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Scope of Dyeing Polyester Cotton (PC) Blended Fabric in Single Bath Process for Water, Energy and Time Saving.

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Abstract: *Dyeing of fabric blends such as Polyester/Cotton (P/C) is presently done with two chemically different classes of dyes namely disperse for polyester and reactive for cotton, in two bath process. Experimental work was carried out on finding the possibility of dyeing the P/C blends in one bath process without drain the liquor after polyester part dyeing. All the existing chemical and conventional temperature range were applied in this study. The result indicates that, the using of one bath method in the polyester cotton dyeing can slightly change the fastness properties than the conventional method. The one bath dyeing method showed level dyeing having good fastness properties and offers the option of cost effective and eco-friendly dyeing process.*

Keywords *– PC blend fabric, Single bath dyeing, Shade matching, Color fastness, Cost effective*.

I. Introduction

In textile industry polyester / cotton (P/C) blends have dominant market share having share of 58.45% in worldwide - market. These blends are famous due to their aesthetic value and user friendly performance. Limitations of both fibers are balanced adequately by blending these two fibers making perfect blend. However, the P/C blends posses some challenges to dyer as polyester shows a hydrophobic character while cotton shows a hydrophilic character making it inevitable to dye them with chemically different class of dyes. The conventional method of exhaust dyeing for P/C blends is to dye each component separately under its optimum conditions, i.e. in a two-bath process. To address the issue of productivity and raising environmental concerns, several attempts have been made in the past to shorten this to one-bath processes. Various other combinations of dyes like disperse/direct and disperse/vat can be used in single bath dyeing but, the matching of shade is quite difficult. Reactive dyes have some significant advantages over other dyes applicable to cotton: viz., color value, reproducibility of color, and fastness properties are usually better, and the dyeing is easier to wash-off. The one-bath dyeing process uses a separated high-pH and low temperature reactive fixation step after the high temperature, low pH disperse dyeing to avoid a high rate of hydrolysis of both disperse and reactive dyes under high temperature, or high pH dyeing environment. This process is shorter as compared to two-bath dyeing process. This one bath method has the advantages over the conventional dyeing processes on reducing the dyeing cycle as well as energy consumption and water consumption.

II. Materials

2.1 Material used

- **PC blend fabric**

Polyester cotton is a blended fabric made of both the artificial polyester and the natural cotton. The blend is perfect for clothing as it brings both benefits of the two fabrics together. The fabric thus remains lightness and coolness of the cotton and polyester gives the strength and durability. This blend is usually comfortable by combining the natural effects of cotton for softness and moisture adsorption with the no iron crispness of polyester. The most common polyester cotton blend is found 65% polyester and 35% cotton, 80% cotton and 20% polyester etc.[7]

- **Disperse dye**

The majority of disperse dyes are low molecular weight, non-ionic mono-azo and anthraquinone derivatives. Polar substituent is usually present in the dye molecule so that the dye has the slight solubility in water required for dyeing. Hydroxyethylamino groups (NH-CH_2-CH_2-OH) are typical of such substituent. The interaction of such polar groups with the water, by dipole interactions and hydrogen bonds, is crucial for water solubility. Dipole forces and hydrogen bonds, as well as dispersion forces, also bind the dye molecules to polar groups in the fibres.

- **Reactive dye**

The molecular structures of reactive dyes resemble those of acid and simple direct cotton dyes, but with an added reactive group. Typical structures include the azo (a), anthraquinone (b), triphenodioxazine. The key structural features of a reactive dye are the chromophoric system, the sulphonate groups for water solubility, the reactive group, and the bridging group that attaches the reactive group either directly to the chromophore or to some other part of the dye molecule. The chromophoric system consist of azo, quinoid carbonyl, nitroso, nitro-group, carbonyl, vinyl group (-N=N-, C=O, -NO, -NO2, >C=O, -C=C-) etc unsaturated group. Each of these structural features can influence the dyeing and fastness properties. Most commercial ranges of reactive dyes have a complete gamut of colors, many of which are particularly bright. Reactive dyes often have quite simple structures that can be synthesised with a minimum of colored isomers and bi products that tend to dull the shade of the more complex polyazo direct dyes. Some colors are difficult to obtain with simple chromophores. Dark blue and navy reactive dyes are often rather dull copper complexes of azo dyes and the production of bright green reactive dyes remains a problem.[1]

- Anti creasing agent
- Detergent
- Sequestering agent
- Antifoaming agent
- Stabilizer
- Hydrogen peroxide
- Peroxide killer
- Enzyme
- Buffer solution
- Dispersing agent
- Leveling agent
- Softener
- Gluber salt
- Soda ash
- Acetic acid

III. Different Process/Method

3.1 Scouring & bleaching combined process

Scouring is performed to remove any impurities present in the fabric. The impurities (i.e. oil & wax, lubricants, dirt, surfactants, residual tints) are removed using an alkaline solution, typically sodium hydroxide, at high temperatures to breakdown or emulsify and saponify impurities. Bleaching is done to remove natural color from the fibre. Natural color is removed from the fibre by using hydrogen peroxide with stabilizer. Hydrogen peroxide produce perhydroxil ion which can remove the natural color from fibre.

Recipe:

Fino wet-OSR (Detergent)	: 1 gm/L	Dosing at room temperature
Altaslow -ZET	: 1 gm/L	Dosing at room temperature
Albafluid C (Anti-creasing)	: 1 gm/L	Dosing at room temperature
Arboquest 340 (Sequestering)	: 0.5 gm/L	Dosing at room temperature
Caustic soda	: 5 gm/L	Dosing at room temperature
Hydrogen peroxide	: 2.5 gm/L	Dosing at room temperature
Stabilizer	: 1 gm/L	Dosing at room temperature
Time	: 60 min	
Temperature	: 98^0C	
Drain		
Hot wash		
Peroxide killer	: 0.5 gm/L	Dosing at room temperature
Time	: 10 min	
Temperature	: 80^0C	
Drain		
Neutralization		
Acetic acid	: 1 gm/L	Dosing at room temperature
Time	: 10 min	
Temperature	: 60^0C	
Drain		

3.2 Enzyme biopolishing, Polyester Cotton Dyeing Single bath dyeing

Place illustrations the gray PC blended fabric has been subjected to enzyme to remove the fuzzy or projecting fibre from the fabric. After enzyme biopolishing polyester part of PC blend fabric is dyeing with disperse dye at 130^0C by the help of dispersing agent in the same bath without drain the liquor. In the time of polyester part dyeing 95% of disperse dyestuff exhausted by the polyester part. After that in the same bath reactive dyes can be applied to the cotton part in the same bath without drain the liquor. In reactive dyeing absorption was carried out by the gluber salt and migration was done at 60^0C for 30 min. Finally soda ash was dosed at 60^0C for 30 min for fixation. Then dyed sample were neutralized, hot washed and cold washed.

Recipe

Retrocell-PLX (Enzyme)	: 0.5 gm/L	Dosing at room temperature
Albatex AB-45 (Buffer)	: 0.5 gm/L	Dosing at room temperature
Acetic acid	: As required (P^H 4.5)	Dosing at room temperature
Time	: 30 min	
Temperature	: 50^0C	
Polyester part dyeing		
Terasil Red W4B5	: 0.5%	Dosing at room temperature
Terasil Yellow W6G5	: 0.5%	Dosing at room temperature
Suprapole HPE (Dispersing)	: 1 gm/L	Dosing at room temperature
Arboquest 340 (Sequester)	: 1 gm/L	Dosing at room temperature
Time	: 30 min	
Temperature	: 130^0C	
Cotton Part Dyeing		
Novacron Red FN-2BL	: 0.5%	Dosing at room temperature
Novacron Yellow FN-2R	: 0.5%	Dosing at room temperature
Texpart GL500 (Anticreasing)	: 1 gm/L	Dosing at room temperature
Arboquest 340 (Sequester)	: 1 gm/L	Dosing at room temperature
Albatex DBC (Levelling)	: For P^H 6	Dosing at room temperature
Acetic acid	: 1 gm/L	Dosing at room temperature
Gluber's Salt	: 20 gm/L	Dosing at room temperature
Temperature	: 60^0C	
Time	: 30 min	
Soda ash	: 5 gm/L	Dosing at 60^0C temperature
Time	: 30 min	
Temperature	: 60^0C	
Soaping		
Seloson NOS (Detergent)	: 1 gm/L	Dosing at room temperature
Acetic acid	: 1 gm/L	Dosing at room temperature

Temperature	: 90^0C	
Time	: 10 min	
Softening		
Satamine DWS (Softener)	: 1 gm/L	Dosing at room temperature
Acetic acid	: 1 gm/L	Dosing at room temperature
Temperature	: 80^0C	
Time	: 10 min	

3.3 Testing of Color Fastness to Wash

The resistance of a material to change in any of its color characteristics, when subjected to washing is called color fastness to wash. If dye molecules have not penetrated inside the polymer chain of fiber or have not attached to the fiber with strong attractive force, poor wash fastness results. Color fastness to wash of this sample has been done by following the method ISO 105 C03. This process is carried out in a stainless steel container putting on a Wash-wheel with a thermostatically controlled water bath and rating speed of 40±2 rpm. SDC multifibre DW is used to measure the color staining of sample. D 65 light source is used to evaluation of result with using color change grey scale and color staining grey scale.

3.4 Testing of Color Fastness to Rubbing

Rubbing fastness is the resistance of fading of dyed textiles when rubbed against a rough surface. This test is designed to determine the degree of color which may be transferred from the surface of a colored fabric to a specify test cloth for rubbing (which could be dry and wet). EN ISO 105×12 method is followed for testing color fastness to rubbing. In this test the dyed specimens are rubbed 10 times using crockmeter which has a weighted finger covered with piece of desized and undyed cotton cloth. For wet rubbing the cotton cloth is wetted out by distilled water before being rubbed on the dyed sample. Evaluation has been done under D 65 light source with using color change grey scale.

3.5 Testing of Color Fastness to Perspiration

Continuous contact with the human perspiration also affects the fastness of some the dyed fabrics. In fact the perspiration is found to be either slightly alkaline or acidic in nature. When fabric is subjected to this alkaline or acidic perspiration continuously sometimes the tone and depth of the dyed shade gets affected. ISO 105 E02 method is followed to conducting this test in alkaline solution. SDC DW multifibre is used for measuring color staining. Thoroughly wetting one composite specimen in the solution at pH 8 at liquor ratio 50:1 and allowing it to remaining in the solution for 30 minute at room temperature. Wiping of excess liquid from the specimen placed it between two plates of the perspirometer under a pressure 12.5 KPa. Then the perspirometer is placed in an oven at 37ºC for 4 hours. Evaluation is done by color change grey scale and color staining scale in a light box under D65 light source and rated from 1 to 5.

IV. Results And Discussions

4.1 Ratting of Color Fastness to Wash

Ratting of color staining						Ratting of color change
Acetate	Cotton	Nylon	Polyester	Acrylic	Wool	
4.5	4.5	4.5	4.5	5	4.5	4.5

4.2 Ratting of Color Fastness to Rubbing

Ratting	
Dry rubbing	Wet rubbing
5	4

4.3 Ratting of Color Fastness to Perspiration

Ratting of color staining						Ratting of color change
Acetate	Cotton	Nylon	Polyester	Acrylic	Wool	
5	4.5	5	5	4.5	4.5	4.5

V. Conclusion

P/C blend fabrics were successfully dyed by one-bath one-step dyeing process. This process was not cumbersome as other process because here all the existing chemicals were used which has not needed any special requirements. The novelty of undertake study is successful by maintaining the right process with the existing dyes and chemicals as is to give complete shade gamut, which will open up new avenues to dyeing factory owner to cater to the blend dyeing needs of the textile processors. The work is based on the well established process of dyeing however will emerge in readymade dyes as option to dyers to get rid of cumbersome shade matching at their end. Also, this one-bath one-step dyeing process has potential in offering savings in time, energy, water and labor. This research work demonstrates the specific possibility of a commercially acceptable dyeing process for P/C blend using one bath method.

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