given instant the required overfeed conditions be met. In the event that a variable speed is used, it is convenient to calculate the overfeed by using an average speed.

For many purposes, fabrics woven from slubbed yarns containing a preponderance of large slubs provide a pleasing appearance. Such yarns are, however, difficult to weave. Slubbed yarns consisting of small slubs are woven more easily but provide an uninteresting or spunky appearance. The novel yarns of this invention largely overcome both of these deficiencies and can be woven readily into aesthetically pleasing fabrics. These yarns of this invention are characterized by a completely random distribution of a relatively small number of long slubs along a yarn containing a relatively large number of small slubs. The slubs in the yarns produced in accordance with this invention vary in length from about 0.1 inch (0.25 centimeter) up to at least 5 inches, and may include ones about 25 inches (65 centimeters), or more in length. The yarns contain a large number of slubs, e.g., 200 and more per 1000 yards (914 meters) of yarn, at least about 70 percent of which are 0.1 to 1.0 inch (2.54 to 25.4 millimeters) in length. The remaining slubs are of greater length with at least one having a length of at least 10 times the average slub length and preferably at least about 5.0 inches (12.7 centimeters). The slub segments varying in denier from about 1.1 up to at least 15 times the denier of the feed yarn. The feed yarn may be composed of natural or synthetic yarn, preferably cotton, low denier nylon, or synthetic fiber yarns. Such yarns are obtainable in different deniers and may be used for special effects or specific end uses, to produce yarns of desired thickness or of desired color. Other conventional classes of fiber-forming materials include regenerated cellulose, cellulose esters, and the acrylic polymers, as well as the many synthetic fiber-forming copolymers. Preferably, the yarn to be treated is a continuous multifilament yarn or a yarn of approximately zero twist. It may be desirable, however, for special effects or specific end uses, to use a twisted yarn. A preferred or zero-twist yarn may, if desired, be added as a carrier yarn. Conveniently, the carrier yarn can be introduced at the jet used to consolidate the slubs. The carrier yarn may, however, be introduced at the jet device, preferably by passing it through the jet device counter-current to the air flow. A twisted carrier yarn is used, it is preferably of sufficient low twist to aid intermingling of its filaments with those of the slub yarn. While a carrier yarn may be added if desired, it is to be noted that this normally will not be required. Due to the improved weavability of the yarns of this invention, it is not necessary to incur the expense and inconvenience of adding a carrier yarn. A further advantage of not requiring a carrier yarn for economical weaving performance is that the use of a carrier yarn causes considerable loss between the slubs and the rest of the yarn; a particularly significant fact in view of the large number of small slubs.

These yarns can also include staple yarns such as, for example, a polyacrylic or cotton yarn. Staple yarns appear to slub primarily by "knotting" in the turbulent air stream. Commonly, a loop of an interlace jet, these sections will have the characteristics of interlaced yarns.  

While air is the preferred gas to be used in the jets, other gases, e.g., steam, may also be used. Normally the temperature of the air supplied to the jets will be at room temperature but it may, if desired, be heated up to 300° C. or more. Suitable gauge pressure of the air supplied to the aspirating jet can vary from about 5 to about 100 pounds per square inch (0.35 to 7.0 kilograms per square centimeter), with 12 to 30 p.s.i.g. being preferred. The lower pressures are best suited to yarns of low to moderate strength.

The aspirating jet device used in the process of this invention may be any of the types previously used for handling running yarns, which are well known to the art. Aspirating jet devices of the types commonly referred to as sucker guns are preferred because of the simplicity of operation and construction. In some instances the length of the inlet section can be of critical importance. In a series of experiments run under conditions similar to those described in Example I, the length of the inlet section is varied from 2 to 24 inches (5.1 to 61 centimeters). Optimum results are obtained with an inlet length of about 10 inches (25.4 centimeters) and above. The use of an inlet section with a length of 2 inches (5.1 centimeters) results in frequent breaks in the running yarn. Performance is improved as the length of the inlet is increased, becoming satisfactory at 8 inches (20.3 centimeters) and optimum at 10 inches (25.4 centimeters). No further improvement is obtained at lengths up to 24 inches (61 centimeters). The use of outlet sections of 1 inch (2.5 centimeters) and 5.5 inches (13.8 centimeters) produces the same high level of operability; no significant difference is found in the kind or quality of the random slub yarn so produced.

It is to be understood that the yarn entrance portion of the inlet section is where the yarn enters the jet with the air stream and leaves countercurrent to the air stream. If desired, the yarn entrance could be modified to provide both entrance and exit ports.
3,433,007

The apparatus and feed yarn supply are as described in Example I except that the yarn has 80 filaments and a denier of 300. The yarn overfeed is 3.7% and the yarn is wound up at a speed of 418 yards per minute (383 meters per minute). Air is supplied to the aspirating jet at a gauge pressure of 22 pounds per square inch (1.55 kilograms per square centimeter) and to the interlace jet at 20 pounds per square inch (1.41 kilograms per square centimeter). Yarn characteristics are given in Table 1.

**EXAMPLE III**

This example illustrates the formation of a random slub yarn at a high rate of overfeed.

The apparatus and feed yarn supply are as described in Example II. The yarn overfeed is 33.7% and the yarn is wound up at 185 yards per minute (169 meters per minute). The gauge pressure of the air supplied to the aspirating jet and interlace jet is, respectively, 26 pounds per square inch (1.83 kilograms per square centimeter) and 20 pounds per square inch (1.41 kilograms per square centimeter). Characteristics of the yarn so obtained are shown in Table 1.

**EXAMPLE IV**

This example illustrates the production of a preferred slub yarn.

The apparatus and feed yarn supply are as described in Example II. The yarn overfeed is 6.9% and the yarn is wound up at 405 yards per minute (370 meters per minute). The gauge pressure of the air supplied to the aspirating and interlace jets is 18 pounds per square inch (1.27 kilograms per square centimeter) and 20 pounds per square inch (1.41 kilograms per square centimeter), respectively. Characteristics of this yarn are shown in Tables 1 and 2.

**EXAMPLE V**

This example illustrates the production of a polyamide slub yarn using high air pressure at the aspirating jet.

Apparatus similar to that described in Example II is used. The yarn is withdrawn from a supply package and the finish roll is not used. The polyamide is prepared from bis(p-amincocyclohexyl) methane and dodecanedioic acid. Two polyamide yarns are fed to the aspirating jet and slubbed together. Each yarn has a denier of 65, contains 34 filaments and has zero twist. The two yarns are overfed 10.5% and the slub yarn is wound up at 392 yards per minute (360 meters per minute). The aspirating jet is supplied with air at a gauge pressure of 52 pounds per square inch (3.66 kilograms per square centimeter). The interlace jet is operated as described in Example II. Yarn characteristics are reported in Table 1.

**EXAMPLE VI**

This example illustrates the production of yarn by using the interlace jet in an alternate location.

Apparatus similar to that shown in FIGURE 2 is assembled. No snubbing pin is used and the jet is located as shown by dotted lines at 23 of the figure. The yarn supply is the same as for Example II and is overfed 13.6% and is wound up at 378 yards per minute (346 meters per minute). The gauge pressure of the air supplied to the aspirating and interlacing jets is, respectively, 12 pounds per square inch (0.84 kilogram per square centimeter) and 30 pounds per square inch (2.11 kilograms per square centimeter). Yarn characteristics are shown in Table 1.

In a similar run using equivalent apparatus with a package supply, a 100 denier, 68-filament, zero-twist polyethylene terephthalate yarn is fed to the aspirating jet to form a random slub yarn. The overfeed is 20% and the slubbed yarn is wound up at 375 yards per minute (343 meters per minute).
TABLE 1.—YARN CHARACTERISTICS

<table>
<thead>
<tr>
<th>No. of slubs/1,000 yards (914 meters)</th>
<th>Ex. II, 328</th>
<th>Ex. III, 4,368</th>
<th>Ex. IV, 1,369</th>
<th>Ex. V, 1,000</th>
<th>Ex. VI, 864</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of shortest slub, inches (centimeters)</td>
<td>0.1 (0.25)</td>
<td>0.1 (0.25)</td>
<td>0.1 (0.25)</td>
<td>0.1 (0.25)</td>
<td>0.1 (0.25)</td>
</tr>
<tr>
<td>Length of longest slub, inches (centimeters)</td>
<td>5.8 (14.7)</td>
<td>20.6 (52.1)</td>
<td>7.8 (19.9)</td>
<td>8.2 (20.9)</td>
<td>8.1 (20.9)</td>
</tr>
<tr>
<td>Average slub length, inches (centimeters)</td>
<td>4.5 (14)</td>
<td>16.1 (40.3)</td>
<td>6.4 (16.3)</td>
<td>6.9 (17.5)</td>
<td>6.6 (16.8)</td>
</tr>
<tr>
<td>Shortest interval between slubs, inches (centimeters)</td>
<td>0.3 (7.62)</td>
<td>0.5 (12.7)</td>
<td>1.0 (25.4)</td>
<td>2.0 (50.9)</td>
<td>1.6 (41.2)</td>
</tr>
<tr>
<td>Longest interval between slubs, inches (centimeters)</td>
<td>304 (7,694)</td>
<td>104 (264)</td>
<td>130 (330)</td>
<td>114 (290)</td>
<td>157 (398)</td>
</tr>
<tr>
<td>Average slub-interval, inches (centimeters)</td>
<td>78.0 (200)</td>
<td>0.5 (12.7)</td>
<td>28.8 (73.5)</td>
<td>33.7 (85.5)</td>
<td>44.9 (114)</td>
</tr>
<tr>
<td>Percent of slubs having a denier ratio less than:</td>
<td>95</td>
<td>97</td>
<td>98</td>
<td>98</td>
<td>98</td>
</tr>
<tr>
<td>Slub denier:</td>
<td>300</td>
<td>320</td>
<td>300</td>
<td>247</td>
<td>233</td>
</tr>
<tr>
<td>Minimum</td>
<td>1,140</td>
<td>6,260</td>
<td>2,760</td>
<td>1,730</td>
<td>1,800</td>
</tr>
<tr>
<td>Maximum</td>
<td>600</td>
<td>1,020</td>
<td>830</td>
<td>560</td>
<td>500</td>
</tr>
</tbody>
</table>

TABLE 2.—DISTRIBUTION OF SLUB LENGTH AND DENIER RATIO FOR 1,000 SLUBS IN YARN OF EXAMPLE IV

<table>
<thead>
<tr>
<th>Slub length, inches (centimeters)</th>
<th>0.5-1.00 (1.3-2.5)</th>
<th>1.0-2.00 (2.5-5.0)</th>
<th>2.0-3.00 (5.1-7.5)</th>
<th>3.0-4.00 (7.6-10.0)</th>
<th>4.0-6.00 (10.1-15.0)</th>
<th>6.0-10.00 (15.1-25.0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denier ratio less than:</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>15</td>
<td>1</td>
<td>11</td>
<td>4</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>219</td>
<td>25</td>
<td>129</td>
<td>161</td>
<td>45</td>
<td>47</td>
</tr>
</tbody>
</table>

EXAMPLE VII

This example illustrates the production of a slub yarn without an interface jet.

A process as defined in claim 1 wherein the yarn is continuously fed to said entrance at speeds 5% to 20% faster than the slubbed yarn is withdrawn.

A process as defined in claim 1 wherein the compressible fluid is air supplied to the jet device at 5 to 100 pounds per square inch gage pressure.

A process as defined in claim 1 wherein the slubs are formed with a sucker gun aspirating jet device having a yarn inlet section of 8 to 24 inches in length.

A process as defined in claim 1 wherein the yarn fed to the jet device is composed of continuous filaments and has approximately zero twist.

A process as defined in claim 1 wherein a carrier yarn is fed through the jet device counter-current to the fluid flow to become combined with the slub yarn, the combined yarns leaving the jet device by said yarn entrance.

A process as defined in claim 1 wherein a carrier yarn is fed continuously to said entrance at speeds 5% to 20% faster than the slubbed yarn is withdrawn.

5. A process as defined in claim 1 wherein the yarn is fed continuously to said entrance at speeds 5% to 20% faster than the slubbed yarn is withdrawn.

6. A process as defined in claim 1 wherein the compressible fluid is air supplied to the jet device at 5 to 100 pounds per square inch gage pressure.

7. A process as defined in claim 1 wherein the slubs are formed with a sucker gun aspirating jet device having a yarn inlet section of 8 to 24 inches in length.

8. A process as defined in claim 1 wherein the yarn fed to the jet device is composed of continuous filaments and has approximately zero twist.

9. A process as defined in claim 1 wherein a carrier yarn is fed through the jet device counter-current to the fluid flow to become combined with the slub yarn, the combined yarns leaving the jet device by said yarn entrance.

10. A process as defined in claim 1 wherein a carrier yarn is fed continuously to said entrance at speeds 5% to 20% faster than the slubbed yarn is withdrawn.

5. A process as defined in claim 1 wherein the yarn is fed continuously to said entrance at speeds 5% to 20% faster than the slubbed yarn is withdrawn.

6. A process as defined in claim 1 wherein the compressible fluid is air supplied to the jet device at 5 to 100 pounds per square inch gage pressure.

7. A process as defined in claim 1 wherein the slubs are formed with a sucker gun aspirating jet device having a yarn inlet section of 8 to 24 inches in length.

8. A process as defined in claim 1 wherein the yarn fed to the jet device is composed of continuous filaments and has approximately zero twist.

9. A process as defined in claim 1 wherein a carrier yarn is fed through the jet device counter-current to the fluid flow to become combined with the slub yarn, the combined yarns leaving the jet device by said yarn entrance.

10. A process as defined in claim 1 wherein a carrier yarn is fed continuously to said entrance at speeds 5% to 20% faster than the slubbed yarn is withdrawn.

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