



Thesis Report
On
**“Effects of Reductive Stripping of Reactive Dyes on
the Quality of 100% Viscose Knitted Fabric”**
Course Code: TEX-441

Submitted To

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All praises to Almighty Allah alone, the Most merciful and the most compassionate and His Holy prophet “ Muhammad “ (Peace be Upon Him) the most perfect and exalted one among and of ever born on the surface of earth, who is forever touch of guidance and knowledge for the humanity.

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Abstract

Reactive dyes cannot be stripped satisfactorily from cellulosic materials due to the formation of co-valent bonds between dye and fiber. This research was undertaken using around 5% bi-hetero reactive dyes trichromatic combination on pretreated viscose fabric and stripping was carried out in alkali reductive stripping process. The aim of the work was to investigate the effects of reactive dye stripping on the quality of viscose fabric. Stripping performance was evaluated in percentage by k/s analysis using spectrophotometer. Also Strength loss, weight loss, pilling resistance, absorbency and color fastness of stripped fabric were calculated for quality assessment. Though with the increase of concentration of stripping chemicals and temperature, stripping percentages were improved; processing damage to the fabric such as losses in strength, weight and pilling resistance ratings was found. In contrast, increased fabric absorbency was found due to stripping.

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Chapter -01
General Information

1.1 Introduction:

Around 10,000,000 tons of synthetic dyes are annually used in the world (Ghorpade et al. 2000; Goodarzian and Ekrami 2010; Saravanan et al. 2014) by various industries for coloring numerous materials. Textile industry accounts for two-thirds of the total dyestuff market (Anouzla et al. 2009; Riu et al. 1998; Shertate and Thorat 2013). Over 10,000 dyes with an annual production of over 7×10^5 metric tons are commercially available for use by this industry (Campos et al. 2001). However, some common problems of textile dyeing industries include uneven or faulty dyeing and formation of color patches on the fabric surface during dyeing and downstream processing of textiles materials (Fono and Montclair 1980; Ogulata and Balci 2007). Such problems in the finished quality of fabric are generally tackled through a chemical stripping process which is a common practice in dyeing industries for the deep shade batches. Stripping is one of the reproduction processes, used in textile finishing, removing dyes from colored fabric. The process is either termed as 'back stripping' or 'destructive stripping'.

In back stripping only the depth of shade is changed while in destructive stripping the dyes are chemically altered (Ali et al. 2012; Fono and Montclair 1980), such as dyes containing an azo group ($-N=N-$) can be chemically reduced to an almost colorless amine compound by using chemical reducing agents. Sometimes for the analysis of dyes or dyed fabrics, dyes may need to be stripped from the surface by either destructive or non-destructive methods. Non-destructive stripping is essential when the amount of dye on the fiber has to be estimated, or the dye has to be identified or analyzed by techniques such as chromatography. Laboratory methods for stripping dyes seldom mirror those used in bulk processing, since these are usually destructive methods based on strongly reductive or oxidative methods (Park and Shore 2004). Depending on the individual dyes, complete chemical stripping may be carried out in one of the four ways: reduction only; reduction followed by oxidation; oxidation only; and oxidation followed by reduction (Aspland 1997).

As sodium chlorite or peroxide solutions are used in oxidizing process, decreasing in strength of textile material is highly possible, so alkali reductive application is generally preferred for the stripping of reactive dyes. The mechanism of reductive stripping depends on the type of dyes,

fibers and reducing agents. Dyes are commonly stripped from fabric using a reducing agent, and a stripping assistant which is used to enhance the stripping efficiency of a reducing agent. Various chemical combinations of reducing agents and stripping assistants are being used in stripping liquids to strip the dye from fabric(Chavan 1969).The reductive stripping occurs from chemical reactions in case of cellulose dyed with reactive dyes.

The chemical bonds on the chromophore group of reactive dyes are tried to break in order to dissolve of colorfulness. Reactive dyes cannot be stripped satisfactorily from cellulosic materials, due to the formation of co-valent bond between dye and fiber(Choudhury 2006). The stripping performance depends on several factors: raw materials, type of dyestuff, method of dyeing and stripping, type of stripping agents and auxiliaries, and working parameters such as time, temperature etc. Achieving the expected efficiency in the application of stripping process is a very important aspect for the success of reproduction (Ogulata and Balci 2007). However, alkaline reductive stripping also affects the quality of fabric as harsh chemicals such as sodium hydrosulphite and sodium hydroxide as well as high temperature is applied in the stripping process, but the effects are at what extent? The aim of this study was to evaluate such effects of dye stripping on the quality of viscose fabric.

Chapter -02
Literature Review

2. Literature Survey:

2.1. ViscoseFabric:

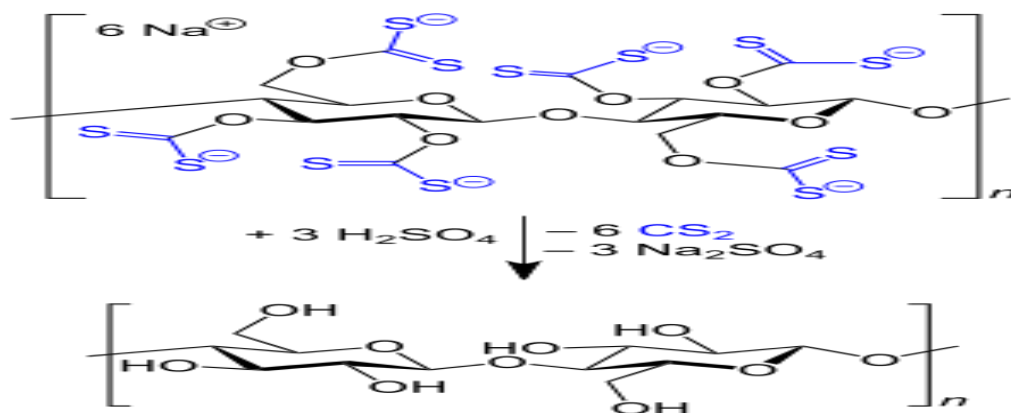
Viscose is both a semi-synthetic fabric formerly called viscose rayon or rayon and a solution of cellulosexanthate produced by treating dissolving pulp with aqueous sodium and carbon used to spin the viscose rayon fiber. Byproducts of the production process include sodium thiocarbonate, sodium carbonate, and sodium sulfide. Viscose rayon fiber is a soft fiber commonly used in dresses, linings, shirts, shorts, coats, jackets, and other outer wear; it is also used in industrial yarns (tyre cord), upholstery and carpets. It is also used in the casting of Cellophane.

2.1.1. History:

French scientist and industrialist Hillarie de Chardon net (1838–1924) who invented the first artificial textile fiber, artificial silk—created viscose. British scientists Charles Frederick Cross and Edward John Bevan took out British patent no. 8,700, "Improvements in Dissolving Cellulose and Allied Compounds" in May, 1892. In 1893 they formed the Viscose Syndicate to grant licenses, and in 1896 formed the British Viscoid Co. Ltd. to exploit the process.

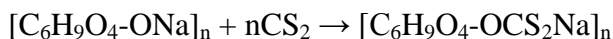
2.1.2. Manufacture:

Cellulose is treated with alkali and carbon disulfide to yield viscose.



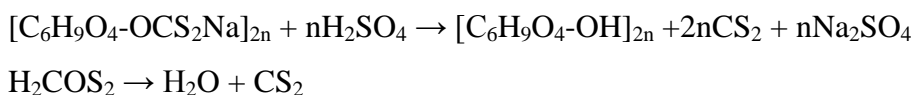
Rayon fiber is produced from the ripened viscose solutions by treatment with a mineral acid, such as sulfuric acid.

Viscose rayon is a fiber of regenerated cellulose; it is structurally similar to cotton but may be produced from a variety of plants such as soy, bamboo, and sugar cane. Cellulose is a linear polymer of β -D-glucose units with the empirical formula $(C_6H_{10}O_5)_n$. To prepare viscose, dissolving pulp is treated with aqueous sodium hydroxide (typically 16-19%) to form "alkali cellulose," which has the approximate formula $[C_6H_9O_4-ONa]_n$. The alkali cellulose is then treated with carbon disulfide to form sodium cellulose xanthate.



The higher the ratio of cellulose to combined sulfur, the lower the solubility of the cellulose xanthate. The xanthate is dissolved in aqueous sodium hydroxide (typically 2-5% w/w) and allowed to depolymerize to a desired extent, indicated by the solution's viscosity. The rate of depolymerization (ripening or maturing) depends on temperature and is affected by the presence of various inorganic and organic additives, such as metal oxides and hydroxides. Air also affects the ripening process since oxygen causes depolymerization.

Rayon fiber is produced from the ripened solutions by treatment with a mineral acid, such as sulfuric acid. In this step, the xanthate groups are hydrolyzed to regenerate cellulose and release dithiocarbonic acid that later decomposes to carbon disulfide and water.



Aside from regenerated cellulose, acidification gives hydrogen sulfide, sulfur, and carbon disulfide. The thread made from the regenerated cellulose is washed to remove residual acid. The sulfur is then removed by the addition of sodium sulfide solution and impurities are oxidized by bleaching with sodium hypochlorite solution. The use of viscose is declining, in part because of the environmental costs of its production. Instead, rayon may be manufactured using the Lyocell process, which uses N-Methylmorpholine N-oxide as the solvent and produces little waste product, making it relatively eco-friendly.

2.1.3. Advantages and Disadvantages of Viscose Fabric:

Advantages:

Fabric which is made from viscose yarn is that takes dyes very well, so that, we can work with a wide variety of colors. Viscose fabric is very shiny; also it stays bright and colorful throughout the life of the products made with it. So, if you want to work with various kind of bold and colorfast fabric then you can choose viscose.

Disadvantages:

1. Fabric tearing possibility is very high during the dyeing process.
2. If the fabric remain wet for long times then some spot creates on it's, which removal process is very difficult. But in cotton fabric we can do this very easily.
3. If the fabric dyed uneven then it is very difficult to remove.
4. During the dyeing process if we fail to maintain the temperature & pressure properly then fabric strength will be reduce.

2.2. Dyestuff:

The historical development of the synthetic dyestuffs dates back to 1856, when eighteen year old, W.H. Perkin discovered the synthesis of Mauveine, a basic dye, by accident, while he was engaged in the study of the action of potassium dichromate on aniline sulphate. He successfully converted the process he had developed in laboratory to a large-scale production, and demonstrated the application of the dye on silk. The intermediates nitrobenzene and aniline required in the production were also made commercially by him. Nitrobenzene was earlier prepared by Mansfield in 1847

2.2.1. Definition of dye:

A dye is a colored organic compound that absorbs light strongly in the visible region and can firmly attach to the fiber by virtue of chemical and physical bonding between group of the dye and group on the fiber. To be of commercial importance a dye should be fast to light, rubbing and water. Color and dye have always played an important role in the life of man from time immemorial.

2.2.2. Some Control parameter of dyeing:

Process parameters

- Internal fabric pH.
- Working liquor ratio on the machine.
- Effective salt concentration (actual).
- Effective alkali concentration (actual).
- Rate of heating.
- Rate of cooling.
- Fixation temperature.

Raw materials

- Water.
- Common chemicals (Salt, Alkali).
- Specialty chemicals (Auxiliaries).
- Reactive dyestuffs.

Dye Bath pH

For most of dyes optimum pH is 10.5 to 11.5 at 20-25°C soda ash is the best alkali for dyeing at 70°C for viscose, mercerized viscose & linen. Increased fixation (due to higher temperature) & increased dye bath stability & better reproducibility are advantages of soda ash as fixing agent.

Dyeing Temperature

As increase in temperature affects rate of physical & chemicals processes involved in dyeing, it is important in reactive dyeing also. Affinity of dye for fiber decreases with increases in temperature (dyeing is an exothermal reaction), & at same time rate of dye hydrolysis increases, adversely affects color yield fixation. However, rate of diffusion of dye in fiber increases with increased temperature. At temperatures lower than 20°C, rate of fixation is very low. Hence for most of dyes a temperature, while for some others' dyeing at 50-60°C with sodium bicarbonate as alkali gives maximum color value.

Electrolyte Concentration

Since reactive dyes have low affinity for cellulose, exhausting dye bath can increase fixation, by adding common salt or Glauber's salt prior to fixation. Amount of salts required to produce adequate exhaustion decreases with decreasing liquor ratio.

Dyeing Cycle Time

Generally, dye may be added in two portions. Salt may also be added in two lots. Exhaustion takes place in 20-30 mins. Alkali is then added in 2 lots (also in Progressive dosing system developed by Hoechst) & dyeing is continued for 30-90 mins. Shade depth & dye reactivity decides dyeing time. For deeper shades, longer times are required.

Liquor Ratio

With increased liquor ratio, both exhaustion & fixation takes place to increased extent. However, rate of fixation of most of dyes is not significantly affected. As liquor ratio is decreased, effectiveness of increasing salt addition also decreases. Hence lower amounts of salts are sufficient to get optimum exhaustion.

Color

Modern concept of color was founded in 1774 by Isaac Newton.

Newton separated white day light in to a sequence of colored light call spectrum (VIBGYOR).

According to the committee of colorimetric of the optical society of America:

Color is the sensation which occurs when light enters the Eyes. It is rising from the activity of the retina of the eye and its attached nervous mechanisms. This activity is being, in nearly every case in the normal individual a specific response to radiant energy of certain wavelength and intensity.

The hue refers to the actual color sensation (red, blue, yellow), the sensation or Chroma (depth of color) to the degree of differentiation from grey (dull or vivid), and lightness to the amount of light reflected from the object (light or dark). In the Mansell color system, these attributes are assigned alphabetic and numerical levels.

Light

That aspect of radiant energy of which a human observer is aware through visual sensations arising from stimulation of the retina by the radiant energy. The wavelength of perceived colors of visible spectral light are between 380 to 740 (as shown in table one).

Dyeing of Hot Brand Reactive dyes

In this case dye is not as reactive as cold brand dyes & hence higher temperatures are required for achieving adequate fixation. Dye bath pH depends on dyeing temperature, is in range of 70°C-100°C for viscose. As with cold brand reactive dyes, & increase in temperature generally results in weaker shades of hot brand reactive dyes because of decreased affinity at higher temperatures & consequent reduced fixation. Similarly lower temperatures reduce reactivity & hence produce lower color value unless dyeing time is prolonged or pH is increased larger amounts of common salts should be used for exhaustion (5g/l, 15g/l, 30 g/l for shades of up to 1.3%, 3.5% & 0.02 % respectively). Dyeing time is generally same as in case of cold brand reactive dyes.

Finishing

After completion of dyeing process dyed substrate, is rinsed with cold water. Then soaping is carried out to remove hydrolysed dye present on fiber. This dye reacted with water molecule, hence is called hydrolysed dye & remains unreacted on fiber surface. Soaping treatment thus

removes unreacted dye present on fiber thus improving fiber brilliancy. Then few hot washes are given & with one cold wash it is sent for drying.

2.2.3. Reactivity & Affinity of Dyes:

If reactivity of dye is increased considerably, reaction rate with fiber increases. So, dyeing can be carried out in a very short time. However, here, dye hydrolysis rate also increases, leading to deactivation of part of dye resulting in dye wastage. If, on other hand, dye reactivity is decreased, extent of hydrolysis can be reduced considerably that, how ever results in slower reaction rate with fiber also. Ultimate dyeing object is to react as much of dye as possible with fiber with minimum dye hydrolysis, is actually achieved in 2 stages:

- ♦ 1st from aqueous medium under neutral conditions when dye does not react with fiber or with water, Then Common salt is added to exhaust dye onto fiber as much as possible.
- ♦ 2nd step of dyeing i.e. fixation of dye on fiber is carried out by adding alkali (usually soda ash).

Since exhausted dyes are already on fiber, it is more likely that exhausted dye reacts with fiber in preference to water.

2.2.4. How Do Dyes Stick To Fibers?

This depends on the dye and the fiber to which the dye is attached. Viscose is a polymer with a string of glucose units joined together. Viscose is soaked in a colorless solution of the reduced form. This is then oxidized to the blue form of Indigo which precipitates in the fibers. Fiber reactive dyes actually form covalent bonds with fiber molecules and are therefore extremely color fast. A dye molecule is reacted with the molecule trichlorotriazine: Trichlorotriazine can react with either –OH groups (present in Viscose) thus effectively bonding the dye to the fabric.

2.2.5. Influencing Factors of Dyeing:

1. Salt.
2. Soda.
3. Time.
4. Temperature.
5. pH .
6. Wetting agent.
7. Sequestering agent.
8. Anti-creasing agent.
9. Leveling agent.

All of these above are important in dyeing but we have worked with time, temperature, and pH.

2.2.6. Reactive Dye:

In a reactive dye a chromophore contains a substituent that reacts with the substrate. Reactive dyes have good fastness properties owing to the bonding that occurs during dyeing. Reactive dyes are most commonly used in dyeing of cellulose like cotton or flax, but also wool is dye able with reactive dyes. Reactive dyeing is the most important method for the coloration of cellulosic fibers.

2.2.7. Properties of reactive dye:

1. Reactive dyes are anionic dyes which are used for dyeing cellulosic protein polyamide fibers.
2. Reactive dyes are found in powder, liquid and print paste form.
3. During dyeing, the reactive group of this dye forms covalent bond with fiber polymer and becomes an integral part of fiber.
4. Reactive dyes are soluble in water.
5. They have very good light fastness with rating about 6.
6. The dyes have very stable electron arrangement and the degrading effect ultraviolet ray.
7. Reactive dyes give brighter shades and have moderate rubbing fastness.

8. Reactive dyes are comparatively cheap.
9. Reactive dyes have good perspiration fastness with rating 4-5.
10. Fixation occurs in alkaline condition.

2.2.8. Reactive Dye & Dyeing Method of Reactive Dye:

Reactive dyes are probably the most popular class of dyes to produce 'fast dyeing' on piece goods. These were first introduced a little over 40 years based on a principle which has not been used before. These dyes react with fiber forming a direct chemical linkage which is not easily broken. Their low cost, ease of application, bright shades produced by them coupled with good wash fastness make them very popular with piece good dyers.

Theory:

A dye which is capable of reacting chemically with a substrate to form a covalent dye-substrate linkage is known as a reactive dye.

Here the dye contains a reactive group and this reactive group makes covalent bond with the fiber polymer and act as an integral part of fiber. This covalent bond is formed between the dye molecules and the terminal -OH (hydroxyl) group cellulosic fibers or between the dye molecules and the terminal amino (-NH₂) group of polyamide fibers.

The general formula of reactive dye can be written as following

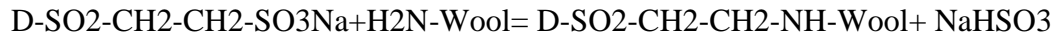
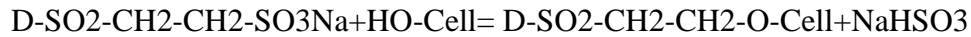
D-X-Y

Here,

- ♦ D=Dye part (color producing part).
- ♦ X=Bridge.
- ♦ Y=Functional group.

D-X-Y + Fiber = Fiber covalent bond.

This is shown in reactions below-



Here,

- ♦ D=dye part
- ♦ Wool=Wool polymer.
- ♦ Cell=Cellulose polymer.

2.2.9. Assistants Used For Dyeing With Reactive Dyes:

Salt

As a salt, NaCl is used widely. The salt end the following things-

1. Salt are used to increase the affinity of dye to fiber.
2. It decreases the hydrolysis rate of dyes.
3. It neutralize the electro negativity of fiber surface when immersed in solution.
4. It puts extra energy to push dye the fiber polymer ie increase absorption.

The amount of salt used depend upon the shade to be produced-

- ♦ For light shade -10-20 gm/litre salt is used.
- ♦ For medium shade-30-50 gm/litre is used.
- ♦ For deep shade-60-100 gm/litre is used.

Alkali

Alkali is used for the following purpose-

1. Alkali is used to maintain proper pH in dye bath & thus to create alkaline condition.
2. Alkali is used as a dye fixing agent.

3. With out alkali no dyeing will take place.
4. The strength of alkali used depend on the reactivity of dyes.
5. As strong alkali caustic (NaOH) is used to create pH 12-12.5 when the dye is of lower reactivity.
6. As medium alkali soda ash (Na₂CO₃) is used to create pH 11-12. when the dye is of medium reactivity
7. As weak alkali (NaHCO₃) is used to create pH 10-11. When the dye is of high reactivity.

Urea

Urea is used in continuous method of dyeing .It helps to get required shade of dye. To get dark shade more urea is used and for light shade less amount of urea used.

Soaping

By soaping the extra color is removed from fiber surface thus Wash fastness is improved.

Soaping increases the brightness and Stability of dye.

2.2.10. Chemistry of Reactive Dyes:

Reactive dyes differ from other coloring matters in that they enter in to chemical reaction with fiber during dyeing & so become a part of fiber substances. A reactive dye is represented as R-B-X, where, R-Chromogen, B-Bridging group X-Reactive system. When it reacts with fiber, F, it forms R-B-X-F. Wet fastness of dyed material produced, depends on stability of true covalent bond X-F.

2.2.11. Reactive Systems:

Reactive dyes are based on Cyanuryl chloride. Cold brand dyes (M brand) are based on di-chlorotriazinyl derivatives whereas "H" brands are mono-chlorotriazinyle derivatives. Reactivity of Chlorine atoms decreases greatly as they are successively substituted. Thus di-chloride derivative (M) is more reactive than mono chloro reactive (H) dyes. This is shown by fact that "M" dyes react readily with regenerated cellulose at room temperature in presence of mild alkalis such as sodium carbonate, where as "H" dyes need to be heated at least to 60C & require stronger

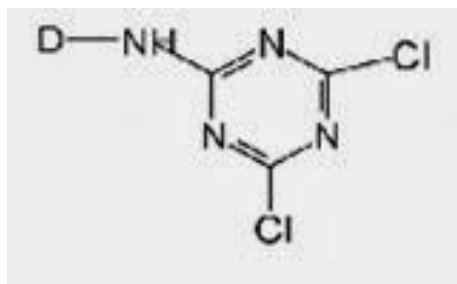
alkalinity before reaction take place at a reasonable rate. Other popular systems are based on Vinyl sulphones & tri-chloropyrimidyl.

2.2.12. Fiber-Reactive Dyes:

A fiber-reactive dye forms a covalent bond with appropriate textile functionality. It is important that once attached, they are very difficult to remove.

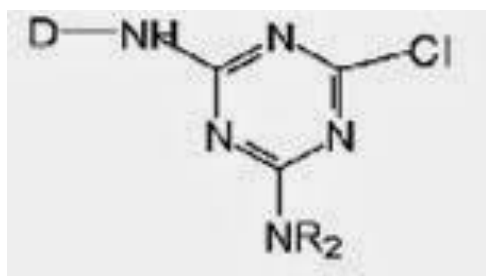
A. Dyes reacting through Nucleophilic substitution reactions

(1) Di-chloro-triazynilamino types of dyes:



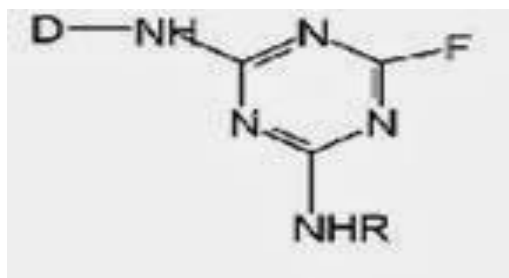
These are more reactive than mono-chloro type of dyes & require lower temperature & milder alkali for dyeing & fixation. These are known as Cold reactive dyes brand.

(2) Mono-chloro-triazynylamino type of dye:



These require higher temperature & stronger alkali for dyeing & fixation, are called hot brand reactive dye:

(3) Mono-fluoro-triazynylamino dyes:



(4) Bis-Triazinyl dyes.

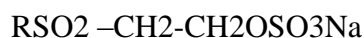
(5) Supra type of dyes.

(6) Di or tri-chloro-pyrimidylamino dyes

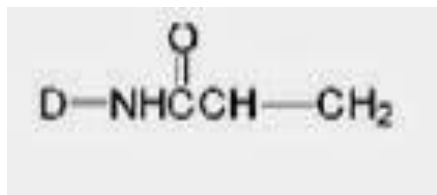
B. Dyes reacting through Nucleophilic addition reactions

(1) Dyes containing Vinyl sulphone group:

As such this is not soluble in water, so it is marketed in its soluble form i.e., β -hydroxy ethylene sulphonesulphuric acid ester derivatives

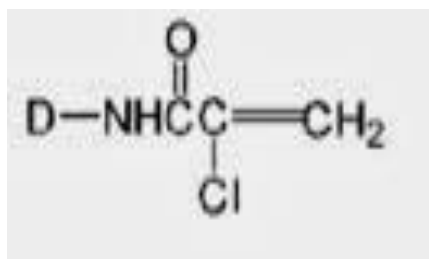


(2) Dyes containing Acrylamido group:



Carbonyl group is less powerfully electron withdrawing group & also reactivity is less as compared to vinyl sulphone type.

(3) α - chloroacrylamido dye:



Due to presence of chlorine atom, they are more reactive than acrylamido dyes.

2.2.13. Dyeing Method:

There are two different methods to transfer the dye from the liquor to the fiber:

Exhaust dyeing (Discontinuous systems)

The dye is dissolved or dispersed in the dyeing liquor. The material is immersed in the dyeing liquor and is removed only when the dye has mostly transferred onto the textile to be dyed, distributed homogeneously, well penetrated into the fiber and fixed. At the end of the process the material is washed or rinsed to remove the unfixed dye .

Pad dyeing (Continuous or semi-continuous systems)

This process is carried out using mechanical means (pad-batch wetting). The dyeing liquor is distributed homogeneously onto the fabric (i.e. also the dye is distributed homogeneously).

In a second stage the dye penetrates into the fabric and is then fixed. At the end of the process the material is washed.

Some operations must be carried out for both exhaust and pad dyeing:

- ♦ Dissolve or disperse the dye in water and filter.
- ♦ Achieve a homogeneous contact between the dyeing liquor and the fiber.
- ♦ Make the dye penetrate into the fiber.
- ♦ Fix the dye in the core of the fiber.
- ♦ Final washing.

2.2.14. Chemistry behind Reactive Dyeing:

Dyeing principle is based on fiber reactivity & involves reaction of a functional group of dyestuff with a site on fiber to form a covalent link between dye molecule & substance. 4 structural features of typical reactive dyes molecule are:

1. Chromophoric grouping, contributing color
2. Reactive system, enabling dye to react with hydroxy group in cellulose.
3. A bridging group that links reactive system to chromophore,
4. One or more solubilizing group, usually sulphuric acid substituent attached to chromophoric group for their color, although Azochromophore $-N=N-$ is by itself the most important.

All reactive dyes contain sodium sulphonate group for solubility & dissolve in water to give colored sulphonate anions & sodium cations. Most reactive dyes have 1 to 4 of these sulphonate groups; General form of reactive dye is as follows:



Where,

- ♦ S = Water solubility group
- ♦ R = Chromophore
- ♦ X = Reactive System
- ♦ B = Bond between reactive system & Chromophore

2.2.15. Dyeing Process of 100% Viscose Fabric:

Actually viscose dyeing process is almost same as single jersey cotton spandex fabric. However, please find below the dyeing process.

1st Step: Scouring (detergent wash) the fabric in the dyeing winch and released the water for perform the next process.

2nd Step: Labeling the fabric by labeling agent which increased the PH of fabric.

3rd Step: Add Salt.

4th Step: Mixing the specific color (reagent) for dye the fabric.

5th Step: Dyeing run (Temperature at 40°C for 30 min) .

6th Step: Soda dosing (1 min).

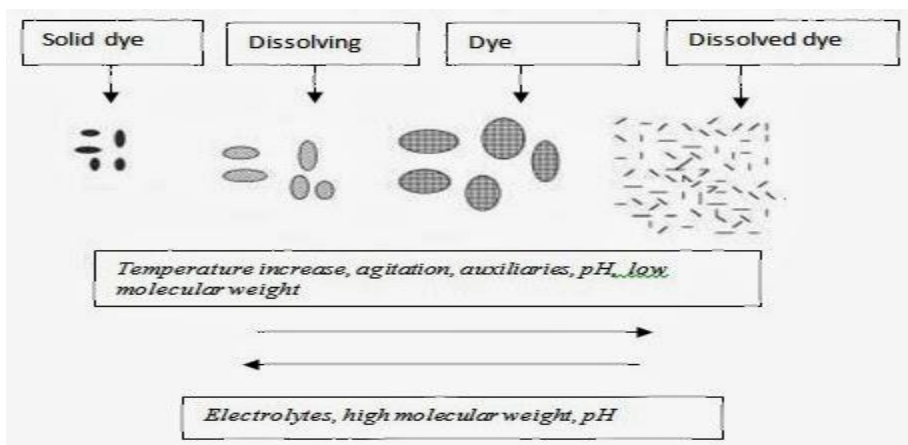
7th Step: Dyeing run (Temperature at 60°C for 80 min) .

8th Step: wash (Cold wash -Hot wash-Cold wash.

2.2.16.Stage of Dyeing:

First stage (Dissolving of the dye)

In this first stage, the dye, in solid form, is equilibrated according to the dye dissolved in molecular form or in micellar form (aggregates of many molecules with good solubility), or in form of dispersed micro powder (micro crystals of dye molecules poorly soluble)



Second stage (Adsorption)

During this stage, by the effect of the dye-fiber affinity, the dye is adsorbed at the surface of the fiber, thus forming chemical bonds with it.

Affinity, temperature, (sometimes pH and/or auxiliaries) affect the thermodynamic interactions:-

- a) The balance of the reactions, thus determining the exhaustion degree of the dyeing liquor.

- b) The affinity between the dye and the fiber is the ability of both dye and fiber to form a permanent bond. The greater the affinity, the stronger and higher are the fiber-dye bonds and the smaller is the dye for the solvent (water). Generally it is also directly proportional to the molecular weight (molecular size) of the dye. Affinity is therefore a condition strictly related to the chemical composition of the dye and the fiber. As far as thermodynamics aspect is concerned, the same above mentioned criteria must be applied and in general an increase of the dyeing temperature causes a change of the balance towards the solution dye, with a reduction of the exhaust, and therefore a reduction of the dye-fiber affinity.

A quick adsorption of the dye on the surface of the fabric reduces the dye concentration near the fiber, thus reducing the adsorption speed. A correct speed of the liquor change in contact with the fiber allows the maximum concentration of the dyeing solution near the fiber, and consequently the correct speed.

At the same time, the liquor flow in contact with the material is spread homogeneously and allows a good distribution of the dye in all the areas of the textile surface; this enhances the dye consistency with the same operating times.

The adsorption reaction is usually sufficiently quick not to affect the dyeing speed, and often it must be slowed down or adjusted (T° , pH, and auxiliaries) on optimum values to avoid an irregular distribution of the dye.

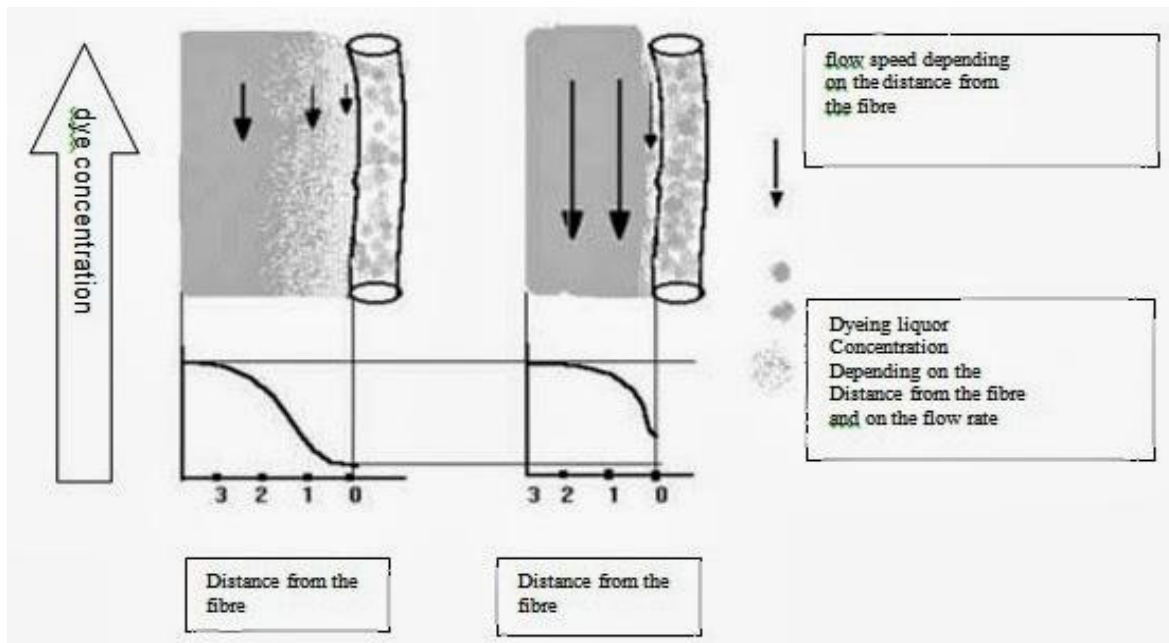


Figure: Dye concentration in the liquor near the fiber depending on the hydrokinetic condition

Third stage (Diffusion)

During this stage the dye, adsorbed in molecular form by the surface, by breaking and restoring the bonds many times tends to penetrate into the bulk of the fiber through amorphous areas, to spread homogeneously and fix steadily.

Fundamental factors are:-

- Crystallinity of the fiber: the dyes penetrate the fibers through amorphous areas and therefore the higher the crystallinity, the lower the diffusion speed.
- Molecular size of the dye: the bigger the dimensions of the dye molecules, the more difficult the diffusion through amorphous areas.
- Strength or dye-fiber bonds (affinity): the stronger the bond, the more difficult the diffusion.
- Fiber and makes the diffusion quicker but simultaneously reduces the affinity and therefore the exhaust.

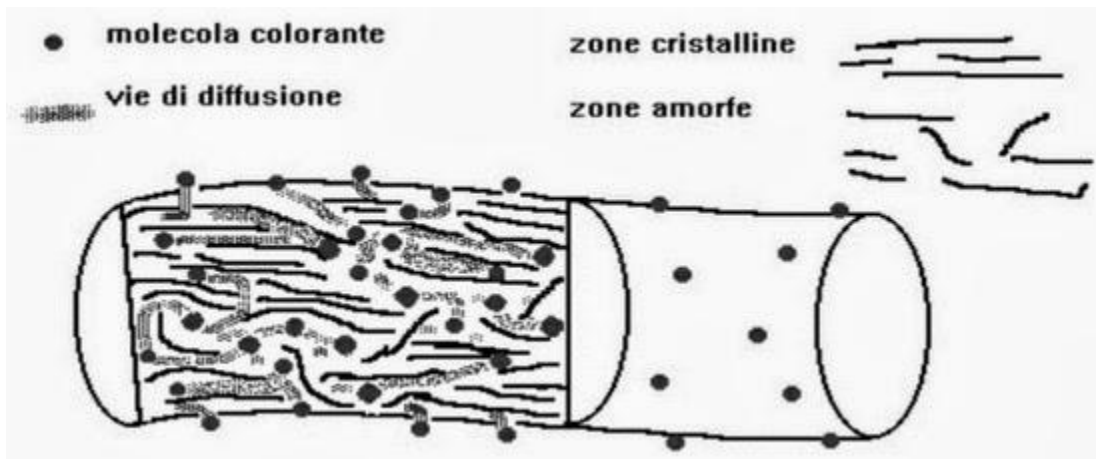


Figure: Dye penetration and migration

The presence of auxiliaries, facilitating the fiber swelling or increasing the concentration of dye near the fiber (swelling agents), tends to increase the diffusion speed.

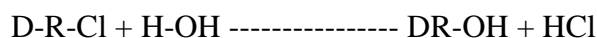
The operating time must be adequate to allow a good penetration of the dyes, since this is a prerequisite for developing the maximum fastness.

On the other hand, a high concentration of electrolytes would facilitate the aggregation of anionic dyeing agents, above all in the core of the fiber, where the dye is more concentrated, improving the exhaustion and reducing the migration phenomenon.

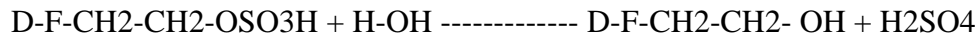
2.2.17. Hydrolysis of Reactive Dye:

Under alkaline reactive dye reacts with the terminal hydroxyl group of. But if the solution of the dye kept for long time its concentration drops. Then the dye react with the hydroxyl (OH) group of water. This reaction of dye with water is known as hydrolysis of reactive dye. After hydrolysis dye can not react with fiber. So hydrolysis increases the loss of dyes.

Hydrolysis of halogen containing reactive dyes:



Hydrolysis of activated vinyl compound containing group:



2.3. Test Method

2.3.1. Stripping

Stripping is a physical separation process where one or more components are removed from a liquid stream by a vapor stream. In industrial applications the liquid and vapor streams can have co-current or countercurrent flows. Stripping is usually carried out in either a packed column.

Stripping of reactive dye:

Partial stripping

Partial stripping is obtained by treating the dyed fabric with dilute acetic acid or formic acid. Here temperature is raised to 70-100 C and treatment is continued until the shade is removed by desired amount.

- o Acetic acid ----- 0.5 - 10 g/L
- o Temperature ----- 70 – 100 C

Full stripping

For complete stripping the goods are first treated with sodium hydro sulphite (hydrose) at boil and then washed off and bleached with 1 g/L sodium hypochlorite (NaCl) or bleaching powder at room temperature. This is carried out as following steps-

Wetting agent ----- 0.5 – 1.0 g/L

NaOH -----3-6 g/L (Temp100-105 x 60-30min)

Hydrose -----7-10g/L

Then,

Wetting agent -----1g/L (RoomTemp x 10min)

Bleaching powder -----1g/L

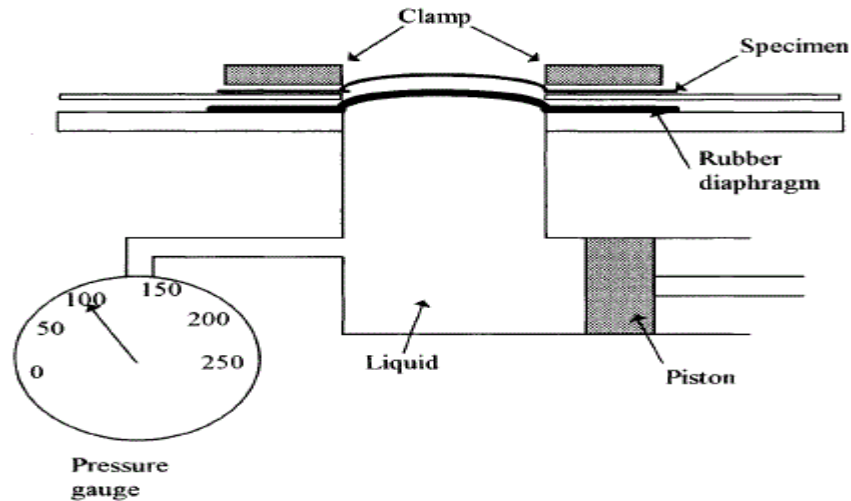
2.3.2. Bursting Strength:

Tensile strength tests are generally used for woven fabrics where there are definite warp and weft directions in which the strength can be measured. However, certain fabrics such as knitted materials, lace or non-woven do not have such distinct directions where the strength is at a maximum. Bursting strength is an alternative method of measuring strength in which the material is stressed in all directions at the same time and is therefore more suitable for such materials. There are also fabrics which are simultaneously stressed in all directions during service, such as parachute fabrics, filters, sacks and nets, where it may be important to stress them in a realistic manner. A fabric is more likely to fail by bursting in service than it is to break by a straight tensile fracture as this is the type of stress that is present at the elbows and knees of clothing.

When a fabric fails during a bursting strength test it does so across the direction which has the lowest breaking extension. This is because when stressed in this way all the directions in the fabric undergo the same extension so that the fabric direction with the lowest extension at break is the one that will fail first. This is not necessarily the direction with the lowest strength.

Diaphragm of Bursting Test:

The British Standard describes a test in which the fabric to be tested is clamped over a rubber diaphragm by means of an annular clamping ring and an increasing fluid pressure is applied to the underside of the diaphragm until the specimen bursts. The operating fluid may be a liquid or a gas two sizes of specimen are in use, the area of the specimen under stress being either 30mm diameter or 113mm in diameter. The specimens with the larger diameter fail at lower pressures (approximately one-fifth of the 30mm diameter value). However, there is no direct comparison of the results obtained from the different sizes. The standard requires ten specimens to be tested.



Bursting Strength Test

In the test the fabric sample is clamped over the rubber diaphragm and the pressure in the fluid increased at such a rate that the specimen bursts within 20 ± 3 s.

The extension of the diaphragm is recorded and another test is carried out without a specimen present. The pressure to do this is noted and then deducted from the earlier reading.

The following measurements are reported:

- ♦ Mean bursting strength KN/m²
- ♦ Mean bursting distension mm
- ♦ Liquid
- ♦ Piston
- ♦ Rubber
- ♦ diaphragm
- ♦ Specimen
- ♦ Clamp

The US Standard is similar using an aperture of 1.22 ± 0.3 in (31 ± 0.75 mm) the design of equipment being such that the pressure to inflate the diaphragm alone is obtained by removing the specimen after bursting. The test requires ten samples if the variability of the bursting strength is not known.

The disadvantage of the diaphragm type bursting test is the limit to the extension that can be given to the sample owing to the fact that the rubber diaphragm has to stretch to the same amount. Knitted fabrics, for which the method is intended, often have a very high extension.

2.3.3. ICI Pilling Test:

Pilling:

Pilling is formation of little balls of fibers (pills) on the surface of a fabric which is caused by abrasion in wear.

Pilling is the tendency of fibers to come loose from a fabric surface and form balled particles of fiber.

Causes of Pilling:

- a. Due to wear and abrasion.
- b. Due to rubbing action of fabric with particular parts of garments and body.
- c. Due to soft twisted yarn.
- d. Due to excess short fibres.

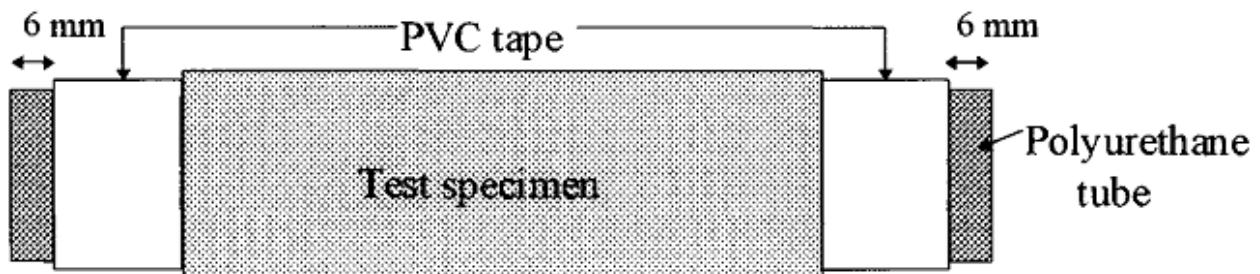
Reduction OR Minimizing pilling:

- a. By using high twisted yarn.
- b. By brushing and cropping of the fabric surface to remove loose fibre ends.
- c. By using singeing process to reduce yarn hairiness, longer fibres.
- d. By using anti pilling technique.

Pilling test:

ICI BOX PILLING TEST:

1. For this test four specimens each 5 inch X 5 inch are cut from the fabric.
2. A seam allowance of 12mm is marked on the back of each square. In two of the samples the seam is marked parallel to the warp direction and in the other two parallel to the weft direction.
3. The samples are then folded face to face and a seam is sewn on the marked line.



7.4 The preparation of a pilling sample.

4. This gives two specimens with the seam parallel to the warp and two with the seam parallel to the weft.
5. Each specimen is turned inside out and 6mm cut off each end of it thus removing any sewing distortion.
6. The fabric tubes made are then mounted on rubber tubes so that the length of tube showing at each end is the same. Each of the loose ends is taped with poly (vinyl chloride) (PVC) tape so that 6mm of the rubber tube is left exposed as shown in Figure.
7. All four specimens are then placed in one pilling box.
8. The samples are then tumbled together in a cork-lined box as shown in Figure.
9. The usual number of revolutions used in the test is 18,000 which take 5 hrs.

PILLING GRADES:

Grade 5 No or very weak formation of pills.

Grade 4 Weak formations of pills.

Grade 3 Moderate formations of pills.

Grade 2 Obvious formations of pills.

Grade 1 Severe formation of pills.

2.3.4. Color Fastness to Wash:

Color fastness to wash is very important for lab-dip. There are varieties of testing procedure, because-

- Washing condition may vary from one country to another.
- The methods depend on the use of dyed goods.
- To evaluate repeated washing accelerated test methods are used.

The degree of fading and staining of dyed goods for washing depends upon the following factors:

- ◆ Temperature range may be from 40-95°C.
- ◆ The type and amount of detergent added to the washing bath. In many testing procedure a standard detergent is used.

- ◆ The extent of mechanical action which can be varied by changing the agitation speed in a washing machine or by adding steel ball to revolving the bath.
- ◆ The washing liquor to goods ratio is 50:01
- ◆ The hardness of water

The rinsing, drying, or pressing methods used to restore the sample after the washing test

Principle of Wash Fastness

A specimen (lab-dip) in contact with specified adjacent fabric or fabric or fabric is laundered, rinsed and dried. The specimen/composite sample is treated under appropriate condition in a chemical bath for short time. The abrasive action is accomplished by the use of a liquor ratio and an appropriate number of steel balls. The change in color of the specimen (dyed sample) and the staining of the adjacent fabric is assessed by recommended Grey scale (1-5).

Apparatus and Materials

1. Wash –wheel with a thermostatically controlled water bath and rating speed of (40 ± 2) rpm.
2. Stainless steel container (capacity 55 ± 50 ml)
3. Stainless steel ball (dia=0.6cm, weight=1 gm)
4. SDC, Multitier fabric (Acetate, cotton, nylon, polyester, acrylic, wool)
5. Thermometer
6. Sewing machine
7. Dryer
8. Color matching cabinet and
9. ISO Scales.

Reagents

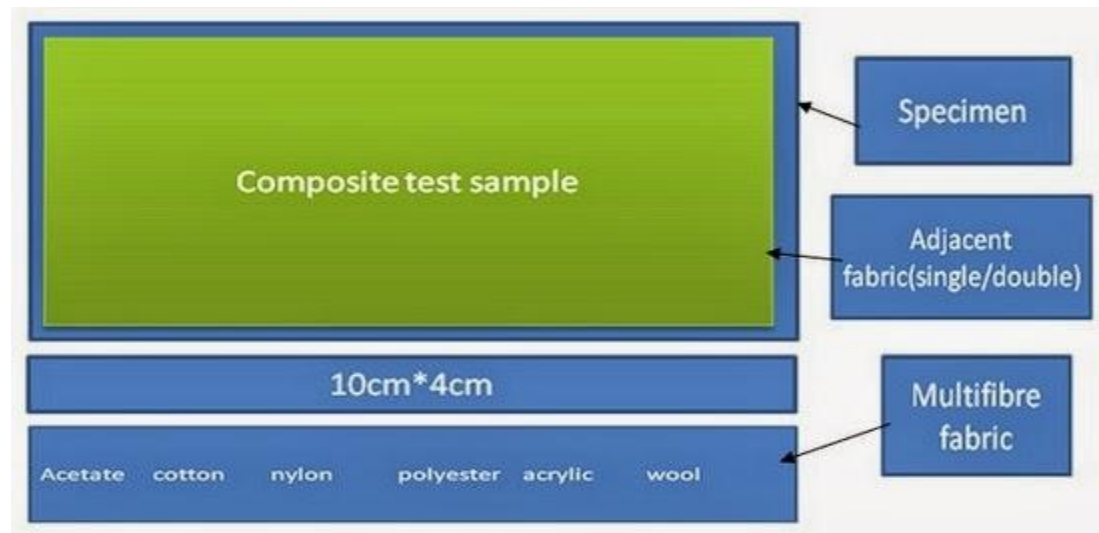
1. Reference detergent.
2. Sodium Carbonate/Soda ash.
3. Distilled water (Grade-3) and
4. Etc.

Test Specimen

Test specimen cut a sample of dyed goods 10*4cm and sew it with same size multifiber fabric. This is the composite test sample.

Test Procedure: (ISO recommendation NO. 1-5)

ISO-105-CO1: Composite sample is treated in a wash wheel for 30 minute at (40 ± 2) °C with 5gm/l standard soap.



Condition for Washing

Test	Temperature °C	Time(minute)	Steel ball	Chemicals
ISO-105-CO 1	40	30	00	Soap (5g/l)

Evaluation of wash fastness

Compare the contrast between the treated and untreated sample with Grey Scale for changing color of dyed sample and staining of adjacent fabric in a color matching cabinet.

Numerical rating for color changing is the shade and staining to adjacent fabric. Number of method used.

Assessment of Color Fastness

Grey Scale	
Numerical rating	For wash and rubbing fastness
1	Poor/ Little
2	Moderate
3	Average
4	Good
5	Excellent

Spectrophotometer:

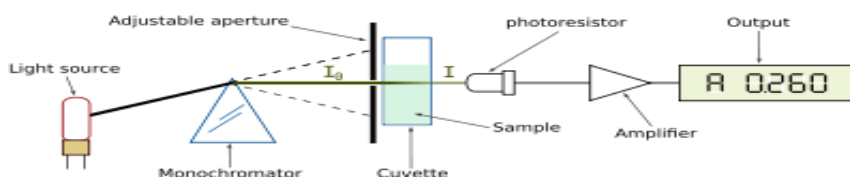
A spectrophotometer is commonly used for the measurement of transmittance or reflectance of solutions, transparent or opaque solids, such as polished glass, or gases. However they can also be designed to measure the diffusivity on any of the listed light ranges that usually cover around 200 nm - 2500 nm using different controls and calibrations. Within these ranges of light, calibrations are needed on the machine using standards that vary in type depending on the wavelength of the photometric determination.

An example of an experiment in which spectrophotometry is used is the determination of the equilibrium constant of a solution. A certain chemical reaction within a solution may occur in a forward and reverse direction where reactants form products and products break down into reactants. At some point, this chemical reaction will reach a point of balance called an equilibrium point. In order to determine the respective concentrations of reactants and products at this point, the light transmittance of the solution can be tested using spectrophotometry. The amount of light that passes through the solution is indicative of the concentration of certain chemicals that do not allow light to pass.

The use of spectrophotometers spans various scientific fields, such as physics, materials science, chemistry, biochemistry, and molecular biology. They are widely used in many industries including semiconductors, laser and optical manufacturing, printing and forensic examination, as well in laboratories for the study of chemical substances. Ultimately, a spectrophotometer is able

to determine, depending on the control or calibration, what substances are present in a target and exactly how much through calculations of observed wavelengths.

Design



Single beam spectrophotometer

There are two major classes of devices: single beam and double beam. A double beam spectrophotometer compares the light intensity between two light paths, one path containing a reference sample and the other the test sample. A single-beam spectrophotometer measures the relative light intensity of the beam before and after a test sample is inserted. Although comparison measurements from double-beam instruments are easier and more stable, single-beam instruments can have a larger dynamic range and are optically simpler and more compact. Additionally, some specialized instruments, such as spectrophotometers built onto microscopes or telescopes, are single-beam instruments due to practicality.

Historically, spectrophotometers use a monochromator containing a diffraction grating to produce the analytical spectrum. The grating can either be movable or fixed. If a single detector, such as a photomultiplier tube or photodiode is used, the grating can be scanned stepwise so that the detector can measure the light intensity at each wavelength (which will correspond to each "step"). Arrays of detectors, such as charge coupled devices (CCD) or photodiode arrays (PDA) can also be used. In such systems, the grating is fixed and the intensity of each wavelength of light is measured by a different detector in the array. Additionally, most modern mid-infrared spectrophotometers use a Fourier transform technique to acquire the spectral information. The technique is called Fourier transform infrared spectroscopy.

When making transmission measurements, the spectrophotometer quantitatively compares the fraction of light that passes through a reference solution and a test solution, then electronically

compares the intensities of the two signals and computes the percentage of transmission of the sample compared to the reference standard. For reflectance measurements, the spectrophotometer quantitatively compares the fraction of light that reflects from the reference and test samples. Light from the source lamp is passed through a monochromator, which diffracts the light into a "rainbow" of wavelengths and outputs narrow bandwidths of this diffracted spectrum through a mechanical slit on the output side of the monochromator. These bandwidths are transmitted through the test sample. Then the photon flux density (watts per meter squared usually) of the transmitted or reflected light is measured with a photodiode, charge coupled device or other light sensor. The transmittance or reflectance value for each wavelength of the test sample is then compared with the transmission or reflectance values from the reference sample. Most instruments will apply a logarithmic function to the linear transmittance ratio to calculate the "absorbency" of the sample, a value which is proportional to the 'concentration' of the chemical being measured.

In short, the sequence of events in a modern spectrophotometer is as follows:

1. The light source is shone into a monochromator and is diffracted into a rainbow and split into two beams and scanned through the sample and the reference solutions.
2. Fractions of the incident wavelengths are transmitted through, or reflected from, the sample and the reference.
3. The resultant light strikes the photo detector device which compares the relative intensity of the two beams.
4. Electronic circuits convert the relative currents into linear transmission percentages and/or absorbance/concentration values.

Many older spectrophotometers must be calibrated by a procedure known as "zeroing," balancing the null current output of the two beams at the detector. The transmission of a reference substance is set as a baseline value, so the transmission of all other substances are recorded relative to the initial "zeroed" substance. The spectrophotometer then converts the transmission ratio into 'absorbency,' the concentration of specific components of the test sample relative to the initial substance.

2.3.5. Absorbency Test by Wicking Method:

Thus it can be said from the wicking test results that the water front line in the stripped samples was pronouncedly higher than the pretreated one. The better wet ability of the stripped samples might be due to the stripping treatment under alkaline condition. In addition, the greater absorbency of the dyed fabric in comparison to the pretreated fabric was due to dyeing of viscose fabric with reactive dyes was carried out in alkaline media (Liu and Wang 2009). Both dyed and stripped fabrics were treated under different concentrations of alkali, material to liquor ratio, temperature and time; but in case of stripping process of the dyed fabrics higher concentration of alkali and temperature were used than the dyed ones and correspondingly found higher wicking distance in the stripped fabrics. Moreover, water is an intercrystalline swelling agent which can penetrate and loosen only the amorphous region of regenerated cellulose; while alkaline solution, as an intracrystalline swelling agent affects both the amorphous and crystalline regions of regenerated cellulose. As a result, alkaline solution is effective in loosening the crystalline region of regenerated cellulose. The action of such swelling agent inherits the outer skin on viscose fibers and causes it to split and form collars; the inner regenerated cellulose layers swell rapidly the collars (Fan et al.1987). Due to loosening of crystalline region of regenerated cellulose by swelling agents, the absorbency of the fabric towards water and dyes is increased. It can be explained in other words. Viscose is pure regenerated cellulose, a naturally occurring polymer. Chemically it is a “cellobiose” which belongs to carbohydrate polymer, containing hydroxyl groups. These negatively charged groups attract water molecules and make cotton absorbs water well. When viscose dyed with reactive dyes, some of these -OH groups are occupied, which slightly reduces absorbency. During the stripping process, viscose fiber releases the maximum number of hydroxyl groups which has been formed covalent bonds with the regenerated cellulose.

This is due to the dye reduction reaction of sodium hydrosulphite and caustic soda on the regenerated cellulose. In addition, the stripping agent can also attack the crystalline region of viscose and as a result, there may also be chances of releasing the hydroxyl groups. Basically, hydroxyl groups are responsible for water absorbency. This is the reason behind the stripped fabric having more water absorbency as well as strength loss. Furthermore, the basic preparation processes of viscose knit fabric include scouring and bleaching. These treatments remove natural

and human induced impurities, that is, no cellulosic constituents and other unwanted substances. Thus increase the affinity of regenerated cellulose for dyes and finishes. It may also be possible that any impurities remained in the fabric could not be removed at the elementary preparation processes and they also remained in the dyed fabrics, which were finally removed due to alkaline reductive stripping action. As a result, absorbency of the stripped fabric might also be increased showing higher wicking distant.

CHAPTER 3
Material & Methods

3.1. Material:

3.1.1. Fabric:

Composition	100% Viscose
WPI	31
CPI	56
GSM	
Yarn Count	30

3.1.2 Dyes, Chemicals & Auxiliaries:

Dyes	Chemicals	Auxiliaries
Remazol Ultra Yellow RGB	Glauber salt	Wetting agent
Remazol Deep Yellow RGB	Soda ash	Sequestering agent
Levafix Blue CA		

3.2. Method:

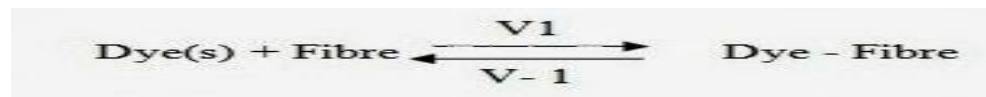
3.2.1. Exhaust Dyeing:

This process can be used for staple fiber, yarns and fabrics. The dye dissolved in the liquor is first adsorbed, i.e. the material is dyed only on the surface (dyeing result depends on the liquor turbulence), then penetrates in the core of the fiber (the dye diffusion is affected by temperature and dyeing time), and finally migrates thus allowing good dyeing uniformity and consistency (the process is affected by operating temperature and time).

During the process, kinetic and thermodynamic reactions interact.

Dyeing Theory (exhaust dyeing)

The dyeing process is a chemical reaction occurring between the dye and the fiber:



We can examine both the kinetics (process speed) and thermodynamic (balance) relationships

3.2.2. Dyeing Recipe:

Sl.No	Shade			Recipe			
	Dyes	Combined Shade	Individual Shade	Glauber Salt(g/l)	Soda Ash(g/l)	Wetting Agent(g/l)	Sequestering Agent(g/l)
1	Remazol Ultra Yellow RGB	4.82	1.3	10	3	0.5	1.0
2	Remazol Deep Yellow RGB		3.5				
3	Levafix Blue CA		0.02				

3.2.3. Stripping Process:

Six different stripping operations were carried out for each shade% in the sample dyeing machine using material to liquor ratio 1:8 for 30 min.

Stripping Operation	Temperature	Conc. of Sodium hydrosulphate (g/l)	Conc. of Caustic soda (g/l)
1	70	5	5
2		15	15
3		30	30
4	100	5	5
5		15	15
6		30	30

3.3. Test Method:

3.3.1 Reflectance & K/S Value by Spectrophotometer:

Stripping Operation	Temperature °C	R _{min}	k/S=(1-R) ² /2R	Stripping%
S1	70	520	3.900	90
S2			2.730	93
S3			1.560	96
S4	100		2.340	94
S5			1.560	96
S6			0.780	98

3.3.2. Stripping Percentage:

The color yields of both dyed and stripped fabric were determined in terms of K/S value by a dual beam reflectance spectrophotometer. The stripping percentage was calculated using equation.

$$\text{Stripping percentage} = \frac{\text{K/S value of dyed sample} - \text{K/S value of stripped sample}}{(\text{K/S value of dyed sample})} \times 100$$

3.3.3. Weight Loss %:

Loss in weight of stripped sample was measured by difference in weight before and after treatment using equation .

$$\text{Weight loss percentage} = \frac{\text{Fabric weight before stripping} - \text{Fabric weight after stripping}}{(\text{Fabric weight before stripping})} \times 100$$

3.3.4. Strength Loss %:

Bursting strength of dyed and stripped fabric was carried out in ISO 13938–1:1999 method by Bursting Strength Tester. Then strength loss of the stripped sample was measured using equation.

$$\text{Strength loss percentage} = \frac{(\text{Fabric strength before stripping} - \text{Fabric strength after stripping})}{\text{Fabric strength before stripping}} \times 100$$

3.3.5. ICI Pilling Test:

Pilling resistance of stripped fabric samples was assessed in EN ISO 12945-1 method using ICI box Pilling Test.

Stripping Operation	Stripping Recipe	Temperature 0C	ICI Piling
1	H-5g/l+C-5g/l	70	3-0
2	H-15g/l+C-15g/l		2
3	H-30g/l+C-30g/l		2
4	H-5g/l+C-5g/l	100	3-0
5	H-15g/l+C-15g/l		2-0
6	H-30g/l+C-30g/l		2-0

3.3.6. Bursting Strength:

Bursting strength is an alternative method of measuring strength in which the material is stressed in all directions at the same time and is therefore more suitable for such materials.

Stripping Operation	Temperature 0C	Bursting Strength	Bursting Strength Loss%
Red sample	-	258	-
S1	70	122	28.7
S2		115	42.2
S3		112	58.53
S4	100	119	32.55
S5		112	46.51
S6		103	62.01

3.3.7. Fabric Absorbency:

Vertical wicking test of fabric was carried out using “Ciba” Test Method reported by Kate Spade & Company (2014). The 15 cm × 2.5 cm strips of samples (Both in wale and coarse direction) was lowered to touch the water reservoir at which moment timer was started, and the position of water front line (cm) over 5 min was recorded.

Stripping Operation	Temperature 0C	Absorbency
Dyed sample	-----	5.4
S1	70	5.6
S2		5.8
S3		6.1
S4	100	5.7
S5		6.1
S6		6.3

Chapter -04
Results and Discussion

4. Result and Discussion:

4.1. Fabric Test Result:

Sl.no	Sample Description	Temperature	GSM	Weight Loss%	ICI Pilling(Grade)	Color Fastness to		Absorbency	Bursting Strength
						Wash Change	staining		
Dyed Sample	AS it is Fabric	-	180	-	4-0	4-0	3-4	5.4	258
S1	H-5g/l +C-5g/l	70 ⁰ C	177	1.6	3-0	3-0	4-5	5.6	122
S2	H-15g/l +C-15g/l		175.5	2.5	2	3-0	4-5	5.8	115
S3	H-30g/l +C-30g/l		173.2	3.8	2	3-4	4-5	6.1	112
S4	H-5g/l +C-5g/l	100 ⁰ C	176	2.22	3-0	3-4	4-5	5.7	119
S5	H-15g/l +C-15g/l		175	2.77	2-0	2-3	4-5	6.1	112
S6	H-30g/l +C-30g/l		172	4.4	2-0	3-4	4-5	6.3	103

4.2. Stripping Percentage:

Stripping process:

Six different stripping operations were carried out for each shade% in the sample dyeing machine using material to liquor ratio 1:8 for 30 min.

Dyeing recipes using 4.82% reactive dyes:

Sl. No	Shade			Recipe			
	Dyes	Total Shade %	Individual Shade %	Glauber Salt(g/l)	Soda Ash(g/l)	Wetting Agent(g/l)	Sequestering Agent(g/l)
1	Remazol Ultra Yellow RGB	4.82	1.3	10	3	0.5	1.0
2	Remazol Deep Yellow RGB		3.5				
3	Levafix Blue CA		0.02				

Stripping Percentage:

Sl.No	Temperature	R _{min}	$k/S=(1-R)^2/2R$	Stripping%
Dyed sample	-	520	39.006	-
S1	70°C		3.900	90
S2			2.730	93
S3			1.560	96
S4	100°C		2.340	94
S5			1.560	96
S6			0.780	98

Stripping percentages of the dyed fabrics for 4.82% shades were displayed in (Figures 1 and 2, respectively).

From Figure 1, for 4.82% shade, it was found that stripping percentages of dyed fabrics increased gradually with the increase of concentration of stripping chemicals (Hydrosand caustic soda) when fabrics were stripped both at 70°C and 100°C. Stripping percentages were also found higher at 100°C than 70°C under each combination of stripping chemicals. As the

temperature of the stripping operation was more, the stripping was more. Both at 70°C and 100°C temperature when concentration of caustic soda was doubled from 5 g/l to 15 g/l with 30 g/l hydrose,stripping percentages were slightly increased. From Figure 2, similar

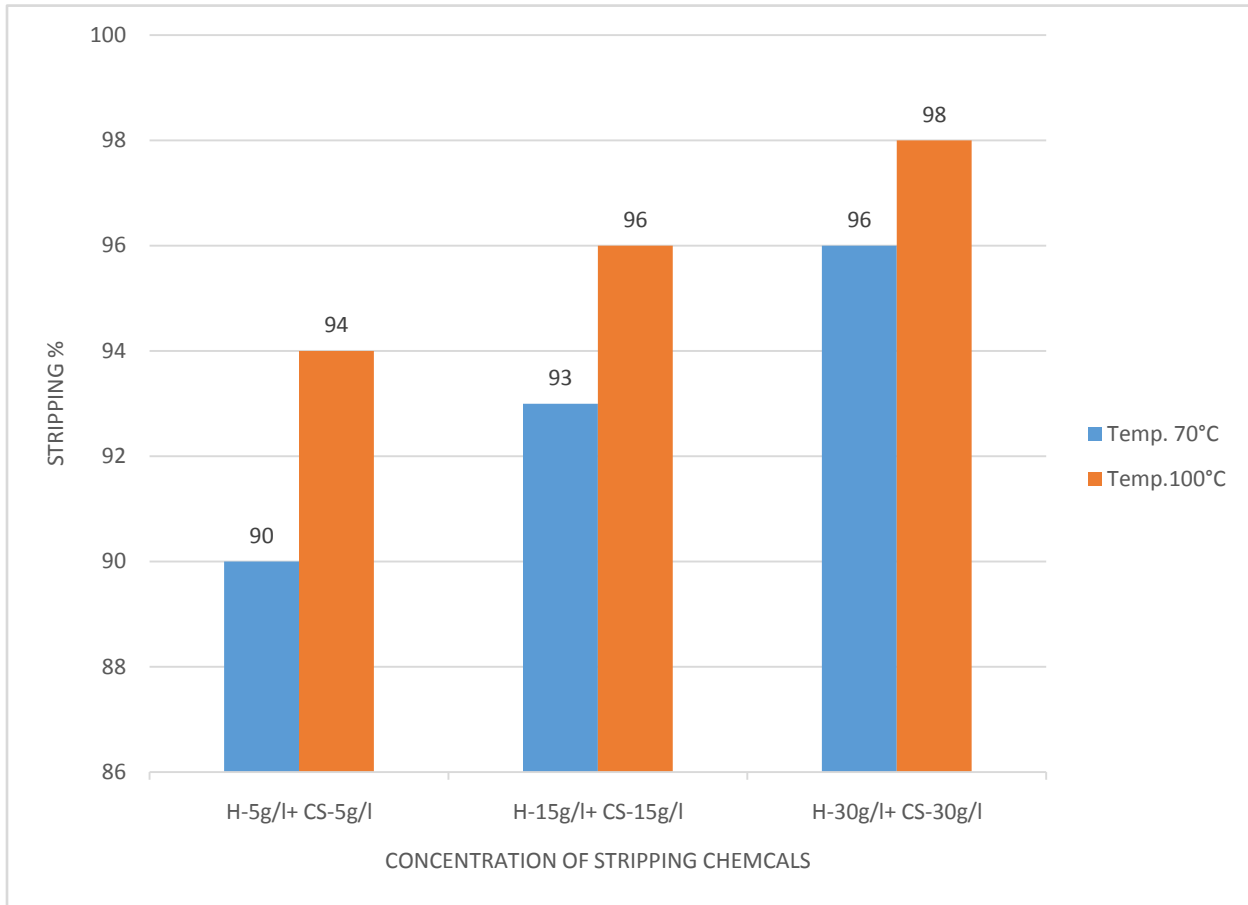


Fig : Stripping Percentage of Dyed Fabric

trends were found for 4.82% shade. Using 5g/l, 15 g/l , 30g/lhydrose and 5g/l, 15g/l ,30 g/l caustic soda and strippingat70%,100°C, the maximum stripping for shades were found4.82% , respectively.

4.3. Strength Loss:

In case of 4.82% shade, strength loss percentages were increased gradually with the increase of concentration of stripping chemicals both at 70°C and 100°C as shown in. In between 70°C and 100°C, it was noticed that strength loss percentages were higher at 100°C when the fabrics were treated in same parameter. Here, the sample dyed with 4.82% shade when treated with 30 g/l hydrose and 30 g/l caustic soda at 100°C showed maximum strength loss of 60% in comparison to the maximum strength loss of

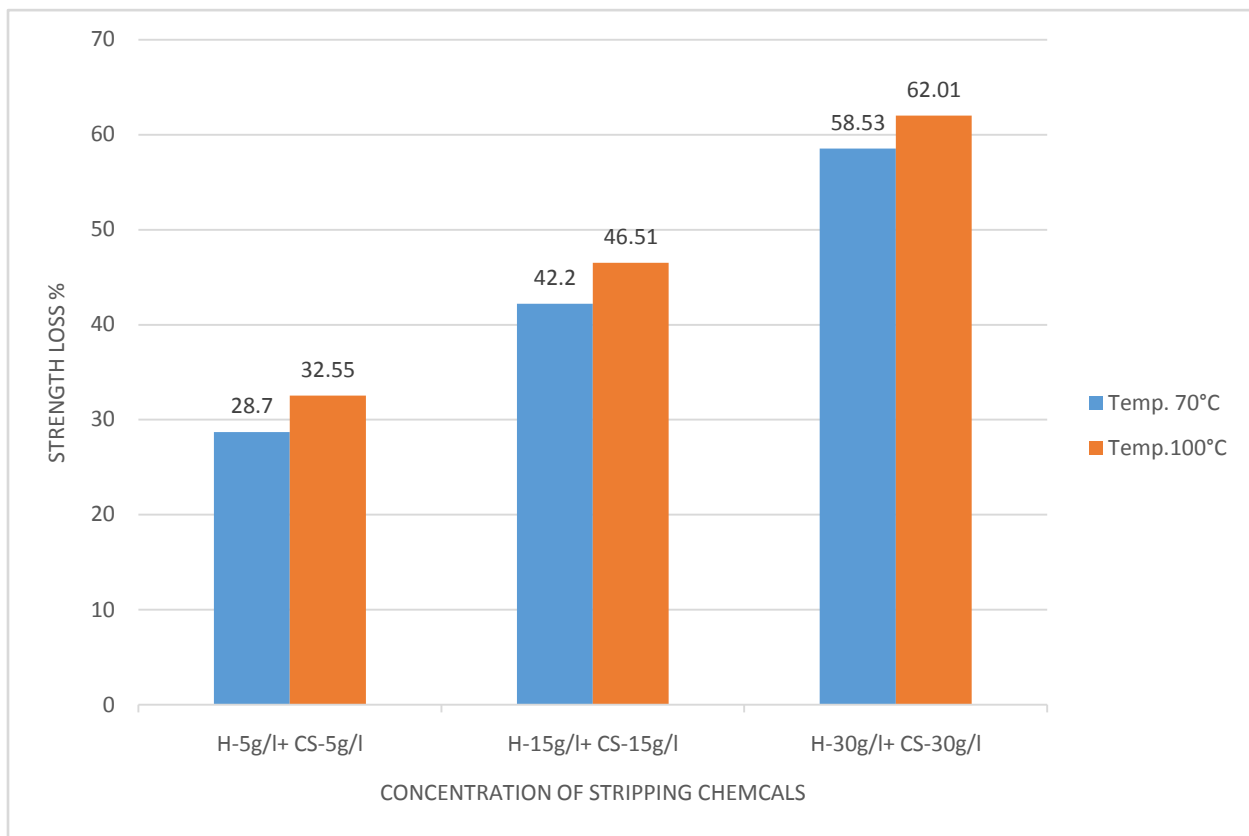


Fig. Strength loss % of stripped fabric

56.6% when treated at 70°C under the same combination of stripping chemicals. As both the temperature and stripping chemicals were comparatively more, the extent of strength loss was also found more. Again, when caustic soda was doubled from 15 g/l with 15 g/l hydrose, strength losses were 55.4 % (In case of 70°C) and 56.6 % (In case of 100°C). For 5% shade, similar trends of gradual increasing of strength loss with the increase of concentrations of stripping

chemicals were found as shown in Figure for both 70°C and 100°C. The samples dyed with 4.82% shade when stripped using 30 g/l hydrose and 30 g/l caustic soda at 100°C showed maximum strength loss of 60.0% in comparison to the maximum strength loss of 56.6% when treated at 70°C under the same combination of stripping chemicals.

4.4. Weight Loss:

Quality of stripped fabric was also evaluated by measuring the percent weight loss. A weight loss percentage of the dyed fabrics for 4.82% shade was displayed in the Figures. From Figure for 4.82% shade it was noticed that weight loss percentages of stripped fabrics increased with the increase of concentration of stripping chemicals when fabrics were stripped both at 70°C and 100°C. The weight loss percentages were found.

Weight Loss % curve

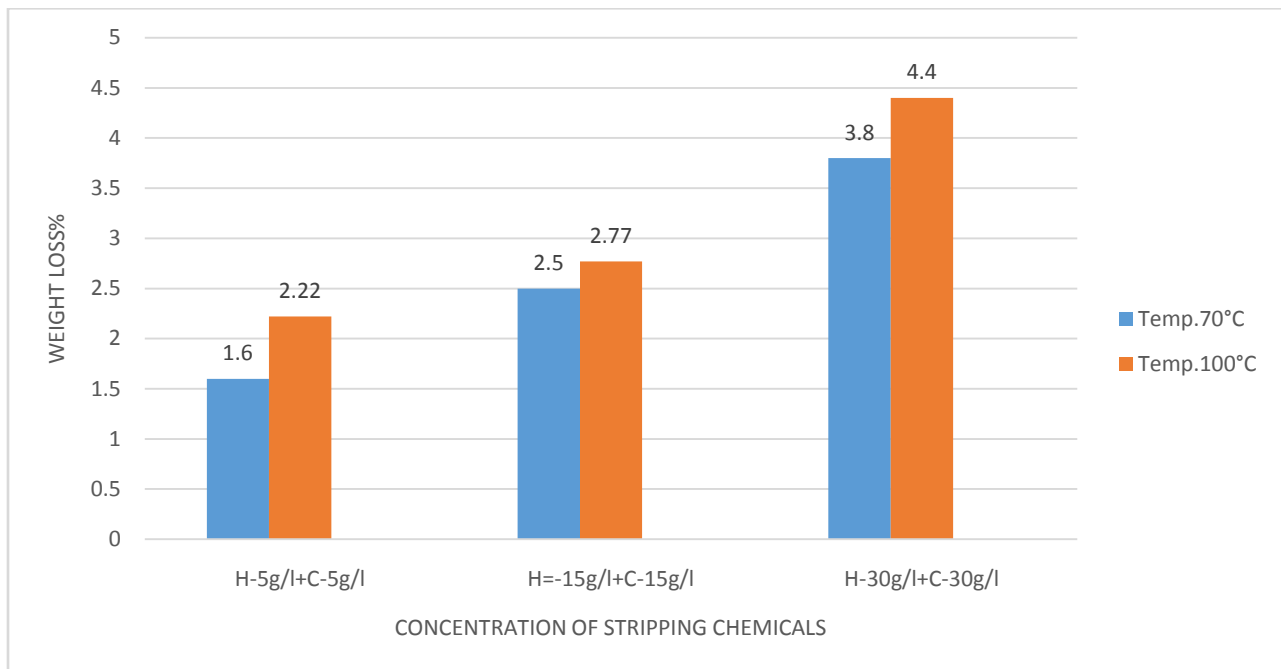


Fig. weight loss% of stripped fabric

Higher at 100°C than 70°C under each combination of stripping chemicals used. As the temperature of stripping operations was more, the weight loss percentage was found more. Here, the sample dyed with 4.82% shade when treated with 30 g/l hydrose and 30 g/l caustic soda at 100°C showed maximum weight loss of 4.4% in comparison to the maximum weight loss of 3.8% when treated at 70°C under the same combination of stripping chemicals.

Reactive dyes are the most substantive of dyes used on viscose because of their covalent bonding with glycoside hydroxyls. As a result, these dyes are the most resistant to extraction or destruction of all dye types. An aqueous solution of a strong base is typically used to remove the dyes from the viscose fiber. The alcohol groups on the glucose units in the regenerated cellulose backbone of viscose act as a weak acid and are ionized under alkaline conditions. As cotton fibers partially dissolve in concentrated sodium hydroxide at elevated temperatures, fabric strength loss occurred. As such, during alkaline dye reductive process fabric strength loss occurred. Strength loss of stripped fabric increased with the increase of stripping action provided by the elevated temperature and concentration of hydrose and caustic soda. Increased weight losses of stripped fabrics are the consequences of higher strength loss due to similar way.

4.5. ICI Pilling Resistance:

Ratings for dyed and stripped samples in case of 4.82% shade Pilling resistance ratings were found 4 and 18000 cycles respectively for fabric dyed with 4.82% dyes as shown in Figures. Ratings were found similar as dyed fabric when 5 g/l hydrose and 5 g/l caustic soda combination were used at 70°C but ratings decreased by 2 grade.

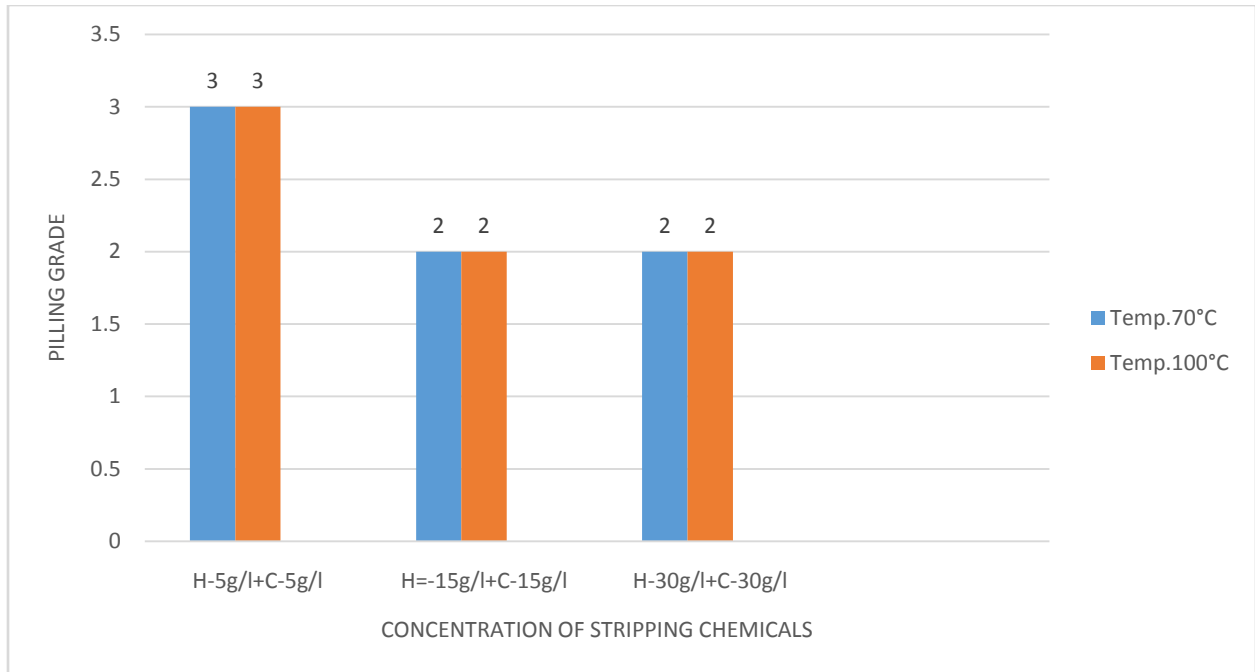


Fig. pilling grade of test stripped fabric

For both the stripping temperatures, in case of 15 g/l hydrose and 15 g/l caustic soda combination, pilling resistance rating was 2,2 under 18000 cycles respectively whereas for 30 g/l hydrose and 30 g/l caustic soda, corresponding ratings were 2,2 at both 80°C and 100°C. The alkali-treated viscose surfaces appeared fuzzy and blurred at the time of reductive stripping at high temperature and so lower pilling resistance.

4.6. Fabric Absorbency:

The wicking test results of pretreated, dyed and stripped fabrics were shown in Table. The absorbing length was found 5.2 cm for pretreated fabric in both wale and coarse direction, whereas it increased to 5.2 cm for dyed fabrics and further increased in the stripped fabrics. For stripped fabrics, it ranged 5.6, 5.8, 6.1 cm for 4.82% shade with the temp. Of 70°C and 5.7, 6.1, 6.3 cm for 4.82% shade with the temp. Of 100°C.

Absorbency Test curve

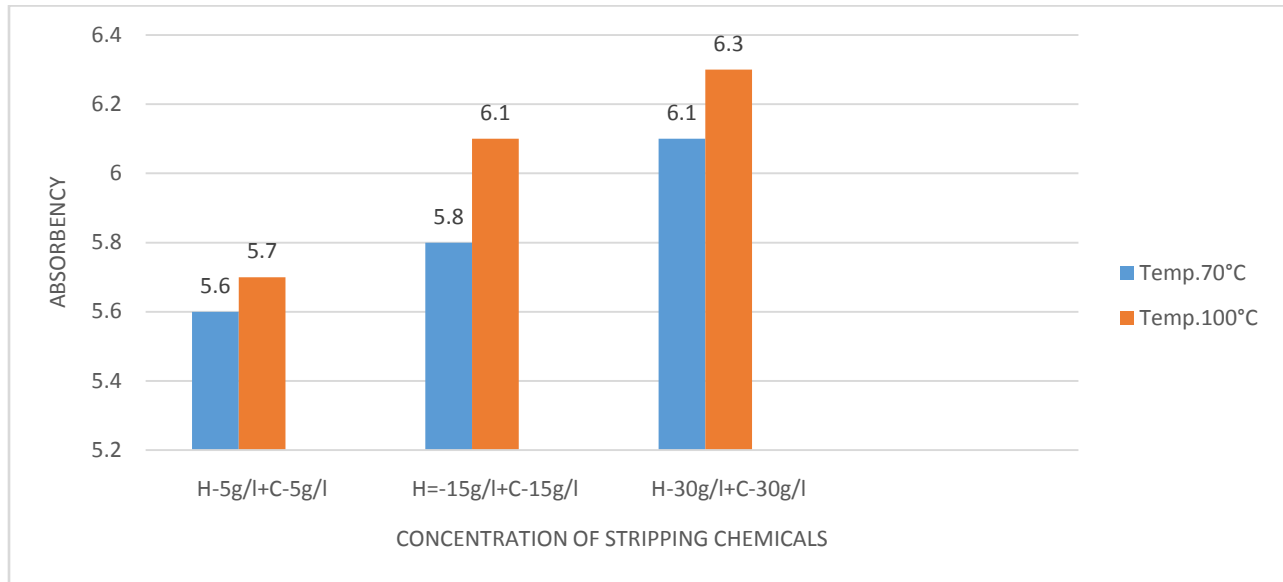


Fig. Absorbency test of stripped fabric

Thus it can be said from the wicking test results that the water front line in the stripped samples was pronouncedly higher than the pretreated one. The better wet ability of the stripped samples might be due to the stripping treatment under alkaline condition. In addition, the greater absorbency of the dyed fabric in comparison to the pretreated fabric was due to dyeing of viscose fabric with reactive dyes was carried out in alkaline media. Both dyed and stripped fabrics were treated under different concentrations of alkali, material to liquor ratio, temperature and time but in case of stripping process of the dyed fabrics higher concentration of alkali and temperature were used than the dyed ones and correspondingly found higher wicking distance in the stripped fabrics. Moreover, water is an intercrystalline swelling agent which can penetrate and loosen only the amorphous region of regenerated cellulose; while alkaline solution, as an intracrystalline swelling agent affects both the amorphous and crystalline regions of regenerated cellulose. The action of such swelling agent inherits the outer skin on viscose fibers and causes it to split and form collars; the inner regenerated cellulose layers swell rapidly the collars (Fan et al.1987). Due to loosening of crystalline region of regenerated cellulose by swelling agents, the absorbency of the fabric towards water and dyes is increased. It can be explained in other words viscose is regenerated cellulose, a naturally occurring polymer. These negatively charged groups

attract water molecules and make viscose absorb water well. When viscose dyed with reactive dyes, some of these -OH groups are occupied, which slightly reduces absorbency. During the stripping process, viscose fiber releases the maximum number of hydroxyl groups which has been formed covalent bonds with the cellulose. This is due to the dye reduction reaction of sodium hydrosulphite and caustic soda on the regenerated cellulose. In addition, the stripping agent can also attack the crystalline region of viscose and as a result, there may also be chances of releasing the hydroxyl groups. Basically, hydroxyl groups are responsible for water absorbency. This is the reason behind the stripped fabric having more water absorbency as well as strength loss. Furthermore, the basic preparation processes of viscose knit fabric include scouring and bleaching. These treatments remove natural and human induced impurities, that is, no cellulosic constituents and other unwanted substances. It may also be possible that any impurities remained in the fabric could not be removed at the elementary preparation processes and they also remained in the dyed fabrics, which were finally removed due to alkaline reductive stripping action. As a result, absorbency of the stripped fabric might also be increased showing higher wicking distant.

Chapter-05

Conclusion

Conclusion:

In this study, an investigation was carried out on alkali reductive stripping process for the viscose knit fabric dyed with the Remazol Ultra Yellow RGB, RGB, Remazol Deep Red RGB and Levafix Blue CA reactive dyes concerning the working parameters as the concentration of reducing agent and caustic soda, stripping temperature. Based on this experimental study, the conclusions drawn were:

1. Fabric strength loss percentages increased gradually with the increase of concentration of stripping chemicals and temperature of stripping bath. The sample dyed with 4.82% shades when treated with 5 g/l ,15g/l ,30g/l hydrose and 5 g/l ,15g/l ,30g/l caustic soda at 70°C, 100°C showed maximum strength loss of 1.6 % and 2.5%, 3.8%, 2.22%, 2.77%, 4.4% respectively.

2. Fabric weight loss percentages of stripped fabrics were increased gradually with the increase of concentration of stripping chemicals and stripping temperature. The sample dyed with 4.82% shades when treated with 5 g/l ,15g/l ,30g/l hydrose and 5 g/l ,15g/l ,30g/l caustic soda at 70°C ,100°C showed maximum weight loss of 1.6 % and 2.5%, 3.8%, 2.22%, 2.77%, 4.4, respectively.

3. In most cases, stripped samples showed lower pilling resistance rating than the corresponding dyed fabric.

1. Fabric absorbency was increased considerably due to stripping.

The stripping of reactive dyes from Viscose knit fabric and its satisfactory performance level directly related to the processing damage to the fabric. Besides the better stripping percentage, the overall fabric quality needs to be considered at the time of stripping. As stripping is a dye destruction process using harsh chemicals, there is no way to stop completely their adverse effects on fabric quality, but this can be controlled within ascertain range. In case of major unevenness 5 g/l hydrose and 5 g/l alkali is commonly used in knit dyeing industries for full stripping of reactive dyes from viscose fabric and according to this study the fabric strength loss and weight loss can be controlled within 5% for both using such combinations. Stripping whether partial or full should be selected at the elementary stage in the bulk production on the basis of

major dyeing faults and expected target shade. In general, dyeing industries take decision of dye stripping when it becomes absolutely necessary for their not ok dyed fabrics. For such not ok, already rejected to delivery batches, manufacturers get ready to compromise with the quality of fabric up to a controlled limit. Unevenness can be removed from the surface of the fabric through stripping and then re-dyeing can give the fabric new look as expected shade, as if it can be said that stripping is an aspect of improving the appearance and evenness.

Chapter -06

Reference

Reference:

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