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PROCESS FOR THE HOT STRETCHING OF YARNS OF SYNTHETIC MATERIALS

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It is known that the utility of yarns consisting of polyamides, polysterens, polyethylene, polycrylonitrile and like synthetic materials can be improved by first subjecting the initially spun yarn to a stretching process in which the molecules are orientated. Whereas the stretching process generally yields a stretched material of uniform thickness, even when elevated temperatures are used, provided that the initial yarns are of uniform diameter, it is not possible to obtain yarns satisfactory for textile purposes when yarns of polycrylonitrile or copolymers with a content of at least 85% of polycrylonitrile are stretched in the hot state, especially when the high operating speeds of more than 100 m./min. which are normal in commercial production are used. The stretched yarns often show irregular fluctuations in thickness, the thicker portions of the yarns having been stretched to a lesser degree than the thinner portions.

The woven or knitted fabrics produced from such yarns show unevenness in the weave or stitch formation. Since the portions stretched to a lesser degree absorb a larger quantity of dye when the woven or knitted fabrics are dyed than the portions which are more highly stretched, the textiles thus obtained are often unsuitable for use.

Apart from this defect, which is found in yarns obtained by the known stretching processes operated at high working speeds, crimping phenomena are found in the yarn as a result of the shrinkage process which the stretched yarns subsequently have to undergo in order to give the yarn the elongation necessary for further textile processing. This is due to the fact that adjacent capillary filaments at one and the same portion of the yarn also have a different degree of shrinkage due to the different degree of stretching. This causes the capillary filaments which shrink to a higher degree in the shrinkage process to displace those capillary filaments which shrink to a lesser degree, whereby a cramped yarn with looped capillary filaments is obtained. This may be of advantage for specialised uses, but in general a rayon yarn is required to have a smooth surface.

It is an object of the invention to provide a process by which these irregularities in the count of the yarn can be prevented.

Another object is the provision of a process which will result in a smooth and even yarn in which the individual filaments possess uniform dyeing capacity.

Further objects will appear hereinafter.

These objects can be accomplished by imparting a false twist to the travelling yarn during stretching. The process is especially well adapted for the stretching of polycrylonitrile yarns or of copolymer yarns with a content of at least 85% of acrylonitrile, which still contain residues of solvent resulting from the spinning process and which are stretched while hot, even at high working speeds. In this connection, it is immaterial how the yarn is brought to the stretching temperature (for example by a hot air duct, a fixed heating frame or a rotating heated roller). The working conditions must however be so adjusted that the false twist extends at least into the zone in which the yarn is stretched. The individual capillary filaments are so closely assembled during the stretching operation that, at one and the same point of the yarn, they have the same degree of stretching and, in the subsequent shrinkage process, the same degree of shrinking. As a result, the looping of the capillary filaments and crimping of the yarns during the shrinkage process is obviated, so that absolutely smooth yarns are obtained.

In the accompanying drawing the single figure illustrates diagrammatically a form of an apparatus suitable for use with this invention.

The unstratched yarn 1 is wound around a supply roller 2 which is positively driven and which is heated to about 150° C. The second positively driven roller 4 is arranged at a distance of about 300 mm. below roller 2, both rollers being disengagably mounted on a common supporting member. The peripheral speed of roller 4 is adjusted with respect to the peripheral speed of roller 2, so that the yarn passing between the two rollers is stretched to the desired amount. A false twist device 3 is fitted about half-way along the travel of the yarn between the rollers 2 and 4. The device 3 can either consist of a small motor having an adjustable number of revolutions per minute and a hollow shaft carrying at its bottom end a small rotary head with an eccentrically disposed eye through which the yarn passes, or consist of a small hollow spindle which is accommodated in a bearing bush and which is driven at the upper end by tangential belts through a belt pulley and again carries at its bottom end the rotatable head with the eccentric eye. After passing over the stretching roller 4 the yarn is collected on a rotating bobbin 5.

A polycrylonitrile yarn is spun with 36 capillary filaments and having a total count of 410 denier. This still contains about 5% of dimethyl formamide from the spinning process. It is wrapped eight times round the supply roller 2. This roller is running at a peripheral speed of 130 m./min. and is heated to about 150° C. The yarn is then guided through the hollow spindle of the false twist device 3 running at 10,000 r.p.m. and taken up by stretching roller 4 with a peripheral speed of 850 m./min. The yarn is thereafter supplied to a conventional twisting spindle 6 running at 11,000 r.p.m., or to another suitable collecting bobbin. The false twist device is preferably given the same direction of rotation as the following twisting spindle.

Observation of the travel of the yarn between the supply and stretching rollers shows that the false twist, which is effective to the point at which the yarn is detached from the supply roller, assembles the capillary filaments already in the drawing zone to form a closed bundle of filaments and causes uniform stretching thereof.

After shrinkage of the yarn by steaming without tension, the yarn is completely uniform and smooth, whereas a yarn stretched in the same way but without using the false twist device has looped capillary filaments and is cramped, even if the final withdrawal speed is reduced to 1/20, i.e. 42 m./min.

The cramped yarn with looped capillary filaments cannot be used on the loom, particularly as a warp thread.

In addition to the uniform stretching and thus the prevention of looped capillary filaments and crimping of the yarn, the false twist also prevents roll formation on the rollers and the resulting breakages of filaments caused thereby.

Example 1

A yarn spun with 40 capillary filaments from polycrylonitrile with a total count of 660 denier, which still contains 8% of dimethyl formamide from the spinning process, is fed at a speed of 31 m./min. to a slightly curved metal frame heated to 170° C. Arranged on the delivery side of the frame is an eye which rotates at 5,000
r.p.m. and through which the yarn passes, the eye imparting a false twist to the yarn by means of a projection arranged thereon. The yarn is drawn off by means of a roller running at a peripheral speed of 230 m./min., so that it is stretched to about 7½ times its original length. The stretching zone is formed in this case at the bottom end of the frame, and it is observed that the yarn is subjected at this place to a violent twisting movement. Since, however, the twist is a false twist, it is automatically cancelled out again when the yarn leaves the false twist device. The yarn has a count of 88 and is collected by a rotating bobbin or a twisting spindle. By steaming the yarn in the loose condition, a yarn is obtained with a count of 100 and a completely smooth appearance. A yarn produced without a false twist shows considerable differences in thickness, and, after the steaming, is crimped and has looped capillary filaments, so that it cannot be worked on the loom.

Example 2

A yarn is spun with 36 capillary filaments from a copolymer of 95% of acrylonitrile and 5% of vinyl acetate with a total count of 410 denier. It still contains 5.5% of dimethyl formamide from the spinning process. It is wrapped 8 times round a roller heated to 145° C. and running at a speed of 89 m./min. From this roller it is supplied by way of a false twist device running at 10,000 r.p.m. to a stretching roller running at a peripheral speed of 580 m./min. Beyond the stretching roller, the yarn is taken up by a twisting spindle running at 9,600 r.p.m. After shrinkage of the thread by a steaming without tension the yarn is uniformly stretched and is smooth, while a yarn produced in the same way but without the use of any false twist has looped capillary filaments and is crimped. This case is related to Serial No. 748,966, Maier et al., filed July 16, 1958.

What is claimed is:

1. In a process for hot stretching yarns of synthetic materials selected from the group consisting of polyacrylonitrile and copolymers containing at least 85% acrylonitrile, the step which comprises imparting to the travelling yarn a high drawing speed in combination with a low false twist of from about 12–22 turns per meter during the stretching operation, and collecting the stretched yarn in an uncrimped condition and of uniform denier.

2. The process of stretching a yarn consisting of an acrylonitrile polymer selected from the group consisting of polyacrylonitrile and copolymers containing at least 85% of acrylonitrile which process comprises supplying the yarn from a positively driven supply roller, heating said yarn in contact with heating means having a surface temperature of from about 130–180° C., passing said yarn through a false twist device having a rotary speed of at least 5,000 r.p.m. to impart a low false twist of from about 12–22 turns per meter, advancing the yarn to a stretching roller having a peripheral speed at least four times higher than said supply roller, and collecting the yarn on a bobbin in an uncrimped condition and having a uniform denier.

3. In a process for the preparation of a molecularly oriented yarn of synthetic material selected from the group consisting of polyacrylonitrile and copolymers containing at least 85% acrylonitrile, orientation normally being affected by hot stretching the yarn in a manner which results in an irregularly stretched yarn with a tendency to crimp, and to form looped capillary filaments after shrinkage, the improvement comprising imparting a low false twist of from about 12–22 turns per meter to the yarn during the hot stretching operation, and then collecting the yarn, the collected yarn being in a smooth uncrimped condition, uniformly stretched, and having no tendency to crimp and to form looped capillary filaments after shrinkage.

References Cited in the file of this patent

UNITED STATES PATENTS

2,332,485 Hanson Oct. 19, 1943
2,332,489 Reinhardt et al. Oct. 19, 1943
2,440,226 Swank Apr. 20, 1948
2,509,741 Miles May 30, 1950

FOREIGN PATENTS

164,179 Australia July 18, 1955
750,761 Great Britain June 20, 1956