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Design of Shaft Is an Important Tool in Mercerization Machine

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ABSTRACT: *Mercerizing is one of part of wet processing technology. It is the special type of treatment. Mercerization is done to get some special properties of the textile materials. In this process, the physical properties of the material get change. The mercerization process essentially consists of treatment of cotton yarn in high concentration caustic soda under tension. If cotton is dipped into a strong alkaline solution such as lithium hydroxide, caustic soda, or potassium hydroxide, the fibers will swell and shrink. If the fibers are placed under tension while in this swollen state and then rinsed with water, the alkali will be removed and a permanent silk-like luster will result It will be highly desirable to introduce this process in khadi sector which will lead to considerable saving in the dying cost. The handling of the hank is in appropriate; disarrangement of the lengths of yarn in one loop can result in different tensions, leading to uneven mercerization due to uneven tension is an unavoidable problem in this methods. This not only reduces productivity, but also results in many yarn-piecing defects during production. In this process tension can be derived by using proper shaft in mercerization machine by measuring the load required to keep the yarn or the fabric at the same length. The latter tension, being a tension intentionally exerted during mercerization, can be considered in three stages, 1) These being during the penetration of the alkaline solution and the swelling, during the fixing of the dimensions 2) Temperature during the treatment, 3) Control of the tension during the different stages is important in the supervision of the mercerizing process. In this process number of hanks are loaded on shaft and rotated for required time. Due to caustic soda treatment, the yarn get swell and length of yarn reduced upto 1/4th, due to continuous rotation of shaft, the load developed on shaft and shaft get bend. These problems may be overcome by designing of optimized shaft in mercerization machine.*

Keywords: *Mercerization, Mercerizing Machine, caustic soda, Shaft failure, Bending, Mechanical tension.*

I. Introduction

Mercerization is the treatment of cotton with a strong caustic alkaline solution in order to improve the luster, hand and other properties, was named after its discoverer, John Mercer, and has been in use for some time. The process of mercerization was developed in 1856, since then it is important in the textile mill sector. Mercerizing is one of part of wet processing technology. It is the special type of treatment. Mercerizing is done for getting some special properties of the textile materials. In which process the physical properties of the material change. Increased dye-uptake, dimensional stability, increased moisture regain, increased reactivity etc. If cotton is dipped into a strong alkaline solution such as lithium hydroxide, caustic soda, or potassium hydroxide, the fibers will swell and shrink. If the fibers are placed under tension while in this swollen state and then rinsed with water, the alkali will be removed and a permanent silk-like structure will result. It will be highly desirable to introduce this process in Khadi sector which will lead to considerable saving in the dying cost. In Mercerization machine number of shaft (10-15) arranged in parallel position, these shafts are supported by another shaft which is in parallel position at lower side. The arrangements of all shafts are star arrangement. Initially the yarn is loaded on upper shaft then lower and again on another upper shaft, in this way the shaft rotates continuously for 7 to 8 minute. The hank (yarn) is loaded through the shaft; each hank has a weight around 0.7 to 1.2 kg. These hanks are dipped in caustic soda solution or alkaline sodium hydroxide solution. Due to absorption of caustic soda solution by the yarn, chemical reaction occurs and as results the length of yarn reduces which are turn develops the stress in shaft.

The stress developed in the shaft due to following reasons

1. Length reduction of the yarn
2. The weight of the yarn gradually increased
3. Twisting movement of the shaft due to rotation

During the course of time the bending of the shaft occurs and misalignment of shaft result which in turn has a great adverse effect on the production line, also the misalignment damages the machine and the yarn.

II. Purpose/Need Of Mercerizing

The main changes occurring in the alkaline treatment of cotton are:

1. Solubility in solvents is increased;
2. The length of yarn or area of cloth is reduced;
3. Tensile strength is increased;
4. Absorption of dyestuff is increased;
5. Physical compactness of either cloth or yarn is increased;
6. Water absorption is increased;
7. Reactivity with oxygen (air) is increased;
8. Reactivity of cotton at lower temperatures is increased;
9. Sodium hydroxide (caustic soda) is preferentially absorbed during the process;
10. Luster is increased;
11. Rate of oxidation causing degradation is increased;
12. Removes immature (dead) cotton;
13. Lowers dye cost (up to 40 % on certain colors).

III. Absorption Of The Alkali And Swelling

The cotton hair swells in a strong caustic soda solution, and on viewing the changes in the cross-section that occur during the mercerization process shown in figure, the cross section, originally shaped like a squashed circular pipe, clearly becomes oval-shaped, thus enhancing the luster. The large differences in the swelling that occur due to the concentration of the alkaline solution are relative to the longitudinal shrinkage of the hair.

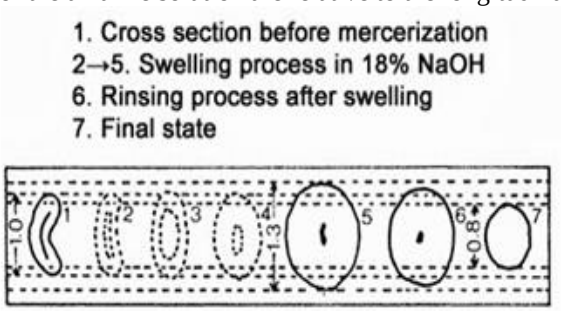

Fig no: 1Changes in the cross-section of a cotton hair during mercerization

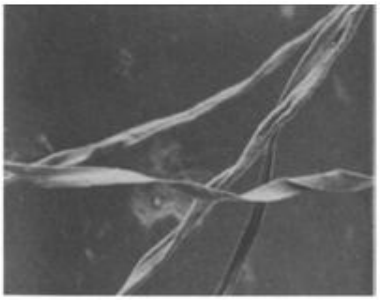

Fig no: 2 Un Mercerized cotton

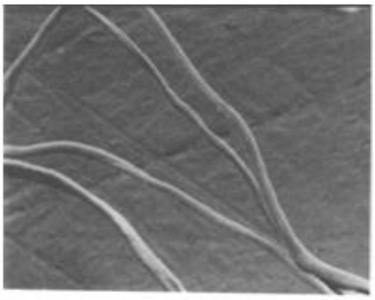

Fig no: 3 Mercerized cotton

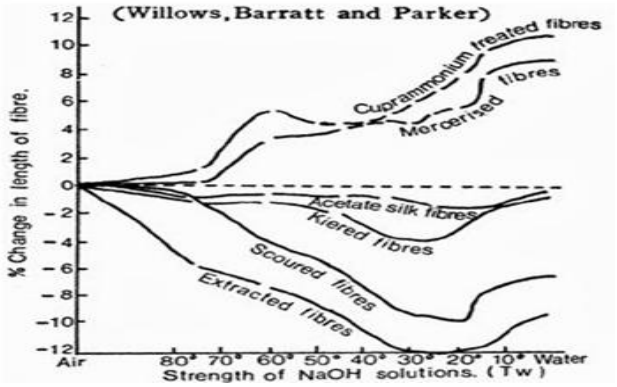

Fig: 4 Change in length of a cotton hair when dipped in decreasing concentrations of alkaline solution (NaOH)

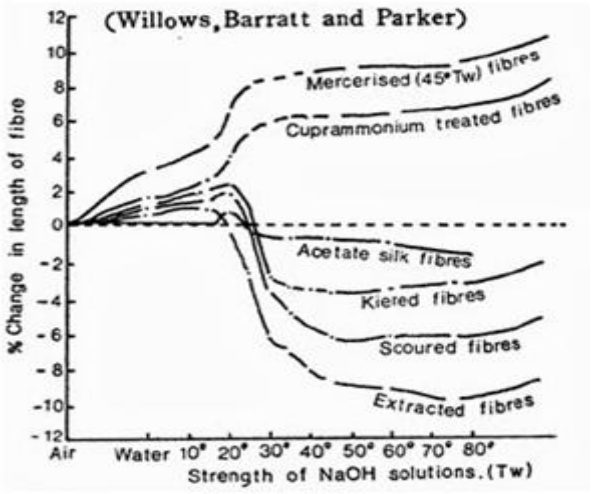

Fig no: 5 Change in length of a cotton hair when dipped in increasing concentrations of alkaline solution (NaOH)

IV. Tension After The Swelling Due To The Alkali

The tension introduced after the swelling of the yarn or the fabric is a mechanical tension exerted to resist the force of the shrinkage of the shrunk yarn or fabric and, by stretching, it fixes the dimensions as required. At this time, the problem in the processing is not the degree of tension required but the amount of stretching. For the generation of a good luster, stretching to the original length before the processing is usually the norm, but stretching beyond the original length will enhance the luster even more. However, stretching is not often beyond the original length of the yarn or the fabric due to the mechanical difficulties and the negative effects on hand and strength.

V. Problem Arises In Mercerization Machine

The winding or the handling of the hank is in appropriate; disarrangement of the lengths of yarn in one loop can result in different tensions, leading to uneven mercerization, which can often result in patchy dyeing. Uneven mercerizing due to uneven tension is an unavoidable problem in current methods of mercerization. While in theory reduction of the amount of yarn in one hank increases the evenness of the mercerization, this not only reduces productivity, but also results in many yarn-piecing defects during production of the weave or knit due to inadequate yarn length. For these reasons, using optimized shaft yarn that has been hank mercerized and then dyed for finishing into solid-color fabrics can result in a barrel effect,

Another problem in hank mercerization is that conventional rinsing after mercerization is insufficient, and without neutralization through separate rinsing with hot water, the remaining alkali can cause problems. While in theory there are no reasons preventing sufficient neutralization through removal of the alkali in this method, complete treatment of batches in hank form a low efficiency, and so not used due to the cost and the level of productivity. Thus, if treatments must be conducted separately by using proper shaft in mercerization machine, Furthermore, handling in hank form is necessary in the scouring and bleaching which follow, as well as in the dyeing, and there is a tendency for the quality of the yarn to deteriorate due to disarrangement of the yarn. Finally, after drying, winding from the hank to a cone or cheese is necessary, and the effort and labor hours needed for this are a major disadvantages. The resulting negative tension can be derived by using proper shaft in mercerization machine measuring the load required to keep the yarn or the fabric at the same length as that before processing, but because this tension cannot be adjusted during mercerization itself, if any adjustments are required, measures must be taken during the design stage of the yarn or the fabric. The latter tension, being a tension intentionally exerted during mercerization, can be considered in three stages,

A)These being during the penetration of the alkaline solution and the swelling, during the fixing of the dimensions

B)Temperature during the treatment,

C)Control of the tension during the different stages is important in the supervision of the mercerizing process.

In this process the hanks are held on shaft. At a time numbers of hanks are loaded on shaft and rotated automatically for required time. Due to caustic soda treatment, the yarn shrinkages and length is reduced. Due to continuous rotation of shaft the load is developed on shaft and shaft get bend. To avoid the bending of shaft, it has important tool to carried out design and analysis of optimized shaft mercerization machine

VI. Need Of Designing Of Mercerization Machine Shaft

As shaft have several types of failure from which bending Failure is have huge impact on mercerization process. We are concentrate on bending failure for design of Mercerization machine shaft.

In the dyeing of cotton, it is well known that if caustic soda is used in vat dyes and other dyes which use caustic soda, the dye's ability to be absorbed will decline, this tendency being especially strong in weak alkaline vat dyes. Caustic soda has an affinity for cellulose fibers, and through routine dyeing experience, it is well known that the removal of caustic soda through rinsing is very difficult when compared with the removal of acid. However, within the range of concentrations of caustic soda generally used in dyeing, the properties and form of cotton does not incur any particular effects, but if the alkaline concentration is gradually increased, they will be affected. Due to the different effects on different yarns, which are a collection of single fibers, or on different knits and wovens a variety of factors have complex cumulative effects, and the basic behavior of cotton exposed to certain alkalis is difficult to ascertain accurately, but clarification has come through using cotton hairs (single cotton fibers). Subsequently, researchers have repeatedly conducted experiments which included quantitative measurements, but the results have lacked consistency. While the reasons for this may be related to experimental procedure or certain errors, essentially, factors involved in the type and the maturation process of natural macro molecules like those in cotton can result in considerable differences in the resulting properties, structure and configuration. In addition to the variations in the responses to alkalis which result from these factors, a precise experimental procedure is difficult to determine, and this can also be considered a factor contributing to the difficulties.

Design and analysis of optimized shaft in machine of mercerization is to minimize the shrinkages in the yarn, increase machining accuracy. The time and capital cost in maintenance can be reduced. The life of machine can be increase, so repair and maintenance charges are minimize. The machine will run smoothly and efficiently so bending of mercerization machine shaft can be avoided.

VII. Significance Of Work

By designing of optimized mercerization machine shaft can control of tension during mercerization. In mercerization process there are two types of tension occur, one produced by the constraining force in opposition to the swelling caused by the twisting of the yarn or the structural density of the yarn when the single fibers which constitute the yarn or the absorb alkaline solution and swell, the other being intentionally exerted on the yarn or fabric during mercerization. The former type of tension occurs due to the relationship between the force of the swelling and the constraining force in opposition to it, and although not certain, as it is due to the force of the swelling, it can be expected to design proper dimension of shaft .

The design of mercerization machine shaft will provide an apparatus for mercerizing the yarn continuously as well as uniformly in caustic soda solution in predetermined quantity under uniform tension in short period of time. This increases the productivity of machine. The fabric produced from mercerized yarn will be dimensionally stable thus reducing the customer complaints of shrinkage of Khadi fabric or garments on washing it will save more dye consumption. By further modification the machine capacity can increase.

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