Air-jet texturing of viscose filament yarn, impact of machine parameters on yarn properties and its testing methods

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ABSTRACT

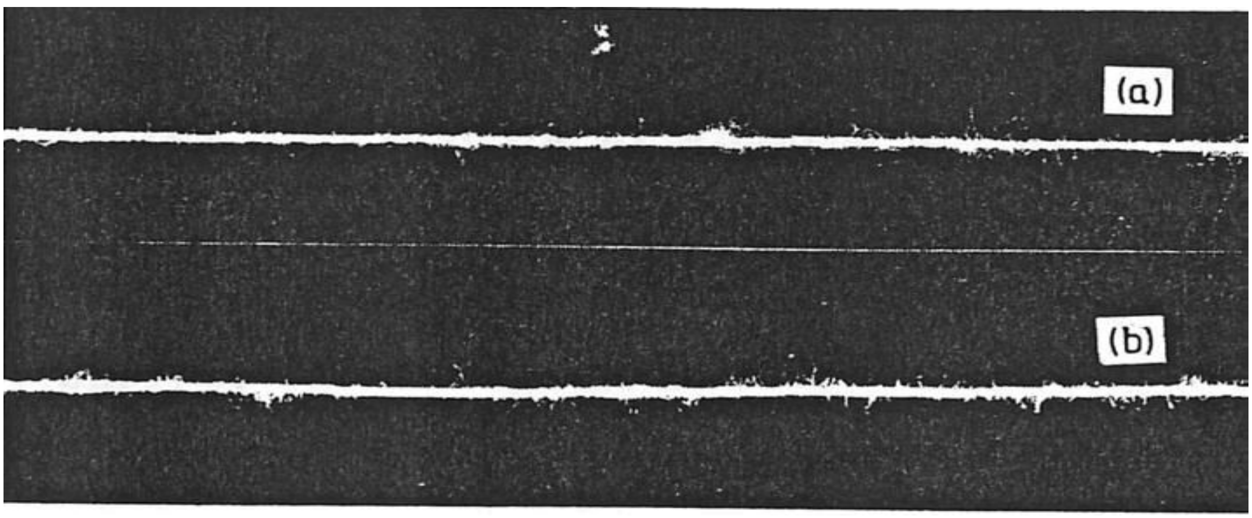
The air-jet texturing process for viscose filament yarn is briefly introduced and its advantages over other texturing processes are summarized. There are wide ranging quality parameters of the air-textured yarns on which depend their end use applications such as upholstery Characteristics of air-jet textured yarns are determined by the instability, linear density, and strength, together with structural properties such as loop size, loop frequency, and degree of entanglement. Such characteristics are affected by various process parameters and supply yarn properties. The effects of these parameters on the final yarn properties have been investigated. Optimizing any given yarn property almost always affects other yarn characteristics, and therefore this must be remembered when selecting suitable process parameters and supply yarns for specific end uses. Test methods used in industry and research to determine the characteristics of air-jet textured yarns are critically reviewed.

INTRODUCTION

Rayon is the oldest regenerated cellulose filament yarn with a wide spectrum property. Cellulose is one of the most useable natural polymers worldwide. It is biodegradable & renewable polymer. The common source for industrial purpose is wood pulp and cotton linter. Viscose is a semi-synthetic fibre which was earlier known as viscose rayon. Due to its feature of ability to breather and absorb liquid. It can be used in making soft smooth fabric for clothing. Viscose is a great option if you're looking for a lightweight material with a nice drape, a lustrous finish, and a soft feel.

Air jet texturing was invested in the early 1950s. the commercial success of this process was delayed in the early stage of its introduction because of unfavorable economics and the problems with the quality of textured yarn. Sustained efforts by Du Pont and others during the last 35 years have solved many of the problems associated with the air texturing. Improvement in jet design and air jet texturing machines have resulted in the production of better-quality air-textured yarn at a much lower cost. Air-jet texturing is a purely mechanical process I n with a high-pressure air stream sperates the overfed bundle of filament and intermingles them imparting a loopy and bulky structure to the final yarn.

The air-jet texturing process produces yarns like spun yarns in terms of their appearance and physical characteristics. An air-jet textured yarn and a cotton yarn of approximately the same linear density are shown in Figure I to illustrate their visual similarity. This similarity arises from the unique air-jet texturing process in which a flat synthetic multifilament yarn is given a spun-like structure with a compact core and surface loops occurring at irregular intervals along its length. Air -jet textured yarns therefore find application in numerous textile products varying from apparel to industrial fabrics



AIR TEXTURING AND ITS PARAMETERS

The basic principles of the air-jet texturing process have been reported in many publications. In this paper major focus on air texturing process for used for the viscose filament yarn and its process parameter. The process involves the "overfeed" principle, where the multifilament supply yarn is fed into the texturing nozzle at a greater speed rate than it is taken away. To achieve this degree of overfeed, the yarn passes through the feed roller system FR l or FR2 faster than it does through the delivery roller system DR. The overfed filaments enter the nozzle and are blown out from the exit end. They are converted into textured yarn by the supersonic, turbulent air jet. The textured yarn is then stabilized between the delivery rollers DR and take-up rollers TR. This "stabilizing extension" is created by the faster rotation of the take-up rollers. Pilot machine picture shown below commercially used for VFY air texturing.

Air texturing Machine Parameters suitable for viscose filament yarn.

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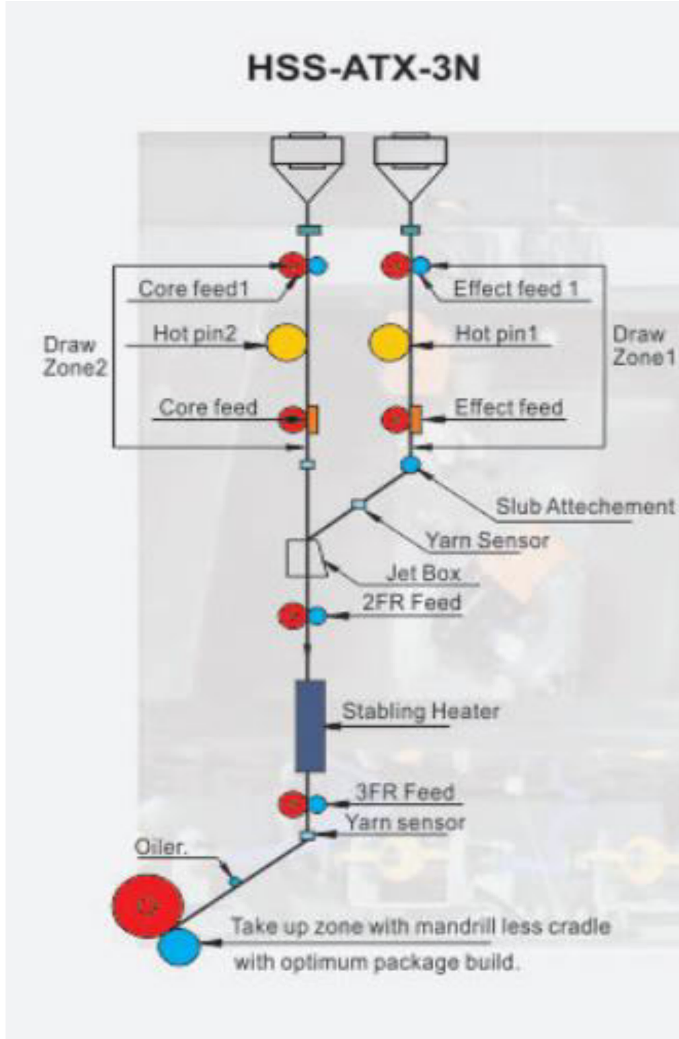
In the overfeeding zone 7-18% overfeeding applied for better intermingling effect. In the stabilizing zone, a stabilizing extension of 2-6% is applied to the yarn to mechanically remove the loose loops to improve yarn stability. The supply yarn is normally wetted just before it is fed into the nozzle to produce better textured yarns. An impact element at the nozzle exit is optionally used to facilitate better texturing. We have confined this investigation to the effects of the process and supply yarn parameters on the properties of air-jet textured yarns.



Process parameter used for texturing of viscose filament yarn.

Parameter	Range
Effect Overfeed	10-20 %
Core Overfeed	7-15 %
Temperature	170 ºC - 200ºC
Air Pressure	7-9 kg
Speed	275-350 mpm
Stabilizing Overfeed	-1.5 to - 5.0 %
Take overfeed	-3.0 to - 8.0 %
Water	Yes

Effects of Process Parameters

AIR PRESSURE

As the air pressure is increased, the flow velocity, which is the main driving force that opens up the filaments to enable them to entangle and texture, also increases. The non-uniformity and turbulence of the air flow are also enhanced by increasing air pressures. An improved texturing of the yarn is therefore expected at higher pressures. One might also anticipate a more stable entanglement, less instability for yarns textured at high pressures, a very slight increase in the instability of air-jet textured yams as the pressure increases. Commercially 7 to 9 bar pressure used for texturing of viscose filament yarn. The ensuing considerations of other properties such as the linear density increase and the decrease in tenacity substantiate increase air pressure.

OVERFEED

When the overfeed is as low, the excess lengths of filament available to form loops and arcs are indeed small. Consequently, the texturing is poor, with very few loops on the surface and a slight reorientation in the core of the yarn, a low level of instability because of the presence of more straight, unlooped load-bearing filament portions, but it would be unacceptable for many end uses.

As the overfeed is increased, more excess lengths of filament are available to form loops, which tend to cover the yarn surface. This increases the instability of the yarn without discrediting its acceptability as we discussed in the section on air pressure. Consequently, the texturing power of the jet decreases at higher overfeeds For the viscose filament yarn and reference process conditions, the overfeed that yields suitable texturing from the loop appearance viewpoint varies between 7% and 25%, but higher overfeeds may as well be deployed for special purposes such as core and effect, fancy and slub yams.

At low overfeeds, the excess lengths of filaments are insufficiently long to form stable loops and arcs. On the other hand, as the overfeed is increased beyond the capability of a particular nozzle, effective entanglement of the filaments is unattainable. Therefore, for any particular nozzle, there is a range of overfeed over which effective texturing can be achieved. The overfeed has paramount influence on the linear yarn and process parameters are acceptable; a desired linear density can be obtained by varying the amount of overfed filaments introduced to the nozzle.

TEXTURING SPEED

Only a very slight increase in yam instability with increasing texturing speeds. Since the resultant forces and torques on the filaments are mainly generated by the relative velocity between the filaments and the surrounding air flow, higher forces and torques are exerted on the individual filaments at lower texturing speeds. These greater fluid forces cause a better entanglement and a more firmly fixed loop formation. As the texturing speed is increased, the filament speed is also increased and the resultant forces therefore decrease. Consequently the texturing becomes less effective, Suitable texturing speed for viscose filament yarn between 300 m/min to 400 m/min.

STABILIZING EXTENSION

The purpose of the stabilizing extension, which is performed on-line on the machine subsequent to the texturing zone, is to pull out those loops that are not firmly fixed to the core of the yam. The level of this extension usually varies from 2% to 6%, because at higher levels, permanent yam damage or even breakage can occur.

When increasing stabilizing extension decrease in instability. This is obviously due to the removal of large and loose loops on the yam prior to the application of increasing stabilizing extensions. We therefore recommend that the stabilizing extension should not be so high as to cause broken filament ends, and a range of about 2%-4% seems reasonable for the particular supply yarn and process conditions used.

WET AND DRY PROCESSING AND USE OF AN IMPACT ELEMENT

Applying water to the filaments prior to their entry to the nozzle is now a well-recognized requirement for better texturing. However, the use of impact elements in the form of cylindrical bars, spherical elements, or flat plates placed at the exit of the nozzle is only recommended for particular applications such as low linear density yarns or high-speed operations. The instability increases with both wet processing and the use of a spherical impact element. Such increases, provided they are within acceptable limits, are indicative of improved yarn quality. In that dry textured yarns exhibit larger and fewer loops than wet textured yarns, as do wet textured yarns with respect to yarns textured with the impact element. The minimum amount of water required was about 0.2 liters/hour, as opposed to the common industrial practice of 2 liters/ hour, such higher levels of water application contributing no further improvement to the process.

Texturing is enhanced by the water application, because the overfed filaments are better entangled and surface loops are firmly fixed to the compact core of the yarn. This better entanglement causes only a small fraction of the linear density increase in the yarn to be lost under both the stabilizing and winding-up tensions. Dry texturing, however, yields poor texturing because most of the loops and entanglements are removed under such tensions.

NOZZLE TYPE

Different types of texturing nozzle available in market. Selection of suitable nozzle is major challenge. Herberline D11, D21 and RC311 most common nozzle used of viscose filament yarn texturing.

Selection of nozzle depends on the liner density, denier per filament or raw material types. Process parameter like Air pressure, Air consumption and texturing speed change with different nozzle. The distinctive nature of the yarn textured by the herberline D11 is that the large loops and arcs are dominant on the surface of the yarn

NUMBER OFFILAMENTS

As the number of filaments (total yarn linear density) increases, an enhancement in yarn quality is rightly expected because the potential for filament entanglement is increased. The experiments with different nozzle types have revealed, however, that this statement holds only for the number of filaments a particular nozzle design can texture effectively at given process conditions. When this optimum number of filaments is exceeded, a deterioration in yarn quality occurs for two reasons: first the air-flow is progressively more disturbed by the presence of increasing numbers of filaments, as is also true in the case of high overfeeds, and second because the increased number of loops arising from the presence of more filaments increases the likelihood of loops being pulled out under applied tension.

YARN PROPERTIES OF TEXTURING YARN AND TESTING METHODS

The characteristics of the Air textured yarn are important of its processing and end-uses. Some of the important properties which characterize the AT yarn: Instability, Physical bulk, Boiling water shrinkage, Size and frequency of loops, Tensile properties and elongation, Leaner density. Various test methods are available for the evolution of these properties and the present review provides and insight into them.

LINER DENSITY OF AT YARN: -

Various units available for measurement of the liner density generally denier for used filament yarns. Measure 90 meters length of the yarn by help of wrap reel instrument than weight using digital balance and convert in denier.

Denier = Weight of 9000 meter length yarn in gm.

TENSILE PROPERTIES AND ELONGATION: -

The tensile properties are of particular importance in any yarn withstand the stress and strain during further processing. Generally, AT yarns are inelastic and have lower tensile strength and extension at break than their feed materials. The reduced mechanical properties are clearly due to the yarn structure of the AT yarn. During texturization, tenacity by 40-50% in the case of Viscose filament yarn.

Testing procedure: -

Instrument – Instron

Principle – CRE (Constant rate of Elongation)

Gauge length – 500 MM

Speed – 300 mm/min

First start Instron instrument and select appropriate test method for yarn tenacity. Hold yarn between jaws of Instron and give start command to instrument. At the braking point load cell measure maximum load required to break and instrument directly give the tenacity in form of gram per denier with elongation %.

BOILING WATER SHRINKAGE

Boiling water shrinkage is the change in length as a percentage of original length of the yarn after immersion in boiling water for a specific time. This is one of the very importance properties of AT yarn because this determines their dimensional stability during subsequent processing stage and fabric. Also, the shrinkage process in the heater zone cusses the yarn core to be compressed and long loops to be drawn into the yarn axis whereby the stability of the yarn improves, and "Velcro" effect is reduced.

Many factors such as heater temperature, processing speed, length of the heater, over feed to the heater zone, affect the shrinkage properties of the final yarn.

Procedure - Take one-meter length of yarn and apply pre-tension accordingly liner density of yarn. Then dip on boiling water and measure length after shrink.

$$\text{Shrinkage (\%)} = \frac{(L1-L2)X100}{L1}$$

L1 – Initial length (100 CM)

L2 – Length after shrinkage

DETERMINATION OF SIZE, FORM AND FREQUENCY OF LOOPS: -

Smaller size and larger frequency of loops yield a better covering power in fabric and reduced Velcro effect. The configuration of loops also play an important role in the warmth and comfort properties of the final product.

Procedure-

For measurement of the bulk in AT yarn used microscope. In this measurement prepare one microscope slide. To measure the loop frequency sandwich the AT yarn between to slide in the tension less stage. View this slide at 25X magnification. Overall and core diameter are measured, and loop sizes are captured. Number of loops counted to determine the loop frequency.

CONCLUSIONS

The properties of air-jet textured yams are greatly influenced by altering the processing parameters. The supply yam properties also affect the final yam properties. The optimization of any given textured yam property almost always affects other yam characteristics, and therefore this must be borne in mind in selecting process and supply yam parameters for specific end uses.

The linear density of a yarn can be increased by increasing the overfeed, by increasing the air pressure, by decreasing the process speed, by wetting the filament yam, and by deploying an impact element. Also, review testing procedure of key characteristic of AT yarn.

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