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65/35 Cotton/Polyester Blended Fabric dyeing in one step by using azeotropic ternary mixture

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Abstract

Polyester/Cotton blended fabrics are normally dyed by two-bath or one-bath two-step dyeing method. This paper deals with a new approach involving azeotropic ternary mixture of organic solvents pretreatment to dye polyester/cotton blends using disperse and reactive dyes in one-bath method. Cotton is a natural cellulose fiber containing hydroxyl (OH) ions in the polymer backbone. And the fibers are easily can be dyed with dyes in low temperature (60^{o}c). The fiber can be dyed easily in presences of alkali. On the other hand Polyester is a fully synthetic fiber consists from Polyethylene Terapthalate (PET) like plastic material. For this the dye molecules cannot inter into the fibers molecule. As a result to dye the fiber like polyester special types of dye is used with high temperature (130^{o}C). It is known to everyone that cotton fiber have low strength, luster, durability compare to polyester fiber. On the other hand polyester fibers are less comfortable, low moisture absorbency compare to cotton fiber. So that, the researcher tried to blend the polyester and cotton fiber together to make different quality of knitted or woven fabric. Most well-known composition is 65/35 where 65% cotton & 35% polyester. But after producing the fabric due to increase the attractiveness fabric should be dyed. As the different molecular structure of the different fiber (Cotton & Polyester) it is difficult to dye in same process (dyestuff, PH, Temperature). For this commercially polyester cotton blended fabrics are dyed by one-bath two-step dyeing method using suitable dyes and chemicals for both fibers. The one-bath two-step dyeing procedure is shorter, but the disadvantages are lower dye ability and poor reproducibility property. Dyeing of cotton by conventional reactive dyes is carried out under alkaline conditions at 60°C -80°C, but this is entirely different condition from that of polyester dyeing, which is carried out at acidic conditions over 130°C by using dispersed dyes with the help of dispersing agent. Many research works have been carried out to dye polyester/cotton blends in one-bath dyeing method using conventional dispersed dyes and newly developed reactive dyes which can be dyed at acidic or neutral conditions around 100–130°C and are added simultaneously to the same bath.

Keywords: *Cotton polyester blended fabric, Temperature, Time, Solvent, Dyeing process, Fastness, Abrasion resistance, Disperse dye, Reactive dye.*

Methodology

The research based on the primary as well as secondary data. The primary data is to collect from lab where dyeing process is done of cotton polyester blended fabric by using sample (5gram) and the secondary data is being collected from the book, journal, articles as well as internet.

Experimental

Materials, Dyes, and Chemicals

65/35 polyester/cotton fabric:
A plain woven polyester/cotton fabric of the following specification was used.
Types of yarn-Cotton (Staple) and Polyester (filament)
Ends per inch-70 (Cotton)
Picks per inch-52 (Polyester)
Gram per Square (GSM)-120

Dyes

The following four disperse dyes were used for dyeing the polyester component of the blend.
C.I. Disperse Red 60
C.I. Disperse Orange 96
C.I Disperse Blue183
C.I. Disperse Yellow 49

The following four reactive dyes were used for dyeing the cotton component of the blend:

C.I. Reactive Red 124
C.I. Reactive Orange 64
C.I. Reactive Blue 116
C.I. Reactive Yellow 14.

Chemicals

Commercially available anionic wetting agent, dispersing agent, Glauber's salt, sodium carbonate (Na2Co3) as well as caustic soda (NaoH) (to maintain the pH between 10 and 11), and borax as buffering agents were used in the dye bath.

Apparatus

Padding mangle was used to squeeze the pretreated fabric to aid the penetration of solvent mixture into the fibers. Dyeing was performed using the dyer bath (Rota dyer 1 8 × 1 0 0-N machine, R.B. Electronics & Engineering Pvt. Ltd., Mumbai-53, India).

Pre-treatment

The above chemicals were used as pretreatment agent. The pretreatments were carried out at room temperature for various time intervals, namely 10 minutes, 20 minutes, and 30 minutes. The pretreated fabrics were then squeezed in the padding mangle and then air dried for removal of residual solvent mixture. Then, the fabrics were subjected to dyeing.

Recipe:

Disperse dye: 2%.
Reactive dye: 2%.
Gluber salt: 5g/l
Soda ash: 3 g/l
Borax: 5 g/l
PH of the dye bath: 10 to 11
M: L (material to liquor ratio): 1: 50
Temperature: 80, 95, and 110°C
Time: 30, 45, and 60 minutes

The pretreated samples were introduced into the above-said dye bath and kept under these conditions for 10 minutes. Then, calculated amount of dye solution and chemicals were added into the dye bath. Then required temperature was reached by increasing the bath temperature at a rate of 2°C per minute. Dyeing was carried out for the above- mentioned durations. After the completion of the dyeing time, the temperature was brought down to room temperature gradually, and then the dyed fabrics were taken out and washed with water. The fabrics after dyeing and washings were reduction cleared by using commercially available reduction clearing agent, Ladipur MCL (Clariant Chemicals, India). Then, it was washed with water at room temperature and then dried in a hot air oven.

Test for Color Fastness

The untreated and solvent-pretreated 65/35 blended fabric after dyeing were tested for their wash fastness, light fastness and rub fastness using AATCC test methods (AATCC technical manual 2000). The washing fastness, was evaluated by AATCC method 61(2A) using an Atlas-Launder Ometer. Fastness to light was evaluated by AATCC method 16E using an Atlas CI 3000 + Xenon Weatherometer. The fastness to rubbing was also evaluated as per AATCC 116-1995 standards using crock meter.

Determination of Weight Loss

The weight loss percentage of the treated fabrics was determined by measuring the weights before and after pretreatments using an electronic balance Sartorius-GD 503-Germany.

Abrasion Resistance

The abrasion resistance of the fabric samples after and before solvent treatment was measured by Martindale abrasion tester as per ASTM D4966 test method.

SEM Topography

Scanning Electron Microscopic (SEM) studies were made on treated and untreated samples with S-3000H-Hitachi, Japan to study surface modifications if any caused by the solvent pretreatments using azeotropic mixtures. The samples were imaged with a magnification of 500x for better understanding of the internal core of the sample.

Result and discussion

Dyeing Behavior of Fabric

The effect of azeotropic mixture of solvent pretreatments on the dyeing behavior of 65/35 cotton and polyester blended fabric was studied by dyeing the pretreated and untreated fabrics for different dyeing time intervals (30 minutes, 45 minutes, and 60 minutes) and at different temperatures (80, 95, and 110°C). It is cleared that maximum dye uptake is observed in the case of samples pretreated for 8 minutes. As the pretreatment time increases, the dye uptake is found to increase with increase in dyeing temperature and duration of dyeing. The dye uptake for the samples treated beyond 8 min was found decreasing. The change in dyeing behavior of the treated fabrics reflects changes in fibre structure of the treated fabrics caused by azeotropic mixtures of solvents. Due to solvent pretreatment, the molecular structure of the fabrics gets loosened, resulting in increased dye uptake. The development in the dye uptake of treated samples is probably due to the large increase in inter surface by swelling or plasticizing action, greater segmental mobility of polymer molecules, formation of micro voids, and so on. The pretreatment enabled to get better dye uptake even at a low temperature of 80°C, and in the cases where the pretreatment time is above 8 minutes, the dye uptake is found to decrease which may be due to the desorption of dye from the fabric due to permanent swelling of the fibre. The degree of upgrading in dyeing behavior was found to be different for different dyes.

Fastness Properties

The wash, light, and rubbing fastness properties of the treated and untreated 65/35 cotton and polyester blended fabric. The results indicate that the solvent treatments involving azeotropic mixtures of solvents have slightly improved the fastness properties of the dyed polyester/cotton blended fabrics. This may be due to the fact that the solvent pretreatments have improved the penetration of the dyestuff molecules into the interior of the fiber matrix and have improved the stability of dye-fiber bond.

Weight Loss and Abrasion Resistance Measurements

It is observed that there are changes in weight and abrasion resistance of the solvent pretreated fabrics in comparison with untreated fabrics. It was found that the weight loss is very small and is dependent upon the pretreatment time. As the pretreatment time increases, there was an increase in weight loss. The abrasion resistance measurements of the treated materials show that there was a slight increase in abrasion resistance. The degree of increase in abrasion resistance was found to increase with increase in treatment duration due to increased hollowing of fiber surface. However, the overall effect of solvent pretreatment has not caused any harmful effect.

Ripping Strength Measurements

Ripping strength measurement of untreated and azeotropic solvent-mixture-pretreated samples showed that there is significant improvement in the ripping strength of the treated materials. In all the cases, the maximum load applied has been found to increase and the elongation percentage remains almost constant. The above changes may be due to very less influence of the solvent treatment on crystallinity index. The mechanical properties of textile fibers depend not only on the degree of crystallinity of fibers but also on the various secondary valence forces that operate in the polymer. The improvement in the strength of treated materials can be attributed to improvement in the structural order of the polymer matrix and generation of more number of crystallinites, leading to improvement in the resistance power to deform the material with higher inter chain bond. These observations are strengthened by the XRD and DSC results as well. The present observations are in conformity with the reports available on the effect of solvent pretreatment on polymers where, in the solvents, it does not penetrate the compact crystalline region in the polymer and therefore do not affect the strength of the polymer material.

Conclusion

The effect of azeotropic mixture of solvent pretreatments on the dyeing behavior of 65/35 cotton and polyester blended fabric was studied. As the pretreatment time increased, the dye uptake was found to increase. The slight development in the fastness properties of the pretreated fabrics revealed that the treatment has not affected the dye fiber bond and the improvement in fastness is due to improved dye pickup and dye fiber bond formation. The abrasion resistance measurements of the treated materials show that there was a small increase in abrasion resistance of solvent pretreated samples up to 6 minutes pretreatment time. Protracted solvent pretreatments led to decrease in abrasion resistance when treated for more than 6 minutes. As the time of pretreatment increased, the weight loss of the fabric was also found to increase. SEM studies showed that the azeotropic solvent mixtures attacked the entire surface of the fabric materials and caused corrosion. As the time of solvent treatment increased, wearing away spreaded into the fibre structure resulting in the formation of elongated pits on the surface. The improvement in the dye uptake of solvent-treated fabrics is due to large increase in inter surface area by swelling and greater segmental mobility of polymer molecules.

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