OPENING MINDS: RESEARCH FOR SUSTAINABLE DEVELOPMENT

Fashionable Colour Fastness Failure to Chlorinated Water of Casual Wear

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1 INTRODUCTION

Fashionable dyes are becoming increasingly important as people become more concerned about the impact on the environment. Developed countries in particular, prefer casualwear with fashionable colours which are resistant to most external agents such as chlorinated water. The colourfastness of casual wear to chlorinated water is becoming increasingly more important as tap water contains higher ppm chlorine levels. Furthermore, detergents for domestic washing contain higher levels of oxidation agents for the purpose of removing dirt (Texlan laboratory, 2013). The combined result of the use of this water and detergents in laundering, is the higher level of active chlorine causing discoloration or fading of colours in casual wear garments. The fading or discoloration of dyed material is due to oxidation caused by the active chlorine. In general Pigment, Azo, and vat dyes can be used for the dying of cotton casualwear and swimwear and these have good colourfastness for chlorinated water (Wikipedia 2016). Colourfastness depends on processing conditions such as dyeing temperature, dyeing time, dye concentration and electrolyte concentration (Alam *et al.*, 2008). Further, Alam *et al*. (2008) report that dye absorption increases with the increase of electrolyte concentration, dyeing temperature and dyeing time but decreases with the increase of dye concentration. Shimohiro *et al.* (1984) report that the tannin can be more strongly fixed to the fibers by further treating with a metal salt, whereby an excellent colour fastness to chlorinated water can be maintained for a prolonged period of time (Shimohiro *et al*., 1984).

There are fashionable dyes supplied by chemical suppliers with specific, different hues and brightness for specific colours that meet colour fastness requirements. Most of the time, the dye house needs to formulate a new recipe using the trichromatic RYB colour model as there are no closely matching shades provided by the chemical supplier. This paper presents a few dyeing routes and the colourfastness test results of these few cases, which were required by most of the customers as fashionable colours with different hues and brightness.

1.1 Research Problem

Customers request fashionable colours with different hues and brightness which require the combining of single dyes. After combination, dye stuffs show poor resistance to colourfastness to chlorinated water. The selection of dyes must be according to the customer performance guidelines in which restricted substances level requirements must be maintained at minimum ppm levels. Furthermore, formulating a new recipe using the trichromatic RYB colour model needs to concentrate on the transparency of effectiveness of effluent plant after water treatment.

1.2 Objectives

Finding suitable, fashionable dye type and dye route which demonstrate resistance to colourfastness for chlorinated water and can be used for colouration of casual wear garments.

2 METHODOLOGY

Fabric samples from cotton casual wear were dyed with fashionable dyes, which are formulated by the dye house using the trichromatic RYB colour model for specific colours, where the required colour cannot be closely matched using the available range of dyes. After dying cotton casualwear with combination of RYB dye recipe, it was tested using the standard AATCC 162 for colour fastness for chlorinated water (5ppm). When the colour fastness to chlorinated water fails, the dye house did some changes to the dye route by changing fixing agent and did the colouring and fastness tests as per the standard AATCC 162.

The samples were evaluated for colour fastness to chlorinated water by comparing the original coloured sample and the sample after washing with chlorinated water. Similarly, colour fastness test results of the fabric sample colours after dying with newly formulated dyes, after changing the fixing agent for newly formulated dyes for all three colours and after washing with chlorinated water are analysed and presented for the purpose of comparison in Table form.

Table 1 shows the selected samples for applied dye type with recommended dye route, dye type and changes, selected 2nd types of dye for different samples for a total of 9 samples.

Cotton casualwear fabrics fabric samples 1.1 and 2.1 were dyed with Hi-white for Khaki and Brown respectively using dye route: as per the chemical supplier's instruction for Hi-White colours and pre-treatment and Rinse at 6.0pH and each step at 500C for five minutes.

Formulated dye at 6.5pH and temperature 900C for 50minutes. Required Hue and Brightness dye stuff were mixed as given in the Table 2. Fabric sample 3.1 was dyed with Reactive for Green using dye route as above. Samples were tested for colour fastness to chlorinated water applying standard AATCC 162. The mildest version of chlorinated water (5ppm) was used during the test. Table 2 shows the photos comparing the original sample after dying with tested sample for colour fastness to chlorinated water.

Failing Samples 1.1 and 3.1 to colourfastness test, applied formulated Pigment dye at 6.5pH and temperature 600C for 70 minutes for samples 1.2 and 3.2. Similarly, failing Samples 2.1 to colourfastness test, applied formulated Reactive dye at 6.5pH and temperature 600C for 70 minutes for samples 2.2. Samples 1.3, 2.3 and 3.3 were dyed with pigment reactive and pigment respectively to get the required colour as shown in Tables 1 and results are shown in Table 3. Further Table 3 shows the trichromatic dye combination to get the required colour.

3 RESULTS AND DISCUSSION

Table 2 shows the change of colour in Samples 1.1, 2.1 and 3.1 just after dying and after colour fastness test for chlorinated water. As it shows all three samples failed although dye route was selected as recommended by the chemical supplier.

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Table 1: Applied dye type and changes to dye route for each sample

	1st types of dye and sample No.	**Changes to dye route and sample No**	**2nd types of Dye and sample No.**
3 Samples 1.1, 1.2, 1.3 Khaki colour	Hi-White Sample 1.1	Hi-White, fixing agent Sample 1.2	Pigment Sample 1.3
3 Samples 2.1, 2.2, 2.3 Brown colour	Hi-White Sample 2.1	Hi-White, fixing agent Sample 2.2	Reactive Sample 2.3
3 Samples 3.1, 3.2, 3.3 Green colour	Reactive Sample 3.1	Reactive, fixing agent Sample 3.2	Pigment Sample 3.3

Table 2: Change of colour after test of fabric sample dyed with Hi-White and Reactive

Required colour (Hue and brightness)	Mix dyes % and added chemicals	Colour Change	Comparing original sample with tested sample (after colourfastness to chlorinated water)
Sample 1.1 Khaki Before changing chemicals Dye route: Hi-White	Yellow 0.0797% Red 0.00182% Olive 0.004464% Brown 0.04565%	1.5 (required 3.5)	Tested Original 
Sample 2.1 Brown Before changing chemicals Dye route: Hi-White	Yellow 0.20165% Red 0.07112% Olive 0.21713%	1.5 (required 3.5)	Tested Original 
Sample 3:1 Green Before changing chemicals Dye route: Reactive	Yellow 1.02419%, Red 0.38867% Blue 1.20187%	1.5 (required 3.5)	Tested Original 

The Table shows that the primary colours can be combined to get the required shade other than olive colour with reactive. Olive colour is not suitable for combining to achieve other fashion colour.

4 CONCLUSIONS

Research analysis show that the newly formulated dye recipe using the trichromatic RYB colour model does not meet the colour fastness requirement to chlorinated water, although the individual single dyes meet the colour fastness requirement with the same dye route. In some cases, with different dye route to the dye route recommended for single dyes by the chemical suppliers meet the colourfastness requirement.

Table 3: Combined dye stuff, dye routes and colourfastness test results of tested 9 samples for three different colours

<table>
<tr><th>Colour dye</th><th colspan="2">Khaki colour (sample 1)</th><th colspan="2">Brown colour (sample 2)</th><th colspan="2">Green colour (sample 3)</th></tr>
<tr><td rowspan="2">Hi white</td><td>Sample 1.1 and 1.2</td><td>Yellow 0.07978%,
Red 0.00182%
Olive 0.04464%,
Brown 0.04546%</td><td>Sample 2.1 and 2.2</td><td>Yellow 0.20165%,
Red 0.07112%
Olive 0.21713%</td><td colspan="2" rowspan="2"></td></tr>
<tr><td colspan="2">Change only fixing agent-Dan Fix Paa 40 x 20 min –CC-3.0</td><td colspan="2">Change only fixing agent-Dan Fix Paa 40 x 20 min – CC-1.5</td></tr>
<tr><td>Pigment</td><td>Sample 1.3</td><td>Yellow 0.3845%
Red 0.08760%
Black 0.1617%
CC-4.5</td><td colspan="2"></td><td>Sample 3.3</td><td>Yellow2.45%,
Red 1.14%
Blue 3.54%
CC-4.5</td></tr>
<tr><td rowspan="2">Reactive</td><td colspan="2" rowspan="2"></td><td rowspan="2">Sample 2.3</td><td rowspan="2">Yellow 0.556%,
Red 0.1218%
Blue0.1431%
CC-4.0</td><td>Sample 3.1 and 3.2</td><td>Yellow 1.02419%,
Red 0.38867%
Blue 1.20187%</td></tr>
<tr><td colspan="2">Change only fixing agent-Dan Fix Paa 40 x 20 min – CC-1.5</td></tr>
</table>

Most of the fashionable colours with combine dyes are not resistant to chlorinated water, although casualwear coloured with individual single dyes show good colour fastness to chlorinated water. Similarly, dying of casualwear with fashionable combine dyes with same dye route show resistance to chlorinated water, although the individual dyes show good colour fastness to chlorinated water with same dye route. It is recommended that fashionable dye producers need to develop new dye route and chemical combinations for dying of casualwear with different hue and brightness to meet colour fastness requirements to chlorinated water.

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