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***Research Paper***

# Colour fastness properties of tie-dyed cotton fabric with hot reactive dye

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**ABSTRACT :** Colour fastness of fabric is very important aspect as end use of fabrics depends on this property. A study was conducted to investigate the colour fastness properties of tie-dyed cotton fabric using reactive dye. The tie-dyed samples were evaluated for colour fastness to washing, rubbing, light and perspiration using the methods prescribed by the Bureau of Indian Standards. The fabric was dyed with reactive dye in two dye concentrations *i.e.*, 2 per cent and 4 per cent. In 2 per cent dye concentration, the washing fastness was excellent whereas in 4 per cent it was very good. Sunlight fastness was good in both 2 per cent and 4 per cent dye concentrations. Acidic perspiration fastness was good in both the dye concentrations and alkaline perspiration fastness was very good in 2 per cent dye concentration and it was fairly good in 4 per cent dye concentration. Dry rubbing fastness was excellent in both dye concentrations *i.e.* 2 and 4 per cent of reactive dye and wet rubbing fastness was very good with both the dye concentrations. The results concluded that colour fastness of the samples dyed with lower percentage gave better fastness than higher percentage indicating that more dye ions hinders the absorption of dye by the fabric.

**KEY WORDS :** Reactive dye, Colour fastness, Dye concentration

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Colour fastness is the ability of dye to retain its colour after exposure to sun, perspiration, atmosphere, washing or other colour destroying agents. The fastness of color has a direct bearing on the consumer choice for certain colours and fabrics. Good colour fastness means that a dye or pigment will retain its original colour with conditions of wear or use, cleaning, washing and storage. Beauty of colour on any fabric is of no value to the consumer unless the dye is considered fast under conditions in which fabrics will be used.

Tie-dye is a process of resist dyeing textiles or clothing which is made from knit or woven fabric, usually cotton; typically using bright colors (Anonymous, 2009). Traditionally tie and dye was done using natural dyes but with the invention of synthetic dyes like direct dye which is cheap and easy to apply is generally used for tie and dye but the color fastness of direct dyes is very poor.

Gohl and Vilensky, 1983; Imada *et al*., 1994; Alam *et al*., 2008 pointed it out that reactive dyes have very good wash fastness, this is attributed to the very stable covalent bond that exists between the dye molecule and the fibre polymer. It was also emphasized that general textile materials coloured with reactive dyes have good light fastness, these dyes have a very stable electron arrangement and provide good resistance to the degrading effect of the ultraviolet component of sunlight. Reactive dyes bond chemically to the cotton fiber, preventing the dyes from bleeding after they are set (Anonymous, 2007; Gohl and Vilensky, 1983). This is especially important for tie-dyed items. There are many desirable properties of dyes but one of the most important is how well they adhere to the materials and how well they stay attached because fastness is the ability to remain unchanged.

Hence, an attempt has been made to assess the colour fastness properties of tie-dyed fabric with reactive dye.

## RESEARCH METHODS

The suitable cotton fabric was selected on the basis of maximum dye absorption. Fabric was desized, scoured and bleached for uniform absorbance of dyeing. Preliminary data of fabric *i.e.* fabric count, fabric thickness and fabric weight was studied using standard test methods. The cotton fabric samples were tied and dyed with reactive red H brand dye.

The method of dyeing of cotton fabric with reactive dye was standardized on the basis of optimum wave length, dye concentration, dyeing temperature, dyeing time, dyeing pH and dyeing auxiliaries. Colour fastness of tied-dyed fabric to sunlight, washing, rubbing and perspiration were also studied.

**Assessment of colour fastness of the tie-dyed fabrics :**

The wash, light, perspiration and rubbing fastness of tie-dyed cotton samples were tested using standard test methods.

**Fastness to washing :**

For the present study, the washing fastness test was carried out as per recommendations of IS: 3361-1979 method (Anonymous, 1979).

**Fastness to sunlight:**

Colour fastness of textile materials to daylight is of considerable importance to the consumers. The resistance of a material to change its colour characteristics as a result of exposure of the material to the sunlight or to artificial light source is known as its light fastness.The exposure rack was used for testing of fastness to sunlight. The test for fastness to sunlight was carried out according to IS: 686-1985 method (Anonymous, 1985).

**Fastness to perspiration:**

The fastness to perspiration was tested by the test method IS: 971- 1983 as prescribed by the Bureau of Indian Standards (Anonymous, 1983).

**Fastness against rubbing :**

Fastness to rubbing means the resistance of textile materials to every type of rubbing and staining from textiles in actual use. The fastness to rubbing was carried out according to IS: 766-1988 method (Anonymous, 1988).

## ■ RESEARCH FINDINGS AND DISCUSSION

Preliminary data of the selected cotton fabric were studied before dyeing. The fabric had thread count of 104x85 ends and picks per inch, weight 86 g/sq.mt and thickness was found to be 0.23 mm, respectively.

The optimum proportions of different dyeing variables are presented in Table 1. The maximum optical density was observed at 520 nm wavelength. The optimum concentration of dye was 2 per cent on the basis of maximum dyeing absorption and 4 per cent on the basis of colour fastness properties. The optimum dyeing temperature was $80^0$C and the optimum dyeing time was 90 minutes for both the dye concentrations. The optimum pH for dyeing was 10.5 for both the dye concentrations. The optimum concentration of sodium sulphate was 60 g/l for 2% and 70 g/l for 4% and the optimum concentration of sodium carbonate was 15 g/l for 2% and 20 g/l for 4%.

The samples were tie-dyed using standardized dyeing conditions and assessed for colour fastness for further application on articles. The fastness grades of tie-dyed samples for colour change and staining using hot reactive dye are given in Table 2.

**Washing fastness :**

It is clear from Table 2 that for 2 per cent dye concentration washing fastness grades for colour change were excellent (5) and grades for colour staining were very good (4/5) but with 4 per cent dye concentration the grades for colour change were very good (4/5) and for colour staining were good (4). Vastsala (2003) emphasized that reactive dyes exhibited good fastness properties which may be due to the very stable electron arrangement and covalent bond that existed between the dye molecules and the fibre polymers which provide good resistance to washing and sunlight, respectively. Imada *et al*. (1994) endorsed that cotton fabrics dyed with reactive dyes showed very little colour change

**Table 1: Optimum proportions of dyeing variables for dyeing of cotton fabric with reactive dye**

| Sr. No. | Dyeing variables | Trial proportions | Selected proportions |
|---|---|---|---|
| 1. | Determination of wavelength (nm) | 400-700 | 520 nm |
| 2. | Dye concentration of reactive dye (%) | 1, 2, 3, 4, 5, 6, 7, 8 | 2 % and 4% |
| 3. | Dyeing temperature ($^0$C) | 60, 70, 80, 90,100 | $80^0$C |
| 4. | Dyeing time (minutes) | 80, 90, 100, 110, 120 | 90 mins. |
| 5. | Dyeing pH | 9, 9.5, 10, 10.5, 11,11.5 | 10.5 |
| 6. | Concentration of sodium sulphate (g/l) | 30, 40, 50, 60, 70, 80, 90 | 60 g/l for 2%,70 g/l for 4% |
| 7. | Concentration of sodium carbonate (g/l) | 5, 10, 15, 20 ,25 | 15 g/l for 2%,20 g/l for 4% |

**Table 2: Colour fastness properties of cotton fabric tie-dyed with reactive dye**

| Dye conc. (%) | Fastness grades | | | | | | | | | | | Mean score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Washing | | Sunlight | Perspiration | | | | Rubbing | | | | |
| | | | | Acidic | | Alkaline | | Dry | | Wet | | |
| | CC | CS | CC | CC | CS | CC | CS | CC | CS | CC | CS | |
| 2 | 5 | 4/5 | 4 | 4 | 4/5 | 4 | 4 | 5 | 5 | 4/5 | 4/5 | 4.45 |
| 4 | 4/5 | 4 | 4 | 4 | 4 | 3/4 | 4 | 5 | 5 | 4/5 | 4 | 4.21 |

CC: colour change, CS: colour staining

after washing treatment.

**Rubbing fastness :**

The fastness grades for colour change and colour staining were excellent (5) in dry rubbing and in wet rubbing the grades for colour change and colour staining were very good (4/5) with 2 per cent dye concentration. In 4 per cent dye concentration the grades for colour change and colour staining were excellent (5) in dry rubbing and in wet rubbing the grades for colour change were very good (4/5) but for colour staining it was good (4).

**Sunlight fastness :**

The grades for colour change in both the dye concentrations (2% and 4%) were good (4). Alam *et al*. (2008) revealed that the colour fastness of cotton fabric to exposure under light decreased with increase in exposure time. The fastness of a dyed fabric depends upon the dye-fibre interaction and the intensity of light. An intensive oxidation of the fibre due to the capacity of the dye molecule, excited by the light. This oxidation reaction rapidly occurs at the earlier time of light exposure and hence the colour of the dyed fibre abruptly changes. But when the reaction is completed, change in colour does not occur.

**Perspiration fastness :**

The fastness when tested for acidic perspiration indicated good (4) fastness grades for colour change in both the dye concentrations. The grades for acidic perspiration for colour staining were very good (4/5) in 2 per cent dye concentration and good (4) in 4 per cent dye concentration. The grades for colour change in alkaline perspiration fastness were good (4) in 2 per cent dye concentration and in 4 per cent dye concentration the grades for colour change were fairly good (3/4) and grades for colour staining were good (4) in both the dye concentrations. Alam *et al*. (2008) revealed that the colour fastness of dyed cotton fabric to perspiration is fair.

It clearly indicated that between the two depths of shades, cotton fabric samples dyed with 2 per cent reactive dye showed best colour fastness properties against all four parameters with highest mean score *i.e.* 4.45.Alam *et. al.* (2008) observed that the dye absorption by cotton fabric decreased with the increase in dye concentration in the dye bath. This may be explained by the fact that the presence of more dye ions hinders the absorption of dye by the fabric whereas rare ions favour it. It was found that with the increase in dye concentration, the absolute quantity of the absorbed dye increased while the relative quantity diminished.

Vastsala (2003) emphasized that reactive dyes exhibit good fastness properties. This is due to the very stable electron arrangement and covalent bond that existed between the dye molecules and the fibre polymers which provide good resistance to washing and sunlight, respectively.

**Conclusion :**

The samples tied and dyed with standardized dyeing conditions of red hot reactive dye exhibited the excellent wash fastness for the samples dyed with 2 per cent dye concentration whereas the wash fastness was very good for 4 per cent dye concentration. Sunlight fastness was good in both 2 per cent and 4 per cent dye concentrations. Acidic perspiration fastness was good in both the dye concentrations and alkaline perspiration fastness was very good in 2 per cent dye concentration and it was fairly good in 4 per cent dye concentration. Dry rubbing fastness was excellent in both dye concentrations *i.e.* 2 and 4 per cent of reactive dye and wet rubbing fastness was very good with both the dye concentrations. It can be concluded from the study that the tie-dyed samples dyed with 2 per cent dye concentration of the reactive dye exhibited better colour fastness than 4 per cent dye concentration.

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