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EFFECT OF ALKALINE TREATMENT AND SPINDLE SPEED ON PROPERTIES OF P/C BLENDED YARN

A PROJECT REPORT

Submitted by

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In

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BONAFIDE CERTIFICATE

Certified that this project report **"EFFECT OF ALKALINE TREATMENT AND SPINDLE SPEED ON PROPERTIES OF P/C BLENDED YARN"** is the bonafide work of **R.BALAJI, P.CIBIPANDIYAN, N.KANDASAMY, M.SARAVANAN** who carried out the project work under my supervision.

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(INTERNAL EXAMINER)

(EXTERNAL EXAMINER)

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ABSTRACT

Polyester is the most widely used manufactured fiber .Polyester/cotton fabrics are used for apparel and home furnishings. These include bed sheets, bedspreads, curtains and draperies. Polyester used in knitted fabrics includes shirts and blouses. Fiberfill is also used to stuff pillows, comforters and cushion padding.

The main aim behind this project is to develop more comfortable poly- cotton yarn and hence improving the usage of Polyester/cotton yarns in day to day life. The drawback of the yarn is poor handle property. By the alkali treatment, we can improve the handle and comfort properties.

There are large availability of alkalies such as Potassium Hydroxide, Sodium carbonate. But we chose Sodium Hydroxide because it will not undergo harsh action against the yarn and also it produces better appearance of the yarn compared to other alkalies. As the yarn is treated with Sodium Hydroxide the cotton fibers will undergo swelling that is it will get bulged and it causes mercerization. But in the polyester the Hydrolysis reaction takes place and the surface of the fiber get ruptured.

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1.**INTRODUCTION**

1.1 GENERAL

Polyester is the most widely used manufactured fiber .Woven fabrics are used for apparel and home furnishings. These include bed sheets, bedspreads, curtains and draperies. Polyester used in knitted fabrics includes shirts and blouses. Fiberfill is also used to stuff pillows, comforters and cushion padding. Synthesis of polyesters is generally achieved by a polycondensation reaction. In this project mainly deals with polyester / cotton khadi yarn and their behaviour with alkali solution viz. sodium hydroxide in order to increase their comfort and aesthetic properties. There is a drop in the yarn strength and yarn weight and increase in the wearability.

1.2 ALKALI TREATMENT

Alkali treatment is nothing but treating yarns with chemicals such as sodium hydroxide, potassium hydroxide, etc. The main thing behind the use of sodium hydroxide is that weight loss will be less compared to other alkalis. Hydrolysis of polyester with Sodium Hydroxide is a saponification reaction through elimination of -OH groups, as a result of which polyester losses its weight. During the alkali treatment, the molecular chains in the cotton fiber get broken down due to this the fiber get swelled and mercerization takes place. Caustic hydrolysis initially proceeds over the whole fiber surface and then continues through enlarged surface cavitations causing higher weight loss

2.LITERATURE REVIEW

2.1. COTTON

Cotton is the oldest fiber used for textile purposes. In the tropical countries, it is the most important fiber. India was the centre for world's cotton industry as well as variety of fine yarns till 1600 A.D. the date of origin of cotton is unknown.

2.1.1. CHEMICAL PROPERTIES

The cotton fiber is elongated cell, constructed from millions of cellulose molecules. Small amount of moisture, fatty materials, minerals are other constituents of cotton. So the chemical properties of cotton are mostly influenced by the chemical characteristics of cellulose.

ACTION OF HEAT

Cotton fiber ignites easily and it burns with a bright flame, which continues even after the fibre is removed from fire. Cotton can be heated in a dry state to 150°C without any decomposition. But if heating continues, a brown colour on cotton develops gradually. A slight brown discolouration can occur at temperatures lower than 150°C, which does not deteriorate the fiber. However, it is sufficient to spoil the effects of bleaching.

ACTION OF LIGHT

Exposure to air in presence of sunlight for a long period will have an effect on cotton like that of heat. Oxycellulose is gradually formed accompanied by tendering because of atmospheric oxygen. The tendering effect by light and air is accelerated by traces of metals like copper.

ACTION OF WATER

Raw cotton is very hard to wet because the wax is present on the surface of the fiber. Cold water swells cotton without any chemical damage. Swelling is accompanied by the disappearance of the natural twist i.e., deconvolution. The irregular cross section becomes more circular, which reappears on drying. Structurally, swelling is due to the intercrystalline areas, which means only amorphous regions are affected by swelling.

ACTION OF ACIDS

Cold dilute solutions of mineral acids at boil have no effect on cotton cellulose, provided the acid are neutralised or washed out completely before drying. Cold concentrated sulphuric acid dissolves cellulose and forms cellulose hydrate. Hydrochloric acid affects cotton much more severely than sulphuric acid.

ACTION OF ALKALI

One of the main advantages of cotton is its resistance to alkali solutions. Mild alkalies like sodium carbonate have no action on cotton in the absence of air either at low temperature or at high temperature. However, in presence of oxygen or air, oxycellulose is formed with gradual tendering of cotton.

Generally, dilute solution of sodium hydroxide is used for scouring. Strong alkalies with higher concentration induce structural and physical changes in cotton fiber.. The diameter of these hydrated forms depend on the concentration of the alkali used. As the concentration of alkali increases, the number of water molecules per molecule of alkali decreases for the formation of smaller hydrates. Thus the diameter of the hydrated form of alkali decreases.

2.1.2. PHYSICAL PROPERTIES

FIBER FINENESS

The wall thickness of different types of cotton ranges from 3.5 micron to 10 micron. Ribbon width is said to range from 12 micron to 25 micron. The thickness part of a fiber is not at the base but it is at the middle. The tip end is usually gently tapered. The base end is slightly finer than the middle portion.

FIBER UNIFORMITY

There are considerable differences between cotton grown from the same seed in the same location from time to time. Unless like other fibers will not possess same fiber properties because the cotton properties will change periodically according to the monsoon changes.

POROSITY

Cotton fibers is porous and exhibits capillary effects to a higher degree. The fibrils themselves are dense as a result of the higher packing density of the molecules and so non porus. This part of the structure constitute approximately 70% or more of the fiber.

LUSTRE

The natural lustre of cotton fiber is determined by two factor s i.e., fiber shape and fiber polish. The lustre does not depend upon hair weight , length, diameter, fineness or convolutions. It depends upon the ratio of semi-major and semi-minor axes of the elliptical fibre cross section. If the ratio is be low, the lustre will be high. The highest lustre is noticed in the fiber with circular cross section. So the dominating influence in lustre is the external fiber surface and the exact geometric shape is of secondary importance.

DENSITY & STRENGTH

Cotton fiber has a density of 1.54 gm/cc, which corresponds to a specific volume of 0.64 cc/gm.

The load required tom break i.e., tensile strength of single cotton fiber varies widely. It depends upon the thickness of the wall, prior damage to the fiber and cellulose degradation. Matured fibers with coarse and heavy wall are the strongest fibers. Their strength ranges from 9 gm to 13 gm per fiber. The strength of fiber increases at higher humidity or at higher moisture. In general, the tensile strength increases up to a relative humidity of 60% and then remains mostly constant.

ELONGATION

When load is applied, the length increases, the change in length with respect to the original length is defined as extension or elongation or strain. Average fiber elongation at break is about 5% to 10%, exactly around 6% to 8%. In the structure of cotton fibers, the fibrils spiral round at an angle of about 20° to 30° to the fiber axis. In general, increasing the helix angle reduces the resistance for extension.

TORSIONAL RIGIDITY

The mean rigidity of cotton fiber is about 7.9×10^{-4} g.wt.sq.cm.sq.tex. rigidity varies with the shape, conditions of growth and wall thickness of the fiber. The high rigidity of thick walled fibers suggests why coarse cottons must be more highly twisted than fine cottons to produce yarns of the same size.

2.1.3. MODIFICATIONS OF COTTON WITH ALKALI

The cotton yarn immersed in aqueous solutions of caustic soda (NaOH) exhibited swelling and shrinkage. Changes in fine structure, morphology and conformation of the cellulose chains occur with mercerization. More specifically, treatment of cellulosic fibers with aqueous solutions of sodium hydroxide at various temperatures produces a polymeric change in the cellulose (known as cellulose II).

Sarko and co-authors have proposed elaborate pathways by which native cellulose is converted to each of the soda celluloses that ultimately lead to the thermodynamically stable and irreversible cellulose II structure. The most popular view that has been held for the past fifty years is that cellulose I exists in a parallel chain conformation while cellulose II exists in an antiparallel chain conformation. A more recent and simpler explanation of how cellulose I is converted into cellulose II and what the arrangements of the cellulose chains are in the unit cell is given by Turbak et al. computer- generated models (consistent with x-ray diffraction and other experimental data) indicate that cellulose II exists in a parallel-up chain conformation that can be achieved by initially breaking intramolecular hydrogen bonds between 6-OH and 2-OH on the adjacent glucose residue (trans/gauche or "tg" conformation). The formation of new and stronger intermolecular hydrogen bonds occurs on conversion to cellulose II.

Although these investigators have not specifically discussed " soda cellulose intermediates", their cellulose II structural model is consistent with the presence of different degrees of salvation/hydration of sodium hydroxide between cellulose chains at various degrees of chain separation, swelling and deswelling as well as equilibria in the conversion of cellulose to cellulosate ions.

2.2. POLYESTER

The work of W.H.Carothers, on linear fiber forming polymers put this initial foots on polyesters by polycondensation method. The polyester were aliphatic polyesters, made from dibasic acids like adipic acids and glycols. The melting point of the polyester were below 100°C having molecular weights in the range of 2500-5000. it is only a short step onward from him to J.R.Whinfield and J.T.Dickson, who prepared the first high molecular weight, high melting polyester in 1940. This polymer is poly(ethylene terephthalate) or poly(oxyethylene oxy terephthaloyl) or simply PET. Polyester fiber is defined as " a manufactured fiber in which the fiber forming substance is any long chain synthetic polymer composed of at least 85 % weight of an ester of dihydric alcohol and terephthalic acid. So this may include pure polyester or polyester–ether fiber. Generally polyester fibers are produced from spinnerets. Polyester polymer is produced commercially in a two step polymerization process, i.e., monomer formation by ester interchange of dimethyl terephthalate with glycol or esterification of terephthalic acid with glycol followed by polycondensation by removing excess glycol.

An alternative monomer formation system involves terephthalicphthalate and an catalysed direct esterification rather than ester interchange. The monomer which is the same from both methods expect for some end groups, usually is polymerized in the presence of antimony catalyst. Chain extension is promoted by removal of excess glycol from the various viscous melt at about 280°C,with carefully controlled agitation and a progressive reduction of pressure to about 200 Pa. heating is continued about 280°C until the desired degree of condensation is obtained.

2.2.1. STRUCTURE OF POLYESTER

The length of the repeated unit in poly (ethylene terephthalate) along the chain is 10.75°A, a value only slightly less the expected for a fully extended chain with one chemical unit to the geometric repeating unit, and successive ester groups in the trans configuration to each other (10.9°A). The chains are therefore nearly planar. The unit cell is triclinic, the atomic positions in the crystalline indicate that no special forces of attraction exist between the molecules. The spacing between atoms of neighboring molecules is of order expect if Van der Waals forces operate.

Drawn polyester fibers may be considered to be composed of crystalline and non crystalline regions. The theoretical density of pure crystalline material can be determined mathematically from the dimensions of the unit cell. Percentage crystallinity and molecular orientation relate to tensile strength and shrinkage; however the various methods of measurement are problematic.

Polyester fibers have many favorable properties, such as high strength and resilience, resistance to many chemicals and resistance to abrasion, stretching, shrinking and wrinkling.

It has certain disadvantages, such as tendency to pill, static charges, and high luster, as well as being unbreathable difficult to dye and resistant to oily stain removal, due to its hydrophobic nature and inactive surface. improving the undesirable properties of polyester fibers is done under harsh conditions, since the fibers are resistant to most chemicals.

In order to modify the surface of the polyester enzymes are used. The enzyme, polyesterase, is a serine esterase that acts by cleaving the polymer chain through hydrolysis of ester bonds of the polyester fibers

2.2.2 CHEMICAL PROPERTIES:

EFFECT OF ALKALIES:

Polyester fibers have good resistance to weak alkalis at high temperatures. It exhibits only moderate resistance to strong alkalis at room temperature and degraded at elevated temperature.

EFFECT OF ACIDS:

Weak acids, even at the boiling point, have no effect on the polyester fibers are exposed for several days. Polyester fibers have good resistance to strong acids at room temperature. Prolonged exposure to boiling hydrochloric acid destroys the fibers and 96% sulphuric acid and causes disintegration of the fibers.

EFFECT OF SOLVENTS:

Polyester fibers are generally resistant to organic solvents. Chemical used in cleaning and stain removal do not damage it, but hot m-cresol destroys the fibers, and certain mixtures of phenol with trichloromethane dissolve polyester fibers. Oxidizing agents and bleachers do not damage polyester fibers.

MECHANICAL PROPERTIES:

Polyester fibers exhibit good resistance to sunlight, and it also resists abrasion very well. Soaps, synthetic detergents, and other laundry aids do not damage it. One of the most serious faults with polyester is its oleophilic quality. It absorbs oily materials easily and holds the oil tenaciously.

2.2.3 PHYSICAL PROPERTIES:

MOISTURE REGAIN:

The moisture regain of polyester is low, ranges between 0.2 to0.8 percent. Although polyesters are non absorbent, they do not have wicking ability. In wicking, moisture can be carried on the surface of the fiber without absorption.

SPECIFIC GRAVITY:

The specific gravity 1.38 or 1.22 depending on the type of polyester fibers is moderate. Polyester fibers have a density greater than polyamide fibers and lower than rayon. Yarns made from polyester fibers are medium in weight.

HEAT EFFECT:

The melting point of polyester is close to polyamide, ranging from 250 to 300°C. Polyester fibers shrink from flame and melt, leaving a hard black residue. The yarn burns with strong, pungent odour. Heat setting of polyester fibers, not only stabilizes size and shape, but also enhances wrinkle resistance of the fibers.

2.2.4 MISCELLANEOUS PROPERTIES:

Poly (ethylene-terephthalate) shows non linear and time – dependent elastic behavior. Creep occurs under the load with subsequent delay in recovery on removal of the load, but compared to that of other melt-spun fibers, creep is small.

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2.2.4 CHEMICAL MODIFICATION OF POLYESTER FIBERS:

Polyester fibers have taken the major position I textiles all over the world although they have many drawbacks e.g., (a) low moisture regain (0.4%), (b) the fibers has a tendancy to accumulate static electricity, (c) the cloth made up of polyester fibers pick up more soil during wear and it also difficult to clean during washing, (d) the polyester garments from pills and thus, the appearance of a garment is spoiled, (e) the polyester fiber is flammable. Thus, it has been suggested that surface modifications can have an effect on hand, thermal properties, permeability, and hydrophilicity.

Numerous research papers and patents are available and considerable amount of research works is in progress on the hydrolysis and aminolysis of polyester fibers to overcome their disadvantages.

Namboodri and Haith carried out a comparative study by treating the polyester fibers with alkalies and various alkoxides (e.g. sodium hydroxide with water, sodium methoxide in methanol, sodium ethoxide in ethanol, sodium isopropoxide in isoproponal, and potassium tertiary butoxide in tertiary butanol) at 60°C and at different concentrations. It was found that the loss in weight of the polyester fiber was in the order sodium hydroxide< tertiary butoxide < secondary propoxide < methoxide and ethoxide. It was suggested that the observed order followed the nucleophilicity of the bases and the relatively lower reactivity of the secondary propoxide and tertiary butoxide was assumed to be due to the streric retardation during the equilibrium reactions. The hydrolysis of the polyester fiber was assumed to be taking place on the surface of the fiber. It was assumed that a random attack of the base on the carboxyl groups of the surface polymer molecules took place with removal of the shorter chains from the surface, which were further hydrolyzed by the base present in the solution.

Ko Sohk Won et al. have reported that the treatment of a polyester yarn with aqueous sodium hydroxide solution caused a decrease of weight and breaking strength and improved handle with increasing sodium hydroxide concentration, treatment time and temperature. It has been reported that these effects were further enhanced in the presence of a carrier, such as palanil carrier A. the molecular weight of the fiber was also decreased, but crystallinity was not affected by the alkali treatment.

Hydrolysis improved the smoothness of the yarn and decreased the electrostatic charge fro friction. Elisson et al. observed that untreated polyester fibers have relatively smooth surface, while NaOH treatment causes pitting of the fiber surface. The pits increase in number and depth as the time of hydrolysis was lengthened.

Song and kim found that the weight loss of poly(ethylene terephthalate) fibres by alkali treatment decreased in the order of KOH > NaOH > Na_2CO_3 and increased with increasing alkali concentration and treated temperature and time. With increasing weight loss, drape and flex stiffness and tear strength decreased, and tear strength retention at weight loss 17% was >70%. At the same weight loss, handle was affected by the treatment conditions. Zhang and co-workers observed that the addition of dodecyl-dimethybenzeneammonium bromide cationic surfactant reduced concentration of NaOH and thus lowered the degree of degradation of poly(ethylene terephthalate) fibers.

The hydroxyl ions in the solution of sodium Hydroxide attack the carboxyl group in the polymer which result in the formation of disodium terephthalate and ethylene glycol. Disodium terephthalate is soluble in alkaline solution (pH above 8) up to 13-14%. Free terephthalic acid is on the surface of the yarn which is to be washed out with alkaline water before neutralizing the yarn.

2.3. POLYESTER / COTTON BLENDS ON ALKALI

According to R.T.SHET, S.H.ZERONIAN, H.L.NEEDLES and S.A.SIDDIQUI, Alkali treatment of polyester by a continuous techniques pad-heat technique for a given length of time results in a much higher degree of hydrolysis, as indicated by weight loss, than a batch process employing a large liquor :solid ratio.The moisture related properties of polyester are essentially unaffected by the alkali treatment , and the tensile warp direction ,as indicated by yarn tests , are also not affected when the weight loss is kept below 14%.

Hot alkali treatment of polyester/cotton blend yarns serves a dual purposes subjectively, it imparts a silk like soft hand to the polyester and brings about mercerization of the cotton.The presence of cotton improves moisture related properties while the polyester imparts dimensional stability to alkali treated blend yarns.

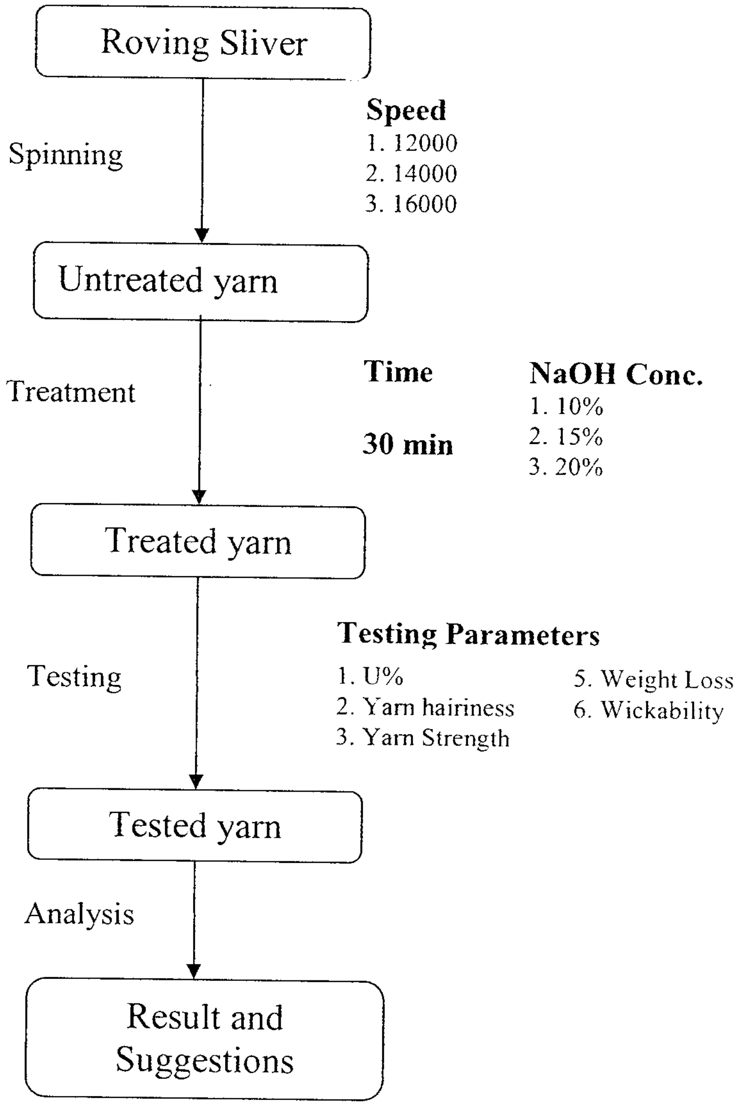
The treatment of cotton with aqueous sodium hydroxide of mercerization strength is a well known process for enhancing its physical properties.It has recently been concluded that although low temperature is required to swell the cotton for mercerization,the treatment has been attributed to the limitation of the reaction mainly to the fiber surface. Cold industrial mercerization is therefore a topochemical reaction resulting in a more condensed skin around the unswollen core of the fiber.

Warm sodium hydroxide on the other hand , penetrates cotton fibres rapidly, resulting in more uniform swelling of the fiber when the temperature is lowered. Hot alkali treatment of polyester/cotton blends could achieve the dual purpose of imparting a soft silky hand to the polyester fiber and improving the hydrophilicity and dyeability of the cotton fiber. The objective of this study was to examine the effect of hot alkali treatments on the physical properties of polyester and polyester/cotton blend yarns.

3. AIM

Scope of this treatment is also improve the polyester/cotton blended yarn and improves the performance of the yarn. Only little work done on the effect of polyester / cotton blends since blends are widely used. Therefore this investigation has been undertaken. The treated samples will be investigated for Yarn Unevenness, Yarn Hairiness, Yarn strength, Wickability,and Weight loss. Based on the results obtained suitable recommendation will be made.

4. PROCESS FLOW DIAGRAM



4.1 .PRE SPINNING OPERATIONS:

The roving used in spinning are processed in Karthikeya spinning mills. The various processes are

Mixing: Shankar-6 (31 mm staple length)
Polyester 0.8 denier (32 mm)
Blending and drawing del hank: 0.12
Feed hank in Card roving :
Cotton: 0 .156(Cotton)
Polyester: 0.172(Polyester)
Simplex:
Roving Hank: 1.6
Breakdraft: 1.31
Draft: 13

4.2 .SPINNING:

The roving slivers are spun at 12000 rpm, 14000 rpm and 16000 rpm.

Machine details:

The machine used for spinning is **TRYTEX MINIATURE SPINNING MACHINE.** It contains inbuilt electronic items, computer and other sophisticated components.

Technical Specifications of the machine:

No. of Spindle: 6
Gauge: 70 mm
Lift: 178 mm
Drafting system: SKF PK 2025
Drafting angle: 45°

Spinning angle: (0-18) °

Operating system: PC Based Windows XP operating system

Drive: AC variable Speed Drive System

Power:1500 watt

Dimension: 1500*800* 1500 mm

Total weight: 1 ton

The **spinning parameters** that we have set for spinning the yarns are

Spindle speed: 12000 rpm/14000 rpm/16000 rpm

Roving Count: 1.47 Ne

Yarn count: 40 Ne

Twist Multiplier: 4.2

TPI: 26.56

Twist Direction: Z

Break Draft: 1.3

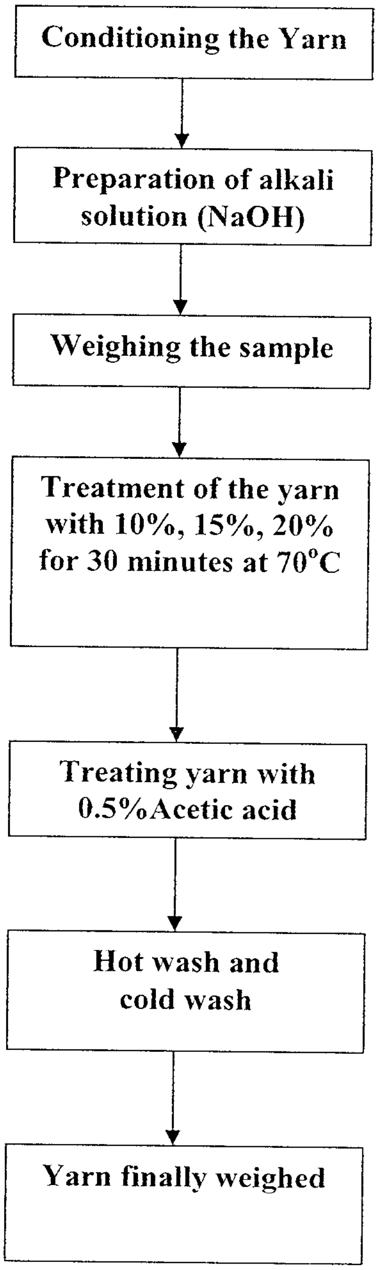
Yarn length: 5000 m

Yarn contraction: 2.9

4.3 Reeling:

The yarns are then subjected to reeling operation. The yarns are converted into skein form and are weighed and packed.

4.4 TREATMENT PROCEDURE



4.5 PROCESS SPECIFICATION

4.5.1.TIME

Weight loss was found to be directly proportional to the time of hydrolysis as the time of hydrolysis increased, weight loss also increased. Generally the time taken for the alkaline hydrolysis is30 minutes. The percentage loss in weight of polyester / cotton blend yarns for the first five minutes was very small. The loss in weight was highest during the next increment of time. The reaction appears to slow down with further increases in time of heating.

4.5.2 TEMPERATURE

When a yarn saturated with aqueous alkali is heated at constant external temperature there will be an increase in the concentration of sorbed alkali due to the evaporation of water from the yarn phase. The temperature of sorbed alkali in the yarn phase, after an initial increase with time will attain an equilibrium value once the loosely bound water is evaporated. For the improvement of luster property and comfort property of cotton hot alkali treatment is necessary for the 70°C is preferred.

4.5.3. CONCENTRATION

At the higher concentration, the surface of the fiber get ruptured and the weight loss of the yarn is increased about 25%. At lower concentration the rate of hydrolysis taken more time to attain its equilibrium so that the concentration that are selected are 10%,15%,20%

4.5.4. LIQUOR RATIO

It is observed that at lower bath ratio (w/w), the yarn exhibits an excellent handle value as compared at those at higher bath ratio, thus confirming the potential of low liquor dyeing principles. The effect depends on several factors and the bath ratio is one among them influencing the mechanical properties of the yarn to a greater extent. Lower bath ratio will exhibit the properties favourable to a soft yarn so finally the liquor ratio of 1:10 is selected.

4.6YARN CONDITIONING:

Yarn conditioning is done to remove the stresses in the yarn and make ready for alkali treatment. For the conditioning treatment the yarn is subjected to treatment with 0.5% soap oil with M: L ratio of 1:20 for 30 minutes under room temperature. Then the skein is taken out and subjected to washing and then the yarn skein is dried for 24 hours with some tension.

4.7. VESSEL SPECIFICATION

4.7.1. CONSTRUCTION

The Vessel is especially suitable for dyeing yarns. Water is poured into the vessel about two third of its volume. The water is heated by means of Electrical coil controlled by an electronic circuit. The vessel is covered by a tray with 6 openings to fit six beakers. Yarn with necessary amount of water and chemicals are added and placed in the tray so that the beaker lies on the surface of the water. The temperature of the water inside the vessel is set by means of an digital dial.

- **Material of construction** : Stainless steel 304 quality
- **Heating medium** : Through water
- **Temperature Control** : digital temperature indicator cum controller DTIC - 200
- **Temperature indication** : By dial thermometer 0 – 150°C

4.7.2. CHEMICAL TREATMENT

The beakers are cleaned and washed with water. The vessel for placing the samples is filled with water and the water bath is set at 70°C. The M:L ratio is 1:10.The yarn skein is weighed and the amount of Sodium hydroxide(10% (or) 15% (or) 20%) and water required are calculated.

Water is poured into the beaker and the calculated amount of sodium hydroxide is added to water and stirred well. Now the yarn skein is added to the beaker and the beaker is placed in the holes in the tray placed over the vessel. Similarly all the holes in the tray are filled with beakers.

The reaction time is 30 minutes. After 30 minutes the yarn skein are taken out and subjected to 0.5% acetic acid with M:L ratio of 1:10 to remove alkali present. Then the samples are subjected to hot and cold wash with water. The yarn samples are dried and weighed.

4.8 Re-reeling:

After the yarn skein is subjected to Sodium hydroxide treatment it converted to cone form by the process of re-reeling. It was the most tedious process and it needed lot of time as the process consists of two stages. At first the yarn skein is converted into Pony forms. Then these ponies are converted to cone in the re-reeling machine.

4.9 TESTING

In order to carried out the test the following testing conditions are required which is 21 ± 1°C (70 ± 2°F) and 65 ± 2 % relative humidity.

4.9.1. TESTS PERFORMED

The yarn samples are tested for the following

1. U%
2. Single yarn strength
3. Hairiness
4. Wickability
5. Weight loss

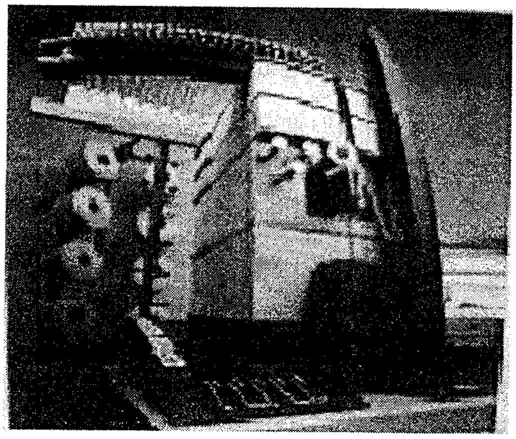
4.9.2. TESTING PROCEDURE:

4.9.2.1U%:

This analysis is mainly done to determine the imperfection level in the yarn. Along with U%,

1. CVm (%) 2. CVm (1m)3. Index4. Thin (-50%) 5. Thick (50%)
6. Neps (+200%)7. Thin (-30%) 8. Thin (-40%)9. Dust Count.

are also been done to assess the imperfection levels ie., mass per unit length variations in the yarn. This test is conducted on **USTER TESTER 4.**



In this test, the test sample is fed to the machine. The machine is made to run at 400m/min. The testing time for each sample is 1 minute. The instrument analyses the yarn and gives the U%, thick place, thin place and no. of neps values in the computer.

4.9.2.2 SINGLE YARN STRENGTH:

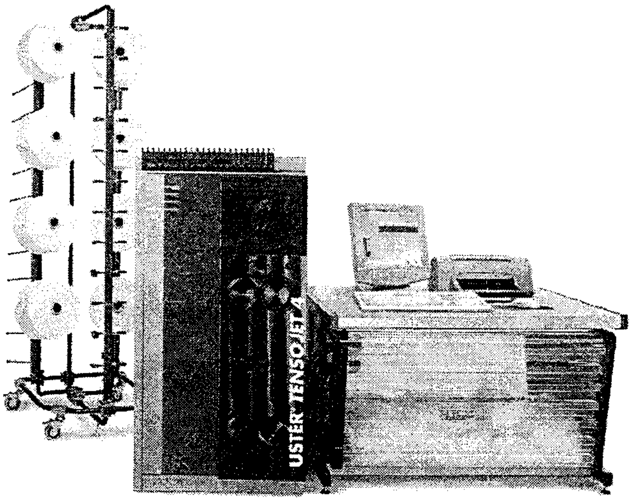
This is mainly analyzed to check whether the strength of the yarn has decreased after the alkali treatment.Along with single yarn strength, Elongation tenacity and B-work is tested.

Breaking force(Single yarn strength): Maximum force value measured during the tensile test.

Breaking elongation: Elongation at maximum breaking force value.

Tenacity: Breaking force in relation to the yarn count of the sample.

Breaking work: Work done to break (enclosed area below the force/elongation characteristic curve up to the point of breaking force).

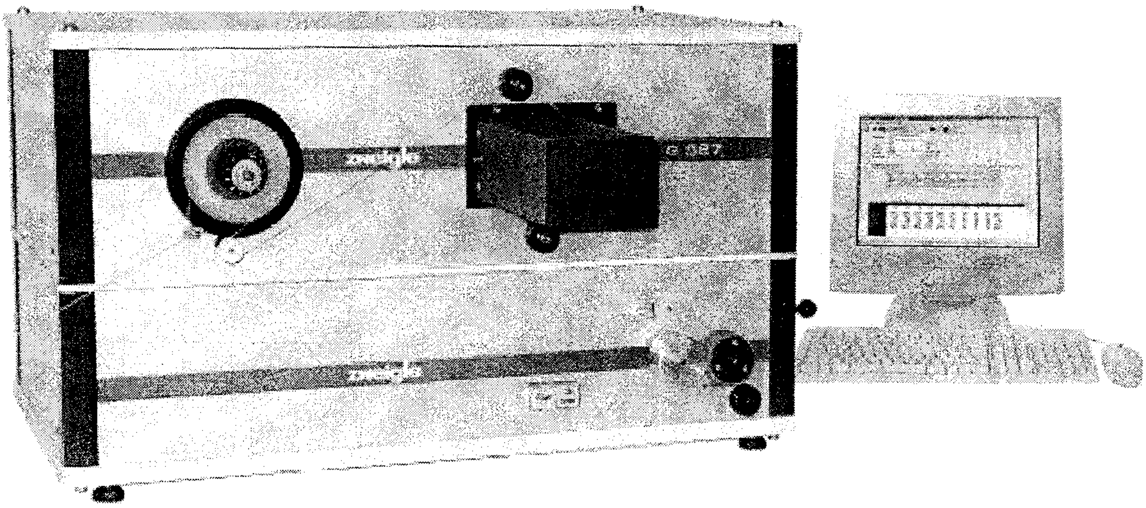


The yarn is tested for the above parameters using **USTER TENSOJET 4**. It works on the principle of **CONSTANT RATE OF EXTENSION**.The yarn in the package is fed to the machine and is automatically hold by the clamps. The test length of the yarn is 500 mm.The clamp/testing speed is 400 m/min.The reading are noted and assessed.

4.9.2..3HAIRINESS:

It refers to the number of protruding hairs on the unit surface of the spun yarn.

The S3 value and Hairiness index of the yarn samples before and after the treatment are tested.



This testing is done in Zweigle G566 machine. Measurement is performed by a newly developed optical measuring head with laser light source having extremely long working life at constant light output.· G 566 covers 9 length zones from 1 mm to 15 mm fibre length in one pass, producing objective reproducible data.· G 566 is controlled by a PC that also undertakes analysis of the test results. Any desired number of measurements can be made on a bobbin. The pretension is set at 5cN. Each yarn sample tested is of 100 m each and 10 readings are taken per cone.

4.9.2.4 WICKABILITY:

The ability of a material to not only absorb sweat but to actually move it away from our bodies.

1.For this test, the yarn is tied at one end to a scale and the other end is placed on the surface of colored water

2. The distance the water travels up the material is measured at various intervals over thirty minutes.

3. The distance is measured in centimeters.

4. A good "wickable" yarn will transport all the water straight up.

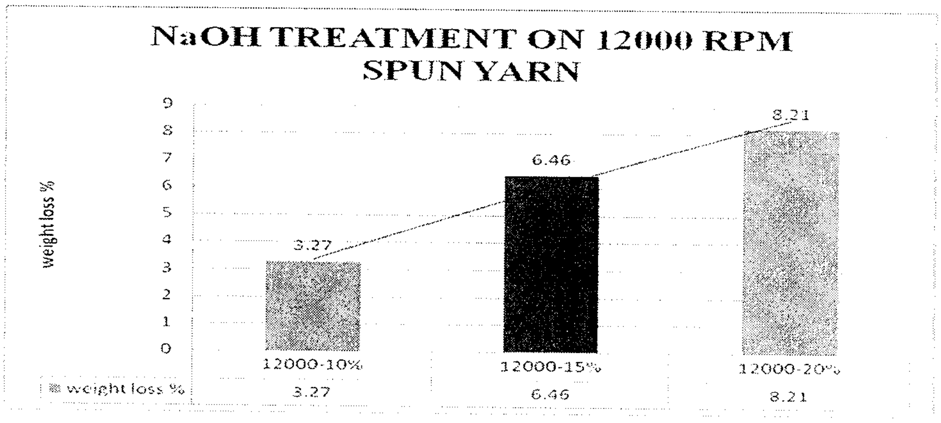
4.9.2.5 WEIGHT LOSS %

1. Weight loss is the Amount weight lost by the yarn after the yarn is treated with the alkali treatment.
2. Initial weight of the yarn in skein form is noted.
3. Yarn is treated with a alkali solution
4. Final weight of the yarn skein is noted before rereeling.
5. Weight Loss is calculated in percentage.

5. RESULTS AND DISCUSSION

5.5. WEIGHT LOSS %

CHART - 1

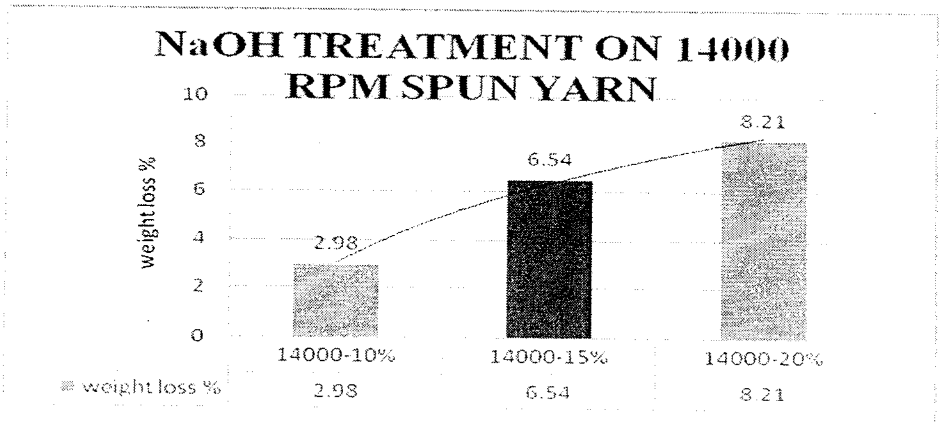


$y = 3.349x0.853$

$R^2 = 0.985$

% WEIGHT LOSS DIFF	COMPARING 12000-10% WITH 12000-15% ↑	COMPARING 12000-15% WITH 12000-15% ↑	COMPARING 12000-10% WITH 12000-20% ↑
	49.38%	21.31%	60.17%

CHART -2

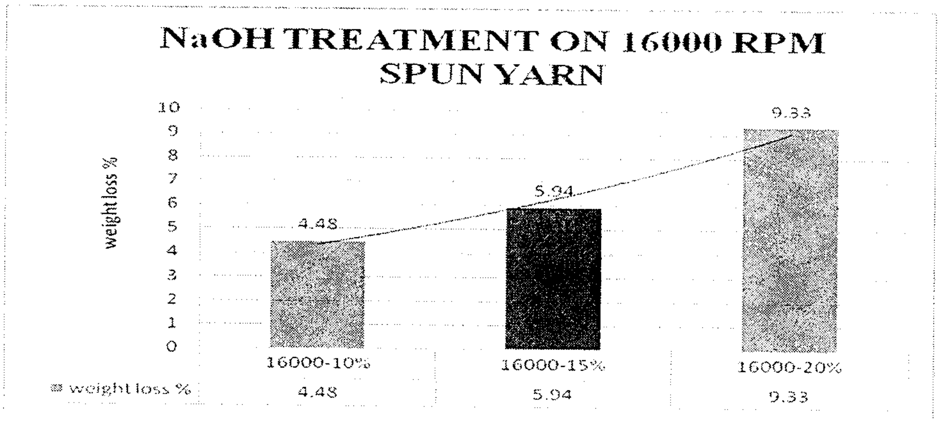


$y = 4.801\ln(x) + 3.042$

$R^2 = 0.996$

% WEIGHT LOSS DIFF	COMPARING 14000-10% WITH 14000-15%	COMPARING 14000-15% WITH 14000-15%	COMPARING 14000-10% WITH 14000-20%
	54.43 %↑	20.34%↑	63.70%↑

CHART -3



y = 3.017e0.366x

R^2 = 0.982

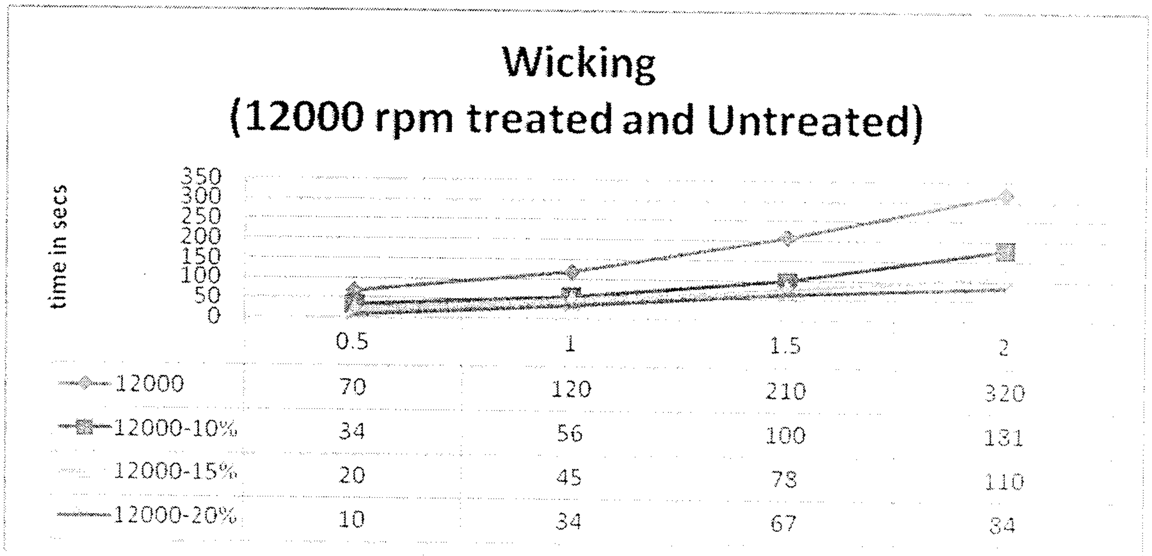
% WEIGHT LOSS DIFF	COMPARING 16000-10% WITH 16000-15%	COMPARING 16000-15% WITH 16000-15%	COMPARING 16000-10% WITH 16000-20%
	24.57% ↑	36.33% ↑	51.98% ↑

Weight loss is mainly due to the hydrolysis reaction took place in the fibers. When the time and concentration of the treatment increases, the weight loss is increases. So Strength of the yarn decreases.

The weight loss is due to the rupture of polyester fiber surface and the alkali absorbed by the fibers. The sample consists of polyester / cotton, the polyester surface of the fiber get ruptured due to the Hydrolysis reaction. In cotton, swelling takes place.Weight loss is more in the 20% concentration. There is a moderate weight loss 10% interval. As the concentration gets increased the weight loss % also get increased.

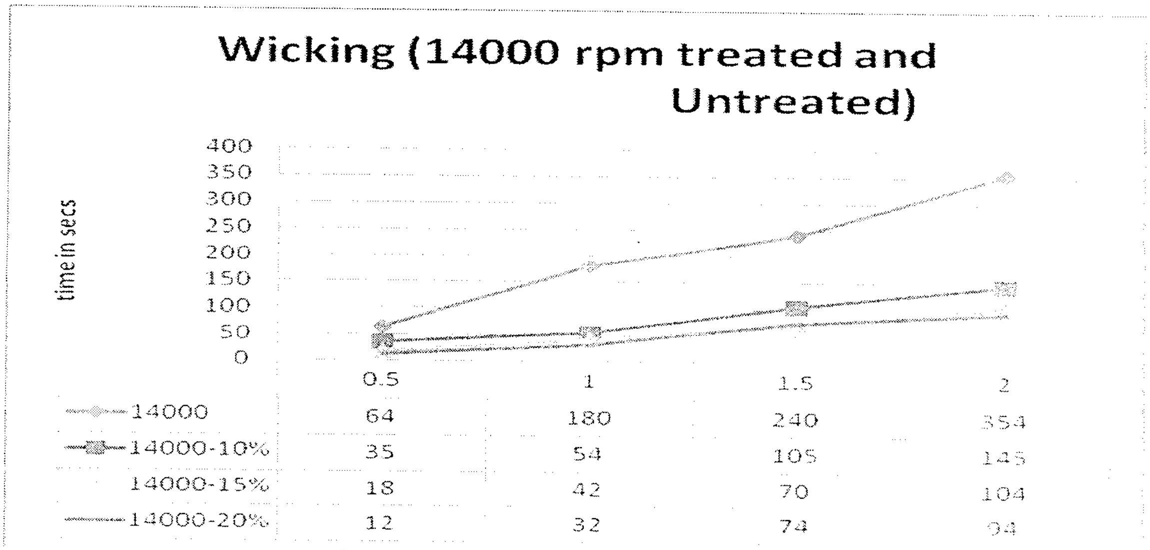
5.6. WICKABILITY

CHART – 4



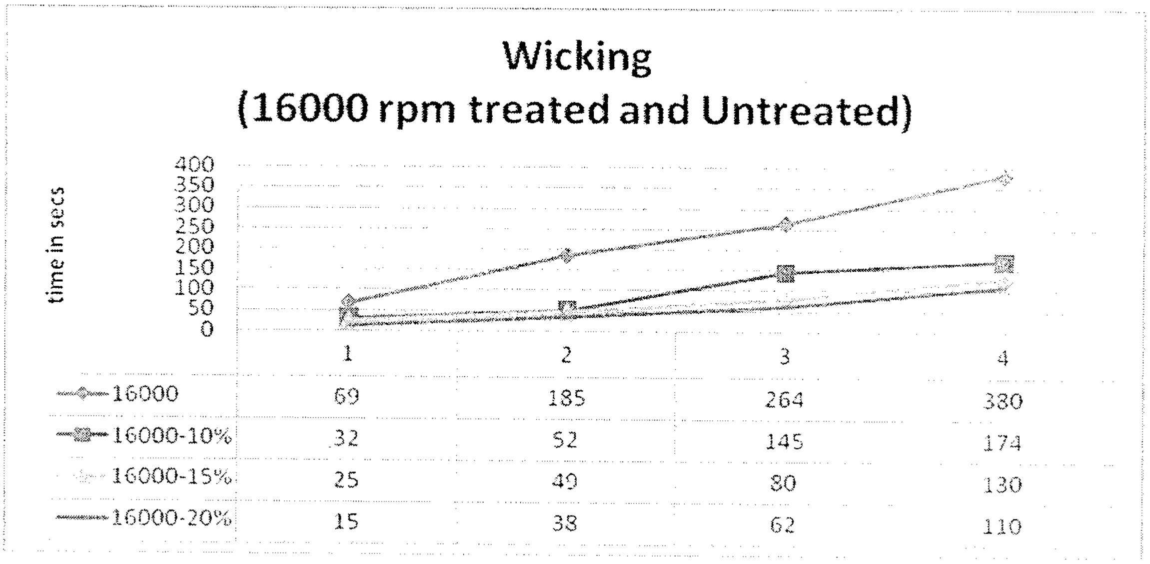
	0.5	1	1.5	2
12000	70	120	210	320
12000-10%	34	56	100	131
12000-15%	20	45	78	110
12000-20%	10	34	67	34

CHART-5



	0.5	1	1.5	2
14000	64	180	240	354
14000-10%	35	54	105	145
14000-15%	18	42	70	104
14000-20%	12	32	74	94

CHART-6



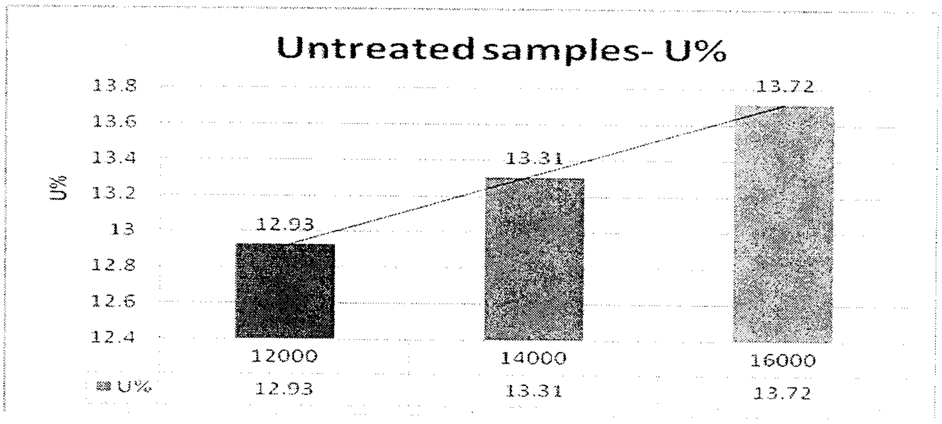
	1	2	3	4
16000	69	185	264	330
16000-10%	32	52	145	174
16000-15%	25	49	80	130
16000-20%	15	38	62	110

It was observed that there is a excellent correlation between the Concentartion of NaOH and time required for the rise of water in yarn suspended from a height of 7 cms. The water was unable rise over 2cm length of the yarn.. The maximum dropped value is at 20% concentration at 30 minutes because the weight loss is more.

Water drop absorbancy time decreases after the treatment of the yarn with Sodium hydroxide. In the polyester the hydrophilic groups such as COOH and OH groups are get increased. The factors that influence the water drop absorbancy is polyester / cotton blend ratio, yarn weight . At the 20% concentration the water absorbancy time get decreased. Water drop absorbancy time is reduced up to 65%.

5.4. UNEVENESS %

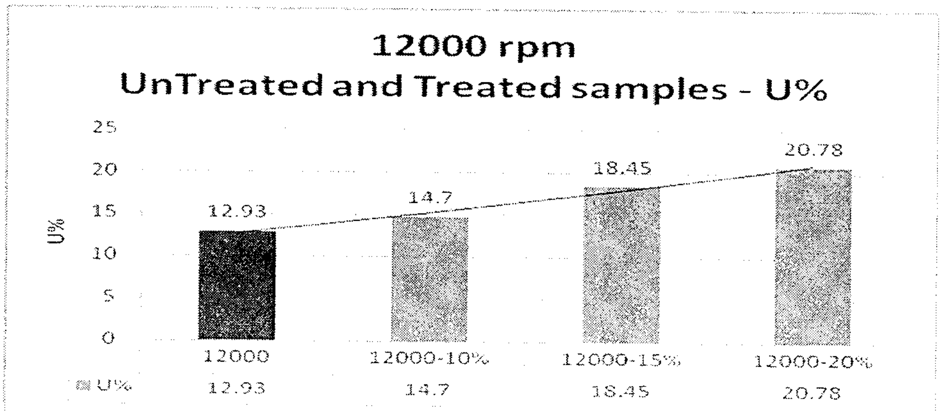
CHART -7



y = 0.395x + 12.53
$R^2 = 0.999$

% DIFF IN U%	COMPARING 14000 WITH 12000 ↑	COMPARING 16000 WITH 14000 ↑	COMPARING 16000-WITH 1200 ↑
	2.85%	2.98%	5.97%

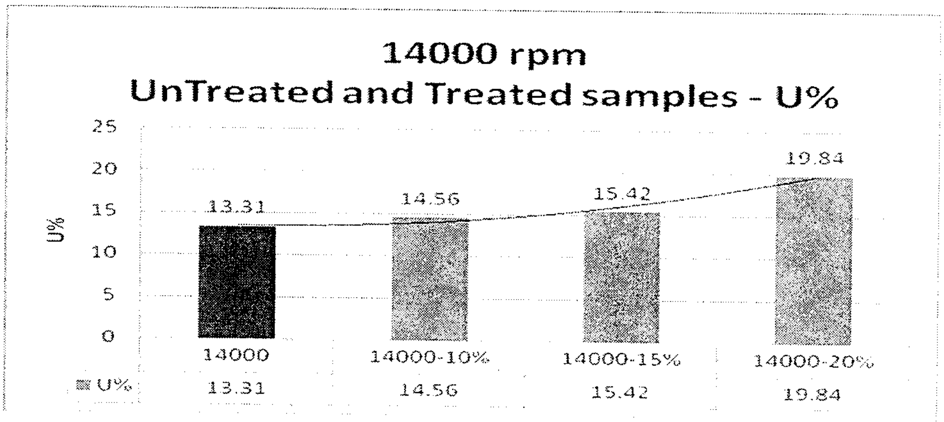
CHART- 8



y = 0.14x² + 2.03x + 10.59
$R^2 = 0.984$

% DIFF IN U%	COMPARING 12000-10% WITH 12000-raw	COMPARING 12000-15% WITH 12000-10%	COMPARING 12000-20% WITH 12000-15%	COMPARING 12000-15% WITH 12000-raw	COMPARING 12000-20% WITH 12000-raw
	12.04%	↑20.32%	↑ 11.21% ↑	29.91%↑	37.7↑%

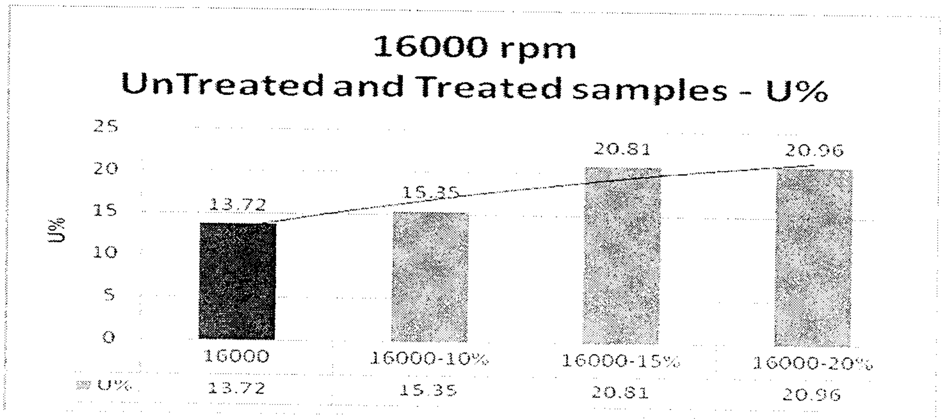
CHART -9



$$y = 0.792x^2 - 1.917x + 14.63$$
$$R^2 = 0.967$$

% DIFF IN U%	COMPARING 14000-10% WITH 14000-raw	COMPARING 14000-15% WITH 14000-10%	COMPARING 14000-20% WITH 14000-15%	COMPARING 14000-15% WITH 14000-raw	COMPARING 14000-20% WITH 14000-raw
	8.58% ↑	5.57% ↑	22.27% ↑	13.68% ↑	32.91% ↑

CHART - 10



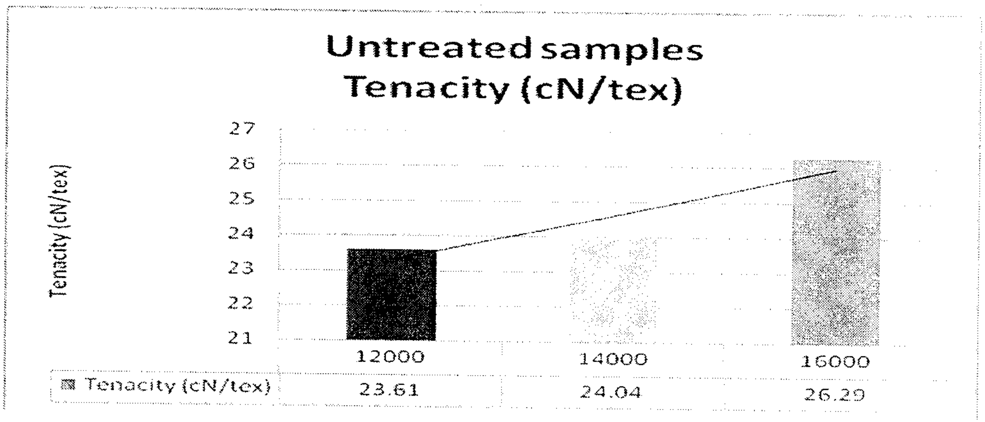
$$\mathbf{y = -0.37x2 + 4.568x + 9.065}$$
$$\mathbf{R^2 = 0.899}$$

% DIFF IN U%	COMPARING 16000-10% WITH 16000-raw	COMPARING 16000-15% WITH 16000-10%	COMPARING 16000-20% WITH 16000-15%	COMPARING 16000-15% WITH 16000-raw	COMPARING 16000-20% WITH 16000-raw
	10.61% ↑	26.23% ↑	0.7156% ↑	34.07% ↑	34.54% ↑

The readings obtained show that as the spindle speed and conc of NaOH increases the unevenness percentage increases. order of variation. The lowest U% is found in Untreated 12000 rpm spun yarn. But the % diff in U% between the spindle speeds are very much low and it showed less impact on U%. But action of NaOH on the yarn samples is in increasing trend of U%. Around 20-35 % increase of U% is noticed in the yarn samples

5.3. TENACITY

CHART - 11

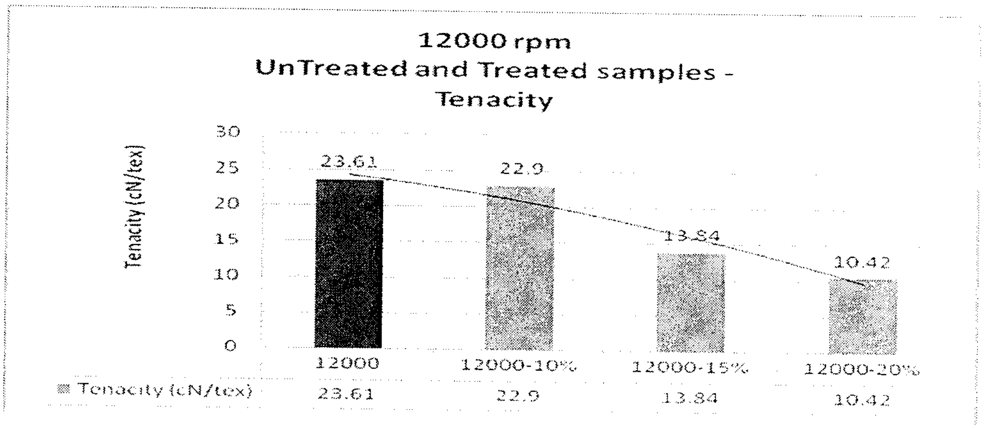


$y = 22.11e^{0.053x}$

$R^2 = 0.871$

% DIFF IN TENACITY	COMPARING 14000 WITH 12000	COMPARING 16000 WITH 14000	COMPARING 16000 WITH 12000
	1.79 ↑	8.79 ↑	10.19% ↑

CHART -12

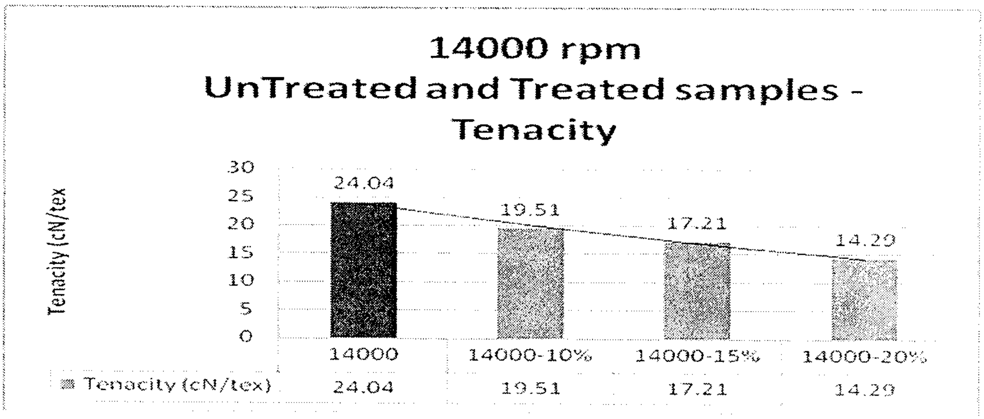


$y = -0.677x2 - 1.475x + 26.46$

$R^2 = 0.924$

% DIFF IN TENACITY	COMPARING 12000-10% WITH 12000-raw	COMPARING 12000-15% WITH 12000-10%	COMPARING 12000-20% WITH 12000-15%	COMPARING 12000-15% WITH 12000-raw	COMPARING 12000-20% WITH 12000-raw
	3.01% ↓	39.56% ↓	24.71% ↓	29.91 ↓	37.77 ↓

CHART – 13

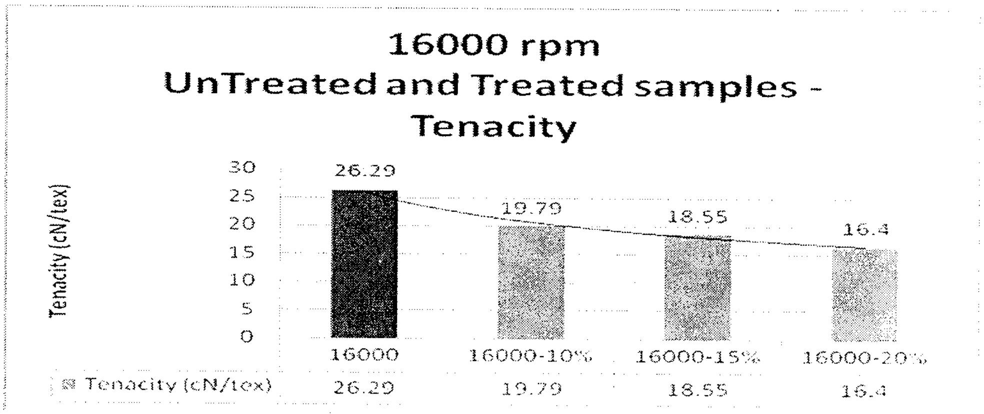


y = 28.09e-0.16x

R² =0.991

% DIFF IN tenacity	COMPARING 14000-10% WITH 14000-raw	COMPARING 14000-15% WITH 14000-10%	COMPARING 14000-20% WITH 14000-15%	COMPARING 14000-15% WITH 14000-raw	COMPARING 14000-20% WITH 14000-raw
	18.84% ↓	11.79% ↓	16.96% ↓	28.41% ↓	40.55% ↓

CHART – 14

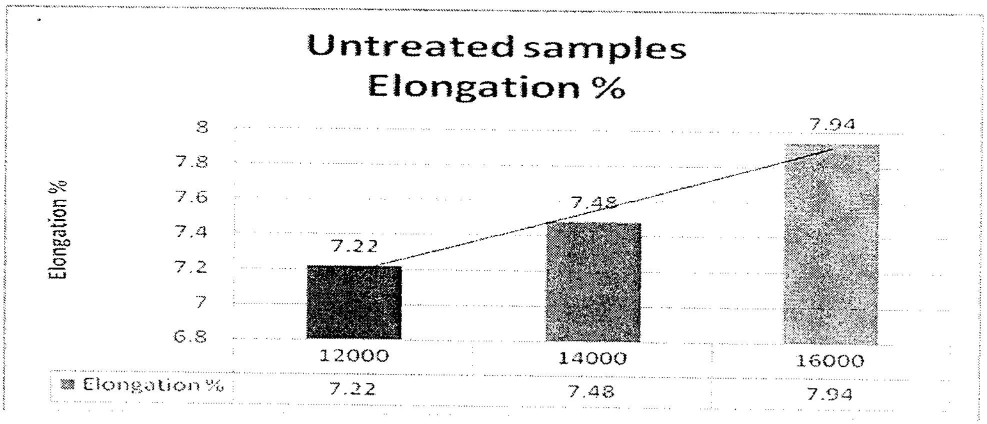


y = 25.90x-0.32 **R² = 0.977**

% DIFF IN TENACITY%	COMPARING 14000-10% WITH 14000-raw	COMPARING 14000-15% WITH 14000-10%	COMPARING 14000-20% WITH 14000-15%	COMPARING 14000-15% WITH 14000-raw	COMPARING 14000-20% WITH 14000-raw
	18.84% ↓	11.79% ↓	16.96% ↓	28.41% ↓	40.55% ↓

ELONGATION %:

CHART – 15

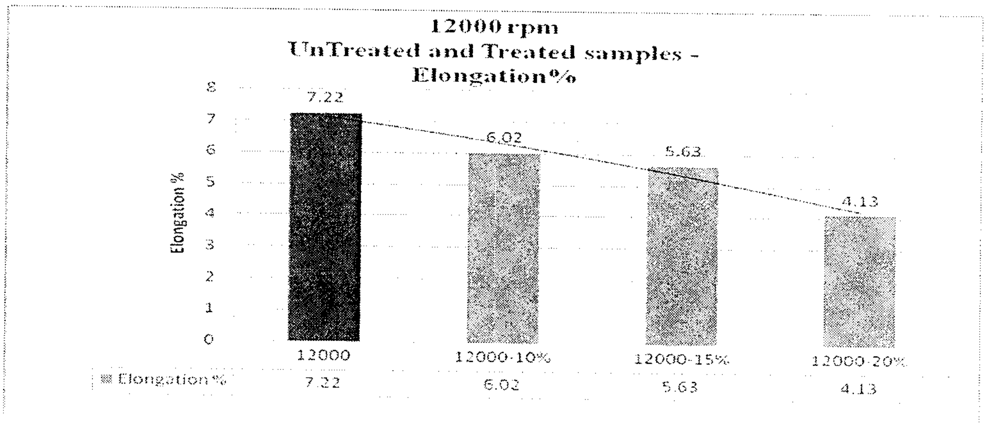


$y = 6.857e^{0.047x}$

$R^2 = 0.978$

% DIFF IN TENACITY	COMPARING 14000 WITH 12000	COMPARING 16000 WITH 14000	COMPARING 16000 WITH 12000
	3.47%↑	6.14%↑	9.1% ↑

CHART – 16

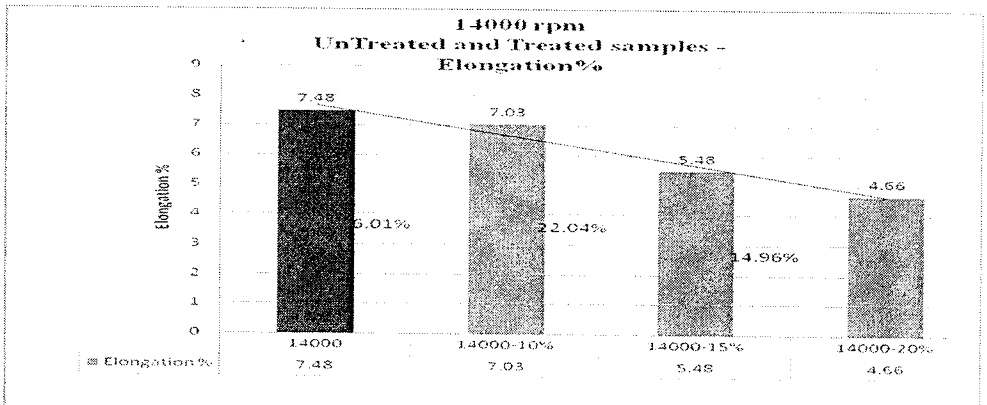


$y = -0.075x^2 - 0.591x + 7.79$

$R^2 = 0.962$

% DIFF IN Elongation%	COMPARING 12000-10% WITH 12000-raw	COMPARING 12000-15% WITH 12000-10%	COMPARING 12000-20% WITH 12000-15%	COMPARING 12000-15% WITH 12000-raw	COMPARING 12000-20% WITH 12000-raw
	16.62%	↓ 6.47%↓	26.64% ↓	22.02%↓	42.79%↓

CHART – 17

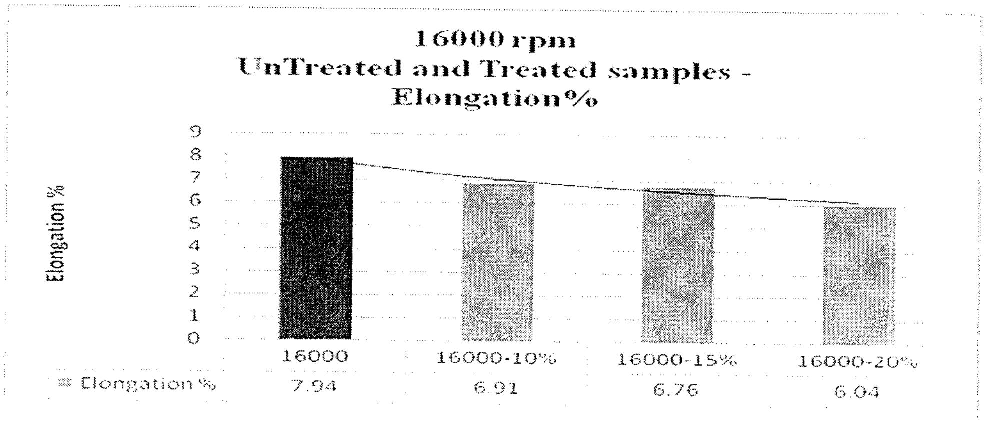


y = -1.001x + 8.665

R² = 0.961

% DIFF IN Elongation%	COMPARING 14000-10% WITH 14000-raw	COMPARING 14000-15% WITH 14000-10%	COMPARING 14000-20% WITH 14000-15%	COMPARING 14000-15% WITH 14000-raw	COMPARING 14000-20% WITH 14000-raw
	6.01%↓	22.04%↓	14.96%↓	26.73%↓	37.7%↓

CHART – 18



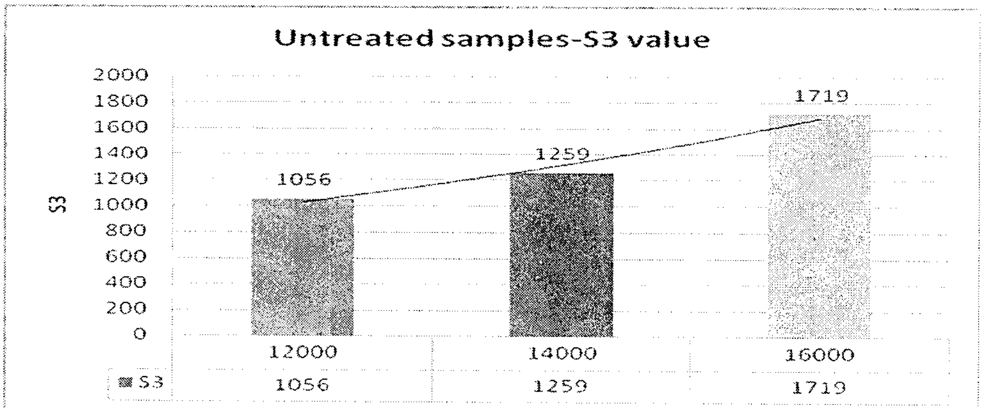
y = -1.27ln(x) + 7.922 R² = 0.952

% DIFF IN Elongation%	COMPARING 16000-10% WITH 16000-raw	COMPARING 16000-15% WITH 16000-10%	COMPARING 16000-20% WITH 16000-15%	COMPARING 16000-15% WITH 16000-raw	COMPARING 16000-20% WITH 16000-raw
	12.97% ↓	2.17% ↓	10.65%↓	14.86%↓	23.92%↓

Tenacity tends to increase slightly as the spindle speed is increased. The change is not more than (5-10)%. Tenacity of yarn tends to increase as the spindle speed is increased because the yarn is binded well as the spindles speed in increased. But Elongation % shows very light impact on the Elongation% of the yarn. This is in the order of (3-5) %. But after alkali treatment, the samples showed an decrease in Tenacity as well as Elongation % up to (10-15)% .Decrease in Tenacity is due to the breakage of bonds in polyester as well as mercerization in cotton. Both cause a great impact on Tenacity of the yarn. Elongation % tends to decrease as the yarn gets swelled and loses some of the crystalline regions.

S3 value:

CHART – 19

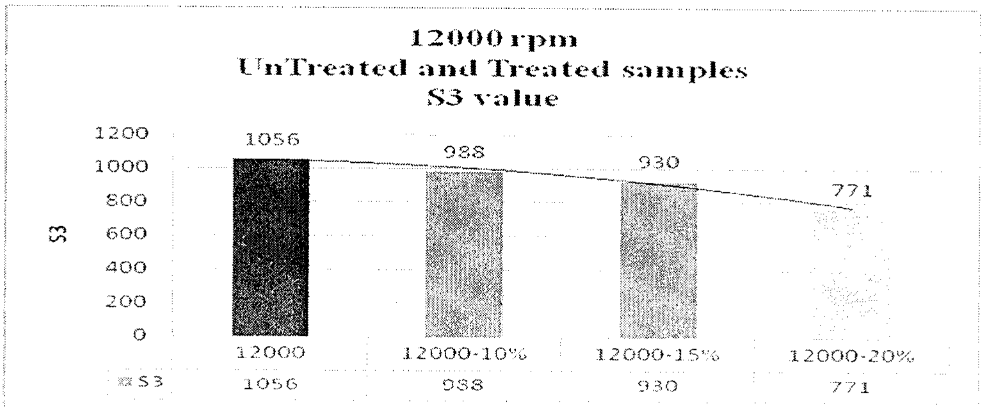


$y = 809.1e0.243x$

$R^2 = 0.974$

% DIFF IN TENACITY	COMPARING 14000 WITH 12000	COMPARING 16000 WITH 14000	COMPARING 16000 WITH 12000
	16.12% ↑	26.75% ↑	35.33% ↑

CHART – 20



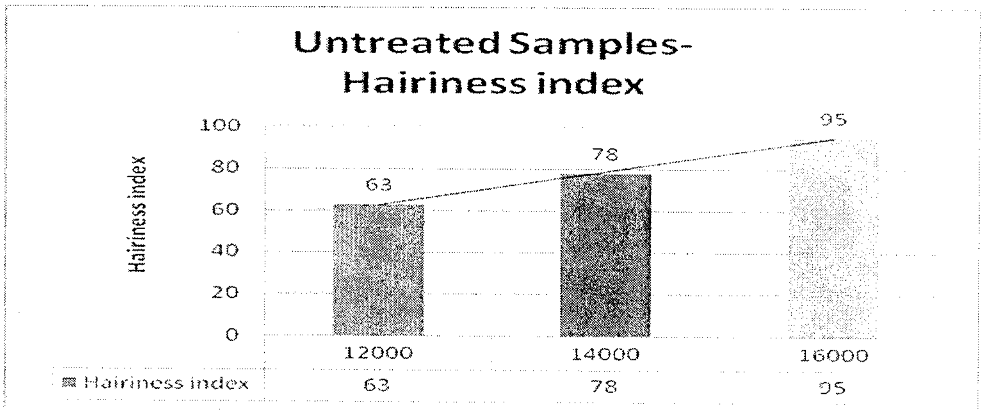
$y = -22.75x^2 + 22.45x + 1050$

$R^2 = 0.986$

% DIFF IN S3 value	COMPARING 12000-10% WITH 12000-raw	COMPARING 12000-15% WITH 12000-10%	COMPARING 12000-20% WITH 12000-15%	COMPARING 12000-15% WITH 12000-raw	COMPARING 12000-20% WITH 12000-raw
	6.43% ↓	5.87% ↓	17.09% ↓	11.93% ↓	26.98% ↓

HAIRINESS INDEX:

CHART – 23

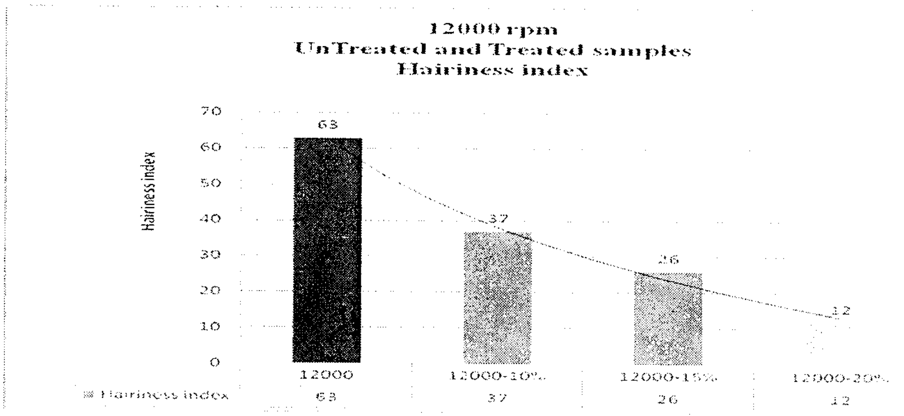


$y = 16x + 46.66$

$R^2 = 0.998$

% DIFF IN Hairiness index	COMPARING 14000 WITH 12000 ↑	COMPARING 16000 WITH 14000 ↑	COMPARING 16000 WITH 12000 ↑
	16.12%	26.75%	35.33%

CHART – 24



$y = -35.7\ln(x) + 62.93$

$R^2 = 0.993$

% DIFF IN Hairiness index value	COMPARING 12000-10% WITH 12000-raw	COMPARING 12000-15% WITH 12000-10%	COMPARING 12000-20% WITH 12000-15%	COMPARING 12000-15% WITH 12000-raw	COMPARING 12000-20% WITH 12000-raw
	41.26% ↓	29.72% ↓	53.82% ↓	58.73% ↓	80.95% ↓

7. CONCLUSION

- When the concentration of the treatment increases, the weight loss is increases. The weight loss increases up to 50% as the concentration is increased.Weight loss is minimum at 14000 rpm -10% NaOH.
- The wicking properties of the yarn tends to improve as the concentration of the NaOH is increased. Wicking is better for 14000 rpm -20% NaoH.
- U% increases as the spindle speed increases and conc of alkali decreases. Minimum of U% is by 12000-10% NaOH. But 14000 rpm at all conc., shows only minimum impact on yarn.
- Tenacity and Elongation %is increased as the spindles speed is increased and is found to be maximum at 16000 rpm spun yarn. But both showed negative impact on the alkali treatment.
- S3 value and Hairiness index increases as spindle speed is increased and decreases as the conc., of NaOH is increased. The minimum hariness is acheivced at 14000 rpm -20 % NaOH of yarn.
- To obtain optimum quality of yarn it is recommended the yarn is spun at 14000 rpm for Polyester/ cotton mix and subjected to 15% NaOH so that the mutual benefits of decrease in Hairiness with minimum weight loss is achieved.

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