Effect of Functional groups of Reactive dyes on the Dyeing Properties of Cotton Knit fabric

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Abstract

Maximum natural textile substrates are dyed with reactive-based dyes. The exercise of this dye is progressed in an elevated celerity for its moderate to good light fastness, simple and variant dyeing methods, and an apparition of many bright colors. A trichromatic mixture of dyes of the same reactive group is always preferred. In this research work, single jersey cotton knitted fabric was dyed with the same amount [2%] of reactive dyes (red, yellow & blue) of different functional groups (Mono-functional; Triazine and Vinyl sulphone, Bi-functional; Pyrimidine and Vinyl Sulphone and poly-functional). Colorfastness (wash, rub, perspiration and light) of dyed fabrics were evaluated. Bursting strength was also measured for different functional groups. It was found that Reactive dyes of MCT and Bi-Functional groups showed better rubbing, light fastness, and bursting strength properties than other functional groups.

1. Introduction

In 1954, reactive dyes were started to apply on cellulosic materials as the rising class of dyes. In 1956, ICI introduced Procion dye as a reactive dye with extreme popularity in England. The Great Popularity was established due to easy application methods such as discontinuous, semi-continuous, continuous, etc.; scope of application both in modern and old machines; different spreading power; application for dull to bright shades. Due to environmental issues of Sulphur and azoic dyes, pricing issue of vat dyes, colorfastness issue of direct dyes peoples accepts reactive dyes readily but the environment pollutes much by this class of dyes [1].

The reason for the good fastness properties of reactive dyes is the formation of covalent bonds with the fibers that are created during dyeing. Cellulosic materials like cotton or linen fibers are dyed satisfactorily with reactive dyes Reactive dyes are most commonly used in the dyeing of cellulose like cotton or flax, but also wool can dye wool and nylon with reactive dyes. The degree fixation of reactive dyes is low compared to other types of dyestuff, since the functional group of reactive dyes also bonds to water molecules, creating hydrolysis [2].

Md. Anwar Kamal et al. [3]; was confirmed the fastness property to wash is better in the combination of different functional groups of reactive dye. They also showed that the bi-functional group is stronger than the mono-functional for shade change and staining.

Abu Naser Md. Ahsanul Haque [4] found that electrolyte, alkali, and temperature positively influence the depth of the shade on cotton fabric with Fluoro Chloro Pyrimidine reactive dyes. He also found that the 1:20 liquor ratio was suitable for better color value.

Muhammad Iftikhar et al. [5] was confirmed that varying concentrations of alkali, dye, and salt influenced the dyeing of cotton knitted fabrics with reactive dyes. They recorded excellent results for washing and light fastness at 30% salt, 10% alkali, and 1% dye concentration. They also found that colorfastness to

perspiration was improved at maximum alkali concentration but with increasing salt concentration perspiration fastness decreased.

Awais Khatri et al. [6]; was confirmed that pad-steam dyeing of cotton fabric produces better lightfastness than pad-dry-bake dyeing of the same recipe by using reactive dyes. However, they also showed that pad-steam dyeing is not suitable for producing medium to dark colors but suitable to produce pale colors.

The most consumable commercial dyes are now used as Reactive dyes which are water-soluble. The reason for the solubility of reactive dyes in water is the presence of sulphonic acid groups in the dye structure. Reactive dyes contain various functional groups in their structure like triazine groups, pyrimidine groups or sulfato ethyl sulfone groups, etc. The fixation of these dyes with the functional groups of fibers such as $-OH$ of cellulose and $-NH_2$ of protein fibers is carried out by alkali like sodium carbonate, sodium silicate, sodium hydroxide, etc. Based on reactive groups, reactive dyes can be mono-functional, bi-functional, and poly-functional. So, this research has been conducted on 100% cotton knitted fabric to find out the best functional group of reactive dyes by comparing various properties of dyed fabric.

2. Materials And Methods

2.1. Materials

Through this research work, well scoured- bleached 100% cotton single jersey knit fabric was selected. The fabric GSM was 160 and the yarn count was the 30^s with stitch length 2.72mm. The fabric was collected from the Niagara Textiles Ltd. of Bangladesh. Commercially used Reactive dyes namely Monofunctional reactive dyes Triazine and Vinylsulphone (Drimaren Yellow P-6GS, Drimaren Red P-4B, Drimaren Blue P-3RLN) individually; Bi-functional reactive dyes (Pyrimidine and Vinyl Sulphone); and poly-functional reactive dyes were collected from the available market sources.

The Chemicals Glauber salt, Soda ash, Soaping agent, Sequestering agent, Leveling agent, Wetting agent, Caustic soda (NaOH), Hydrogen peroxide (H_2O_2), Sodium Carbonate (Na_2CO_3), Acetic Acid, Peroxide stabilizer were collected from commercial sources.

2.2 METHODS

2.2.1 Fabric Preparation

For the scouring and bleaching process at first, a recipe was prepared by mixing H_2O_2 : 2.5 g/l, NaOH: 2.5 g/l, Wetting agent: 1 g/l, Detergent: 1 g/l, Sequestering Agent: 1 g/l, Stabilizer: 2 g/l and scouring and bleaching was done in single bath combined process.

2.2.2 Fabric Dyeing

Fabrics after being well scoured and bleached, then dyed with the different reactive dyes; i.e. monofunctional, bifunctional and polyfunctional reactive dyes. The dyeing was carried out with the same amount in a sample dyeing machine according to the recipe of sample weight 10 g, reactive yellow: 0.4% owf, reactive red: 0.8% and reactive blue: 0.8%, soda ash: 18 g/l, salt: 50 g/l, Sequestering agent: 0.5 g/l, wetting agent: 0.5 g/l, time: 60 minutes, temperature: 60°C and materials to liquor ratio: 1:10. Then the bath was cooled, drained, rinsed, and dried.

2.2.3 Color Fastness Properties Test

Colorfastness test properties of all dyed specimens were carried out by the test methods provided by the ISO Standard. Colorfastness to washing was determined by the test method provided by the ISO 105-C06 Standard. Colorfastness to water was carried out by the test method provided by the ISO 105-E01 Standard. Colorfastness to perspiration was determined following the test method provided by the ISO 105-E04 Standard. Colorfastness to rubbing was determined per the test method provided by the ISO 105-X12 (dry and wet) Standard. Colorfastness to light was conducted in accordance with the test method provided by the ISO 105-B02:2013 Standard.

3. Result And Discussion

3.1 Colorfastness to Wash Test Result

Table 3.1: Colorfastness to wash test result

Fig. 3.1: Wash fastness properties of various reactive dyes for color changing scale

Fig. 3.2: Wash fastness properties of various reactive dyes for color staining scale

The color fastness rating for changing scale was the same for different functional groups when the fabric was dyed with the same percentage of red, yellow, and blue in the trichromatic method. Here good to excellent colorfastness rating was achieved for all functional groups. But colorfastness rating for the staining scale was observed approximately the same for Monofunctional, Vinyl Sulphone & Bifunctional but differs in the case of Poly Functional group dyes. Poly Functional dyes showed less color staining rating in the case of polyamide fiber.

3.2 Colorfastness to perspiration test result

In Acidic Condition

Table 3.2: Colorfastness to acidic perspiration test result

Fig. 3.3: Perspiration fastness properties of various reactive dyes for color-changing scale in acidic conditions.

Fig. 3.4: Perspiration fastness properties of various reactive dyes for color staining scale in acidic conditions.

In Alkaline Condition

Table 3.3: Colorfastness to alkaline perspiration test result

Fig. 3.5: Perspiration fastness properties of various reactive dyes for color changing scale in alkaline condition.

Fig. 3.6: Perspiration fastness properties of various reactive dyes for color staining scale in alkaline conditions.

It was observed that both in acidic and alkaline conditions, all functional groups showed good color fastness properties for color-changing scale. But in the case of color staining, different functional groups showed different colorfastness to perspiration with different fibers.

3.3 Colorfastness to Rubbing test

Table 3.4: Colorfastness to rubbing test result

Fig. 3.7: Rubbing fastness properties of various reactive dyes

The monofunctional & Bifunctional groups were shown good to excellent colorfastness to dry rubbing, Vinyl Sulphone was shown good and Poly Functional was shown average to good colorfastness properties. In addition, monofunctional dyes were shown maximum (Good) and polyfunctional dye were shown lowest (moderate to average) fastness properties compared to others.

3.4 Bursting Strength Test

Table 3.5: Bursting strength test results

Fig. 3.8: Bursting strength properties of various reactive dyes.

The maximum (366 KPa) Bursting Strength was found at Bifunctional and minimum (256 KPa) Bursting Strength was achieved with Poly Functional dyes. But Bursting strength was evaluated at 356 KPa for Vinyl Sulphone and 328 KPa for the Mono Functional group of dyes.

3.5 Colorfastness to Artificial Light

Table 3.6: Colorfastness to light test result

Fig.3.9: Light fastness properties of various reactive dyes

Colorfastness to artificial light Vinyl Sulfone dyes was very poor. MCT and Bifunctional groups showed fair light fastness properties which were better compared to others but Poly functional groups showed poor to fair light fastness properties.

4. Conclusion

Colorfastness to washing, Colorfastness to rubbing, Bursting strength, Colorfastness to light, and colorfastness to perspiration of s/j cotton knitted fabric was evaluated in this experiment after dyeing with different functional groups of reactive dye. Wash fastness and perspiration fastness was good and the same for all functional groups. Rubbing fastness was better in MCT and Bifunctional groups than Vinyl Sulphone and Polyfunctional groups. Bursting strength was better in Bifunctional and MCT group dyes but polyfunctional showed the lowest bursting strength. MCT and Bifunctional groups showed better light fastness properties compared to Vinyl Sulphone and Polyfunctional reactive dyes.

Declarations

Competing interests:

The authors declare no competing interests.

References

1. 'Golden Jubilee of Reactive Dyes-Future Trends SDC Conference Organized: by Mumbai Region; 'Cellulosic Dyeing', Edited by John Shore; SDC, 1995
2. Horst Tappe, W., Helmling, P., Mischke, K., Rebsamen, UweReiher, W., Russ, Ludwig Schläfer and Petra Vermehren "Reactive Dyes" in Ullmann's Encyclopedia of Industrial Chemistry 2000, Wiley-VCH, Weinheim
3. Md. Anwar kamal¹, moni sankar mondal², md. Mahbubul haque³, Stanley srijon mondal⁴ dyeing with reactive dyes by the combination of different functional groups and evaluation of colorfastness to washing on cotton knitted fabric
4. IJRET: International Journal of Research in Engineering and Technology. ISSN: 2319 – 1163 ISSN: 2321–7308. Volume 03 Apr-2014
5. NISAR AHMAD JAMIL AND BABAR SHAHBAZ the influence of: salt, alkali, and dye concentration on washing, light, and perspiration fastness of reactive dyed cotton knitted fabric. International Journal of Agriculture and Biology.1560–8530/2001/03-1-95-98
6. Mazhar Hussain Peerzada², Rafique Ahmed Jhatial³ Department of Textile Engineering, Mehran University of Engineering and Technology, Jamshoro ^[1,2] National Institute of Science and Technical Education, Islamabad³. ISSN 10135316; CODEN SINTE 8

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Figure 2

Fig. 3.2: Wash fastness properties of various reactive dyes for color staining scale

Figure 3

Fig. 3.3: Perspiration fastness properties of various reactive dyes for color-changing scale in acidic conditions.

Figure 4

Fig. 3.4: Perspiration fastness properties of various reactive dyes for color staining scale in acidic conditions.

Figure 5

Fig. 3.5: Perspiration fastness properties of various reactive dyes for color changing scale in alkaline condition.

Figure 6

Fig. 3.6: Perspiration fastness properties of various reactive dyes for color staining scale in alkaline conditions.

Figure 7

Fig. 3.7: Rubbing fastness properties of various reactive dyes

Figure 8

Fig. 3.8: Bursting strength properties of various reactive dyes.

Figure 9

Fig.3.9: Light fastness properties of various reactive dyes

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