EXAMINATION OF COLOURFASTNESS FAILURE OF CASUALWEAR TO CHLORINATED WATER

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ABSTRACT

*The colourfastness testing for chlorinated water is well established for swimwear. But it has now become increasingly more important to also test a wider range of casual wear type garments, as tap water can contain higher ppm chlorine and detergents for domestic washing contain oxidation agents. Casual wear and swimwear made of cotton and/or polyamide which are dyed or printed can be sensitive to high chlorine content in water and laundry wash liquors. Hence it is essential to confirm the fastness to chlorinated water of these products. Chemical suppliers can provide a range of specific single dyes that can achieve a range of colours (hue and brightness) which are fastness to chlorinated water. However, if a dye is not available for the required colour, a dye house needs to formulate a new recipe using the trichromatic RYB colour model. It was found that the majority of cotton casualwear dyed using a combination RYB dye recipe to achieve a good matching shade, were not resistant to chlorinated water. This paper shares insight and outcome of number of dyeing case studies and summarizes the outcomes and gives conclusions.**Keywords: Colourfastness testing, chlorinated water, oxidation agents.*

INTRODUCTION

The colourfastness testing for chlorinated water is well established for swimwear. But it has now become increasingly more important to also test a wider range of casual wear type garments. In some areas of the world (such as Japan) Tap water has been found to contain higher ppm chlorine levels to kill bacteria. Further, detergents for domestic washing contain higher level of oxidation agents for the purpose of removing highly dirt[1]. When this water and the detergents are used for laundering result is in higher level of active chlorine, which can cause 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 the colourfastness of reactive, direct, metal complex and acid dye is very poor and casual wear and swimwear made of cotton and/or polyamide which are dyed or printed with these dyes are sensitive to high chlorine content in pool water and laundry wash liquors[2]. Whereas Azo, reactive direct and vat dyes can used for dying of cotton casualwear and swimwear having good colorfastness for chlorinated water[3]. However, depending on the processing conditions such as dyeing temperature, dyeing time, dye concentration and electrolyte concentration. Alam et al. report that the dye absorption increases with the increase of electrolyte concentration, dyeing temperature and dyeing time but decreases with the increase of dye concentration. Further they report that the cotton casualwear dyed with reactive dye sensitive to strong acid and alkaline, so recommend the uses to keep away from strong acid and alkaline[4]. Shimohiro Y et al. report that the combination of the diamine and hydrolyzable tannin increases the color fastness to chlorinated water. Further state that the tannin can be more strongly fixed to the fibers by further treating with a metal salt, whereby an excellent color fastness to chlorinated water can be maintained for a prolonged period of time[5]

Time, temperature and pH during dye route can cause the resistance to various external agents such as sunlight, mechanical forces and chemicals. Chlorine and oxidation agents in detergents are one of the most important external agents that need to be considering when developing dye routes. Company is trying to find out suitable dye route and chemical combinations for dying of casualwear to meet colourfastness requirements. This became very serious after receiving some complaints from the foreign market for random fading or discoloration of garments dyed with combined dye recipes. This paper present few dyeing routes and the colorfastness test results of few cases where the dye house formulated new recipe using the trichromate RYB colour model as there were no closely matching shade provided by the chemical supplier. Most of the customer requirements are for fashionable colours with different hue and brightness.

RESEARCH PROBLEM

Colourfastness of metal complex, reactive, direct and acid dyes are very poor

Pigment, vat and Azo dyes can be used for cotton casual wear, which has good fastness to chlorinated water

Customers request fashionable colours, which requires combining single dyes

Combining dye stuffs show poor resistant to colourfastness

Dye selection must meet the customer performance guidelines

GOTS, GREEN SCREEN, OEKO TEX, GS, ZDHC, ETAD & BLUESIGN certified chemicals

RSL requirements are following - substances ppm levels

Transparency of effectiveness of effluent plant after water treatment

Dyes cannot be used if they do not meet the above environmental restrictions

GOTS-Global Organic Textile Standard, OEKO TEX-Standard is for various textile products to ensure that the chemicals used, ZDHC- Zero Distortable Hazard Chemicals, ETAD-Textile Products, Ecological And Toxicological Association, GS Mark- which stands for "Geprüfte Sicherheit" in German and means Safety Tested, is a licensed mark.

OBJECTIVES

Discover the reasons for colour fastness failure of cotton casualwear to chlorinated water

Finding dye type, which severely effect on colourfastness failure of casualwear to chlorinated water

Finding dye route, which severely effect on failing colourfastness to chlorinated water

Finding suitable dye type and dye route, which can be used for casualwear garments, with resistance to colourfastness in chlorinated water

METHODOLOGY

Cotton casual wear were dyed selecting new dye recipe, which are formulated by the dye house using the trichromate RYB colour model for specific colour, where the required colour cannot be closely matched using available range of dyes. Below table bshows the dye type, colour and the colourfastness values of available as single dyes. These dyes were used for formulation of new recipe to meet the closely matching colour using trichromate RYB colour model.

Table 1: Colour fastness values of dyes selected for mixing to get colour hue and brightness

Single Hi-White dyes colourfastness table		
Colourfastness failure of casualwear to chlorinated water		
Method-5ppm		
Dyes	Dye %	Colour Change
Black Hi-White	2	4/5
Blue Hi-White	1	4/5
Blue Royal Hi-White	1	2
Bordeaux Hi-White	1	¾
Brown Hi-White	1	4
Golden Yellow Hi-White	1	4
Green Hi-White	1	4-4/5 Duller
Olive Hi-White	1	¾
Olive Hi-White B	1	3-3/4
Orange Hi-White	1	4/5
Red Hi-White	1	5

Turquoise Hi-White	1	4
Yellow Hi-White	1	3/4 Duller

If we required the colours specified in the table (Self shades), colourfastness can be accepted except for Blue Royal Hi-White. Single colours were not considered in this case studies, only new formulated recipe using above dyes were considered. After dying cotton casualwear with combination RYB dye recipe, tested using the standard AATCC 162 for colourfastness for chlorinated water (5ppm).

Once coloring and testing dye house did some changes to dye route and chemicals as most of the newly formulated dyes were not satisfied the colourfastness to chlorinated water. Colourfastness results of fabric sample colours after dying with newly formulated dyes and after washing are presented for comparing purpose. Similarly colourfastness results and the fabric sample colours after dying with changes to newly formulated dyes and after washing are presented for comparing purpose.

Testing of casualwear

If the samples failed colourfastness to chlorinated water even after changing dye route and the fixing agents, new fabric samples were dyed using different dye stuff.

Similar testing procedures and the changes of recipes were completed to achieve the required colourfastness values.

For some of colours, still could not achieve the required customer specified colourfastness values.

Case study 1

Fabric samples 1.1, 1.2 and 1.3 Cotton casualwear fabrics
Customer required colour – Khaki -A
Selected dye rout: as per the chemical supplier's instruction for Hi-White colours
Pre-treatment and Rinse at 6.0pH and each step at 50^0C for five minutes.
Formulated dye at 6.5pH and temperature 90^0C for 50minutes
Four dyes, yellow, red, olive and brown given weightages given as in Table 2 were mixed to get the Khaki-A Colour
Sample were tested for colourfastness to chlorinated water applying standard AATCC 162,
Mildest version of chlorinated water (5ppm) used during the test
Sample 1.1 failing to colorfastness test, change the fixing agent - Dan Fix Paa 40 x 20 min and did the test for sample 1.2, poor results
Failing Sample 1.2 to colorfastness test, applied formulated pigment dye at 6.5pH and temperature 60^0C for 70minutes for sample 1.3 and finally found good results.

Table 2: The combination of dyes for Khaki -A colour and the colourfastness values tested in EAM Maliban laboratory.

Required colour (Hue and brightness)	Mix dyes % and added chemicals	Colour Change (AATCC Grey scale)	Photos -Comparing original sample with tested sample (after colourfastness to chlorinated water)

Sample 1.1 Khaki A Before changing chemicals Dye rout: Hi-White	Yellow-0.0797% Red – 0.00182% Olive-0.004464% Brown-0.04565%	1.5 (required 3.5)	Tested Original 
Sample 1.2 Khaki A After changing chemicals Dye rout: Hi-White	**Changed fixing agent- Dan Fix Paa 40 x 20 min**	3.0 (required 3.5)	Tested Original 
Sample 1.3 Khaki A New Dye rout: Pigment	Yellow-0.3845% Red – 0.08760% Black -0.1617%	4.5 (required 3.5)	Tested Original 

Results: First trial with newly formulated dye for Khaki A colour give required colour (hue and value) but the colourfastness to chlorinated water is not acceptable. After adding chemicals/changing dye route colour and the colourfastness satisfied the customer requirement.

A selection of casualwear garments dyed with widely used fashionable dyes was tested for colourfastness with milder chlorinated water. Observations found that the appearance and the other test results were passing except for colourfastness to Chlorinated water. The standard used was AATCC 162; however it is a practice of some international brands to specify the test method AATCC

162. Colourfastness to chlorinated pool water is to be applicable only for the Swimwear, bathrobes and bath towels.

Case study 2

Fabric samples 2.1, 2.2 and 2.3 Cotton casualwear fabrics

Customer required colour – Brown -A

Selected dye rout: as per the chemical supplier's instruction for Hi-White colours

Pre-treatment and Rinse at 6.0pH and each step at 50^0C for five minutes. Then applying formulated dye at 6.5pH and temperature 90^0C for 50minutes

Four dyes, yellow, red, olive and brown given weightages given as in Table 3 were mixed to get the Brown-A Colour

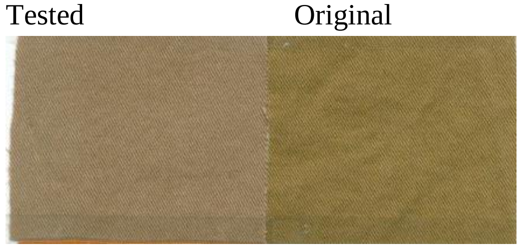
Sample were tested for colourfastness to chlorinated water applying standard AATCC 162,

Mildest version of chlorinated water (5ppm) used during the test

Sample 2.1 failing to colorfastness test, change the fixing agent - Dan Fix Paa 40 x 20 min and did the test for sample 2.2, poor results

Failing Sample 2.2 to colorfastness test, applied formulated reactive dye rout for sample 2.3 and finally found good results.

Table 3: The combination of dyes for Brown A colour and the colour fastness values tested in EAM Maliban laboratory.

Required colour (Hue and brightness)	Mix dyes % and added chemicals	Colour Change (AATCC Grey scale)	Photos -Comparing original sample with tested sample (after colourfastness to chlorinated water test)
Sample 2.1 Brown A After changing chemicals	Yellow -0.20165%, Red – 0.07112% Olive -0.21713%	1.5 (required 3.5)	Tested Original 

Dye rout: Hi-White			
Sample 2.2 Brown A After changing chemicals Dye rout: Hi-White	**Changed fixing agent- Dan Fix Paa 40 x 20 min**	1.5 (required 3.5)	Tested Original 

Sample 2.3 Brown A New Dye rout: Reactive	Yellow -0.556%, Red – 0.1218% Blue -0.1431%	4.0 (required 3.5)	Tested Original 

Case study 3

Fabric samples 3.1, 3.2 and 3.3 Cotton casualwear fabrics

Customer required colour – Green A

Selected dye rout: as per the chemical supplier's instruction for Reactive & Pigment combination colours

Pre-treatment and Rinse at 6.0pH and each step at 50^0C for five minutes. Then applying formulated dye at 6.5pH and temperature 90^0C for 50minutes

Three dyes, yellow, red, blue and brown given weightages given as in Table 4 were mixed to get the Green-A Colour

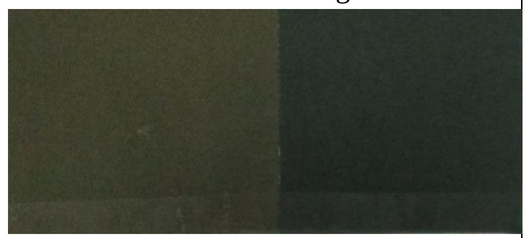
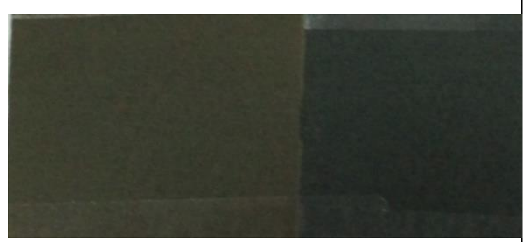
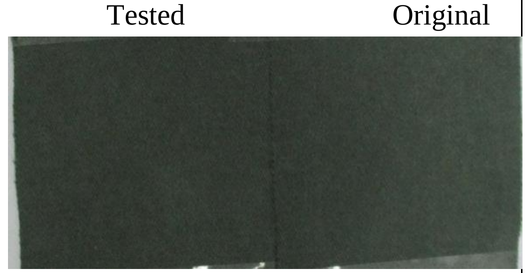
Sample were tested for colourfastness to chlorinated water applying standard AATCC 162,

Mildest version of chlorinated water (5ppm) used during the test

Sample 3.1 failing to colorfastness test, change the fixing agent - Dan Fix Paa 40 x 20 min and did the test for sample 3.2, poor results

Failing Sample 3.2 to colorfastness test, applied formulated pigment dye at 6.5pH and temperature 90^0C for 50minutes for sample 3.3 and finally found good results.

Table 4: The combination of dyes for Green A colour and the colour fastness values tested in EAM Maliban laboratory.

Required colour (Hue and brightness)	Mix dyes % and added chemicals	Colour Change (AATCC Grey scale)	Photos -Comparing original sample with tested sample (after colourfastness to chlorinated water test)
Sample 3:1 Green A After changing chemicals Dye rout: Reactive	Yellow -1.02419%, Red – 0.38867% Blue -1.20187%	1.5 (required 3.5)	Tested Original 
Sample 3.2 Green A After changing chemicals Dye rout: Reactive	**Changed fixing agent- Dan Fix Paa 40 x 20 min**	2.0 (required 3.5)	Tested Original 
Sample 3.3 Green A New Dye rout: Pigment	Yellow -2.45890%, Red – 1.1420% Blue -3.540%	4.5 (required 3.5)	Tested Original 

DATA ANALYSIS

According to the below table colourfastness of casual wear for chlorinated water can be accepted only if the grade is above 3.5 and 3.5 and below can't accepted. Most of the sample dyed with combine dyes gave the colourfastness value below 3.5 and needed to change the dye combination or the dye rout. Chemical suppliers provided some of the cotton samples dyed with their specific colours before and after colourfastness test to show the resistance to chlorinated water, but not for colours with RYB colour models having different hue and brightness.

Grade: meaning of grade	
5	No colour change
4.0-4.5	Slight colour change
3.5	Moderate colour change
3	Noticeble colour change
2.0-2.5	Considerable colour change
1.0-1.5	Much change in colour

Meantime chemical suppliers communicate that their dye stuff resistance to chlorinated water even for combined dyestuff for other colours. However, when we request them to perform dyeing of cotton casualwear and conduct the test for chlorinated water in our laboratory using their chemicals, they couldn't achieve the customer expected colourfastness values for many casualwear colours.

We have noted from our test results two major out comes as below

That the primary colours can be combined to get required shade other than Olive colour A with reactive

Olive colour is not suitable for combining to achieve other fashion colours

Above two points can be observe in the below summarized table

Colour Dye	**Khaki colour A**	**Brown colour A**	**Green colour A**
Hi white	Yellow -0.07978%, Red – 0.00182% Olive -0.04464%, Brown -0.04546%	Yellow -0.20165%, Red – 0.07112% Olive -0.21713%	
	Change only fixing agent-Dan Fix Paa 40 x 20 min – CC-3.0	Change only fixing agent-Dan Fix Paa 40 x 20 min –CC1.5	
Pigment	Yellow -0.3845%, Red – 0.08760% Black -0.1617%		Yellow -2.45890%, Red – 1.1420% Blue -3.540%

	CC-4.5		CC-4.5
Reactive		Yellow -0.556%, Red – 0.1218% Blue -0.1431% CC-4.0	Yellow -1.02419%, Red – 0.38867% Blue -1.20187%
			Change only fixing agent-Dan Fix Paa 40 x 20 min –CC-1.5

CONCLUSION

It can be concluded that the colourfastness values given by the chemical suppliers could not be achieved for many colours with different hue and brightness, although the recommended dye route and their dye combinations for various colours selected to enable meeting chlorinated pool water colour–fastness requirements. Finally, chemical suppliers communicated that they cannot achieve colourfastness values for chlorinated pool water requirement for the casualwear brands, if we combine the dye stuff.

It is recommended that the fashionable dye producers need to develop new dye route and chemical combinations for dying of casualwear to meet chlorinated pool water colourfastness requirements.

It can't grantee that the fashionable colours with combine dyes are resistant to chlorinated water, although casualwear coloured with individual single dyes show good colourfastness to chlorinated water

It can't grantee that dying of casualwear with fashionable combine dyes with same dye rout show resistant to chlorinated water, although the individual dyes show good colourfastness to chlorinated water with same dye route

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