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Oxidative Clearing of Polyester Cotton Blended Fabric by Hydrogen Peroxide: An Alternative to Reduction Clearing

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Abstract

Reduction clearing is commonly carried out as an after-treatment to remove deposits of disperse dye and other residual impurities from the surface of dyed polyester. Because of certain environmental and economical disadvantages associated with traditional reduction clearing, there is industrial interest in alternative processes. In this study the P/C blended fabric was dyed with disperse dyes in grey state and then treated with H₂O₂ at different concentration for oxidation clearing. Another process was carried out conventionally where pre-treated P/C blended fabric was dyed with disperse dyes and reduction cleared. Fabrics from both processes were dyed with reactive dyes. The performance was evaluated through assessing the changes in absorbency, Kubelka-munk theory (K/S value), wash fastness, rubbing fastness, bursting strength test and by comparing the obtained results. The overall results showed that, the test results of oxidation clearing process were quite similar to reduction clearing process. But after reactive dyeing oxidation cleared samples showed better results than reduction cleared samples.

Key Words: Reduction Clearing, Oxidative Clearing, PC, Disperse Dye, Reactive Dye

1. Introduction

Polyester (polyethylene terephthalate, PET) fibres have emerged as having a leading share among natural and synthetic fibres when production and consumption of different fibres in the world is compared. It enjoys this dominant position due to its desirable properties, the most important of which are versatility and ease of use. It is also blended with natural fibres such as cotton and wool, mainly due to these characteristics, which are lacking in most natural fibres. Polyester and its blends find applications in a range of markets, such as apparel, upholstery and work wear as well as technical textiles, for example, non-woven.

Polyester is dyed with disperse dyes. Disperse dyes are non-ionic molecules with limited solubility in water at room temperature. They are usually applied to polyester from a fine aqueous dispersion at relatively high temperatures where the solubility in water becomes sufficient to allow individual molecules in solution to come into contact with the fibres. Polyester fibres are relatively hydrophobic with a highly crystalline structure and are consequently difficult to dye at low temperatures. Dyeing is generally carried out at high temperatures, often around 130°C, above a temperature referred to as the dyeing transition temperature, which is closely aligned with the glass transition temperature and where higher segmental mobility of the polymer chains enables the dye

molecules to penetrate into the fibre. Because of the low solubility of disperse dyes in water and the tendency for particles in the dye dispersion to aggregate during the course of dyeing, some residual dye commonly remains on the fibre surface at the end of the dyeing phase. These surface deposits may have an adverse effect on the colour fastness and properties of the dyed fabrics, if present, and an after treatment to remove them is generally introduced into the dyeing process. The washing process which is used traditionally to remove the deposits of disperse dye from the surface of the polyester after dyeing is referred to as reduction clearing. This process involves treatment of the dyed polyester with an aqueous solution of a reducing agent in alkaline conditions (DM 1979, Park and Shore 2004). Because of the hydrophobic character of polyester and since the process is conducted below the glass transition temperature, the reducing agent and alkali, both ionic species, cannot penetrate into the interior of the polyester. Thus, only dye on the surface is removed while dye molecules that have diffused into the polymer during dyeing remain unaffected (Aspland 1992).

In addition to the dye, there may be surface deposits of oligomers, which are only soluble in water at the dyeing temperature and may crystallize as a white powder on the fabric and in dyeing machinery as the dyebath is cooled. These oligomers may also be removed by the clearing process.

Reduction clearing is of technical importance in polyester dyeing in order to improve the brightness of the color and the fastness properties of the dyed fabric, especially to wet treatments.

There are, however, certain environmental, technological and economic disadvantages associated with the traditional reduction clearing process. The environmental disadvantage of the process is that it generates sulphur-containing degradation products derived from sodium dithionite which appear in the effluent with potentially toxic effects, notably sulphite, sulphate and thiosulphate. Waste water containing sulphites and sulphates are corrosive and can cause severe damage in waste lines. The oxidation products of sodium dithionite may also cause oxygen depletion in water streams resulting in an increase in chemical oxygen demand. Another technical issue is the sensitivity of sodium dithionite to air oxidation in an alkaline medium at high temperatures, so that an excess is used to compensate for the loss. In addition, the after treatment requires pH adjustment from the acidic conditions during dyeing to the strongly alkaline clearing conditions for reduction clearing, followed by a final neutralization, and this increases the time and cost of the overall dyeing process. Nevertheless, reduction clearing currently retains industrial importance especially for medium to heavy depths of shade, for package dyeing and the dyeing of loose fibres. In addition, it is important in the dyeing of polyester microfibers which require more dye than regular denier fibres to achieve equivalent depth (Aleem 2013).

2. Experimental Equipment

In this project we used Datacolor Ahiba IR (James. H. Heal Co Ltd, UK), Datacolor SF650 Benchtop Spectrophotometer, Hydraulic Diaphragm Bursting Strength Tester (Mesdan, Italy), Gyro Wash Machine (James. H. Heal Co Ltd, UK), Crock Meter (James. H. Heal Co Ltd, UK), Grey Scale S.D.C, England).

3. Materials and Methods

The fabric was collected from Mymun Textiles Ltd. (DBL Group).

Table 3. 1: Specification of Fabric

Type	60/40 PC blend knitted Fabric
Wales Per Inch (WPI)	34
Course Per Inch (CPI)	58
Yarn Count (Ne)	38
G.S.M	120

Chemicals used for pre-treatment NaOH 40 g/mol (Merck, India), H₂O₂ 34 g/mol, stabilizer SOF (Switzerland), wetting agent (Archroma Bd Ltd.), EDTA (Archroma Bd Ltd.), Non-ionic detergent (Archroma Bd Ltd.), Disperse dye T/D: Red EFB (Dysin-Chem Ltd., china), Anionic Dispersing agent Setamol WS, Anionic levelling agent (Jintex, Taiwan), Acetic acid 60.05 g/mol (Vosol), Sodium acetate anhydrate as buffer 82.03 g/mol, Reactive red-D-2B bifunctional, mono-azo type (Dysin-Chem Ltd., china), Soda ash 106 g/mol (Merck, India), Sodium sulphate anhydrous 142.04 g/mol (Merck, India), Sodium hydrosulphate solid, Sulphuric acid (95-97%), Meta Cresol 108.14 g/mol (Merck, India), Direct dye blue (Dysin-Chem Ltd., china).

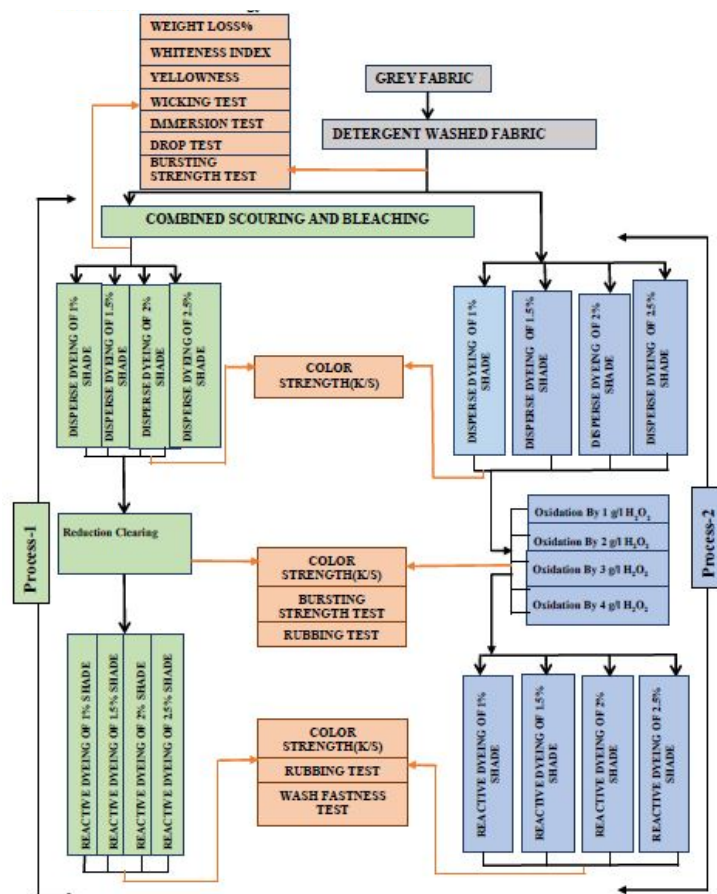


Figure 3.1. Research Methodology

4. Results and Discussion

4.1. Data analysis of Pretreated Samples

Table 4.1. Weight loss (%), Whiteness Index (WI), Yellowness Index (YI), Wicking Test, Immersion Test, Drop Test, Strength Loss (%) of Differently Treated Fabric

Fabric Type	Weight Loss%	WI	YI	Wicking Test (mm)	Immersion Test (sec)	Drop Test	Strength Loss%
Detergent Washed Fabric	0.36	70.13	4.88	71	4.2	Even and Complete	1.03
Combined Scoured and Bleached Fabric	1.81	78.98	2.90	80	3.2	Even and Complete	3.17

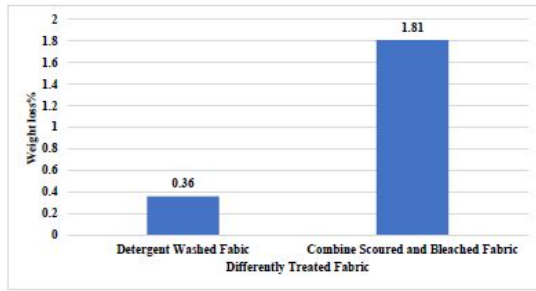


Figure 4.1. Weight loss (%) of Differently Treated Fabric

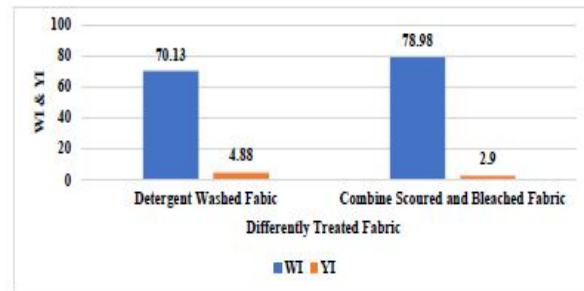


Figure 4.2. Whiteness Index (WI) and Yellowness Index (YI) of Differently Treated Fabric

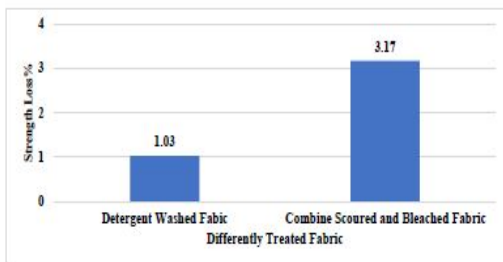


Figure 4.3. Strength Loss (%) of Differently Treated Fabric

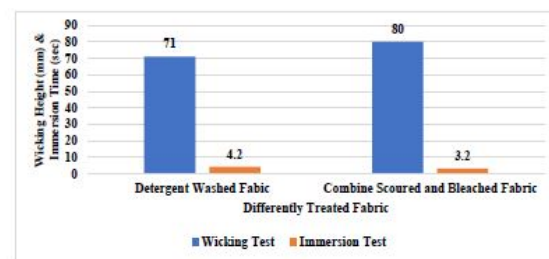


Figure 4.4. Wicking Test and Immersion Test of Differently Treated Fabric

The results show that, after combine Scouring and bleaching weight loss percentage was higher because more impurities removed in combined scouring and bleaching process which results in increased absorbency. After combined scouring and bleaching whiteness index increased and yellowness index decreased as natural color of fabric destroyed during bleaching. After combined scouring and bleaching wicking height is increased to 80 mm and immersion time is decreased to 3.2 second. After combined scouring and bleaching impurities had been removed that is why wicking height increased as well as immersion time decreased. After combined scouring and bleaching strength loss percentage was increased. This is because after combined scouring and bleaching the fabric strength is reduced due to treatment with hydrogen peroxide.

4.2. Analysis of Conventionally Treated Samples

4.2.1. Data Analysis of Process-1 Disperse Dyed Samples

Table 4.2. Color Strength of Disperse Dyed Process-1 Samples

Shade%	K/S value
1	3.759
1.5	4.389
2	4.991
2.5	5.709

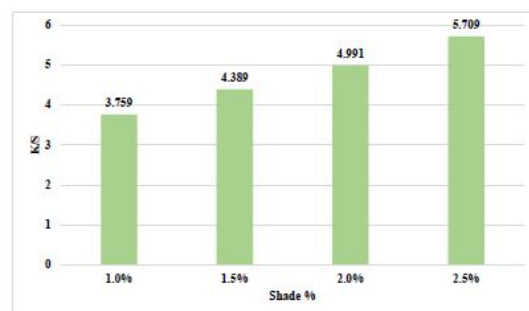


Figure 4.5. Color Strength of Disperse Dyed Process-1 Samples

The results show that, the color strength is increased with shade percentage. It can be explained that, with the increasing of shade percentage, dye concentration increases that is why K/S value increased.

4.2.2. Data Analysis of Process-1 Reduction Cleared Samples

Table 4.3. Color Strength, Strength Loss (%), Rubbing Tests of Process-1 Reduction Cleared Samples

Shade%	Reduction Clearing with $\text{Na}_2\text{S}_2\text{O}_4$	K/S value	Strength Loss%	Rubbing Test	
				Dry	Wet
1	2 g/l	3.494	1.10	5	5
1.5		3.991	1.12	5	5
2		4.441	1.09	5	5
2.5		5.020	1.17	5	5

The results show that, color strength increased with increased shade percentage. Strength loss % remain quite similar for all shade percentage. Excellent rubbing fastness achieved for all shade percentage.

4.2.3. Data Analysis of Process-1 Disperse/Reactive Dyed Samples

Table 4.4. Color Strength, Rubbing Test of Process-1 Disperse/Reactive Dyed Samples

Shade%	K/S value	Rubbing Test	
		Dry	Wet
2 (1%D+1%R)	5.96	5	4/5
3 (1.5%D+1.5%R)	8.446	5	4/5
4 (2%D+2%R)	10.272	5	4/5
5 (2.5%D+2.5%R)	11.922	5	4/5

Table 4.5. Wash Fastness (Staining of multifibre fabric) of Process-1 Disperse/Reactive Dyed Samples

Shade %	Di-acetate	Bleached Cotton	Nylon	Polyester	Acrylic	Wool
2 (1%D+1%R)	4	4/5	4	4/5	4/5	5
3 (1.5%D+1.5%R)	3/4	4/5	3/4	4/5	4/5	5
4 (2%D+2%R)	3/4	4/5	3/4	4/5	4/5	4/5
5 (2.5%D+2.5%R)	3	4/5	3	4/5	4/5	4/5

The results show that, color strength increased with increased shade percentage. Excellent dry rubbing fastness achieved for all shade percentage. Good to excellent wet rubbing fastness achieved for all shade percentage.

The results show that, di-acetate and nylon are the most highly stained among the six fibre types and other showed quite similar result.

Table 4.6. Change in Color of Process-1 Disperse/Reactive Dyed Samples

Shade %	Change in Color
2 (1%D+1%R)	4/5
3 (1.5%D+1.5%R)	4
4 (2%D+2%R)	3/4
5 (2.5%D+2.5%R)	3

The results show that by increasing the depth of the shades wash fastness rating is decreasing.

4.3. Analysis of Process-2 Samples

4.3.1. Data Analysis of Process-2 Disperse Dyed Samples

Table 4.7. Color Strength of Disperse Dyed Process-2 Samples

Shade%	K/S value
1	3.813
1.5	4.541
2	5.132
2.5	5.896

**Figure 4.6.** Color Strength of Disperse Dyed Process-2 Samples

The results show that, by the increasing concentration of dye, color strength increasing.

4.3.2. Data Analysis of Process-2 Oxidation Cleared Samples

Table 4.8. Color Strength, Strength Loss (%), Rubbing fastness Tests of Process-2 Oxidation Cleared Samples Dyed with 1% Disperse Dye

Shade%	Oxidation Clearing with H ₂ O ₂	K/S value	Strength Loss%	Rubbing Test	
				Dry	Wet
1	1 g/l	3.601	1.06	5	5
	2 g/l	3.596	2.01	5	5
	3 g/l	3.540	3.11	5	5
	4 g/l	3.515	6.91	5	5

Table 4.10. Color Strength, Strength Loss (%), Rubbing fastness Tests of Process-2 Oxidation Cleared Samples Dyed with 2% Disperse Dye

Shade%	Oxidation Clearing with H ₂ O ₂	K/S value	Strength Loss %	Rubbing Test	
				Dry	Wet
2	1 g/l	4.700	1.09	5	5
	2 g/l	4.689	3.26	5	5
	3 g/l	4.600	4.35	5	5
	4 g/l	4.539	8.35	5	5

Table 4.9. Color Strength, Strength Loss (%), Rubbing fastness Tests of Process-2 Oxidation Cleared Samples Dyed with 1.5% Disperse Dye

Shade%	Oxidation Clearing with H ₂ O ₂	K/S value	Strength Loss%	Rubbing Test	
				Dry	Wet
1.5	1 g/l	4.332	1.08	5	5
	2 g/l	4.231	2.15	5	5
	3 g/l	4.147	3.23	5	5
	4 g/l	4.147	7.68	5	5

Table 4.11. Color Strength, Strength Loss (%), Rubbing fastness Tests of Process-2 Oxidation Cleared Samples Dyed with 2.5% Disperse Dye

Shade%	Oxidation Clearing with H ₂ O ₂	K/S value	Strength Loss%	Rubbing Test	
				Dry	Wet
2.5	1 g/l	5.400	1.26	5	5
	2 g/l	5.365	3.52	5	5
	3 g/l	5.225	5.02	5	5
	4 g/l	5.139	8.51	5	5

From the results it has been clear that, by the increasing concentration of H₂O₂ more surface dye removed and strength loss percentage increasing.

Excellent rubbing fastness results found for all oxidation cleared samples.

Table 4.12: Absorbency of Oxidation Cleared Samples

Shade% (Disperse Dye)	Oxidation Clearing with H ₂ O ₂	Wicking Height (mm)	Immersion Time (sec)	Drop Test
1	1 g/l	90	2.38	Even and Complete
	2 g/l	89	2.45	Even and Complete
	3 g/l	90	2.35	Even and Complete
	4 g/l	91	2.19	Even and Complete
1.5	1 g/l	92	2.11	Even and Complete
	2 g/l	89	2.43	Even and Complete
	3 g/l	88	2.56	Even and Complete
	4 g/l	90	2.37	Even and Complete
2	1 g/l	86	2.75	Even and Complete
	2 g/l	88	2.61	Even and Complete
	3 g/l	89	2.43	Even and Complete
	4 g/l	91	2.23	Even and Complete
2.5	1 g/l	90	2.33	Even and Complete
	2 g/l	91	2.20	Even and Complete
	3 g/l	93	2.03	Even and Complete
	4 g/l	91	2.29	Even and Complete

The results show that, after oxidation clearing wicking height and immersion time remain more or less similar for all concentration. But, if we compare with detergent washed fabric it can obviously be said that, wicking height increased and immersion time decreased. That means, absorbency increased after oxidation process.

4.3.3. Data Analysis of Process-2 Disperse/Reactive Dyed Samples

Table 4.13. Color Strength, Rubbing Test of Process-2 Samples Dyed with 2% (1%D+1%R) Disperse/Reactive

Shade%	Oxidation Clearing with H ₂ O ₂	K/S value	Rubbing Test	
			Dry	Wet
2	1 g/l	7.4	5	4/5
	2 g/l	7.333	5	4/5
	3 g/l	7.51	5	4/5
	4 g/l	7.702	5	4/5

Table 4.14. Color Strength, Rubbing Test of Process-2 Samples Dyed with 3% (1.5%D+1.5%R) Disperse/Reactive Dye

Shade%	Oxidation Clearing with H ₂ O ₂	K/S value	Rubbing Test	
			Dry	Wet
3	1 g/l	10.555	5	4/5
	2 g/l	10.364	5	4/5
	3 g/l	10.288	5	4/5
	4 g/l	10.497	5	4/5

Table 4.15. Color Strength, Rubbing Test of Process-2 Samples Dyed with 4% (2%D+2%R) Disperse/Reactive Dye

Shade%	Oxidation Clearing with H ₂ O ₂	K/S value	Rubbing Test	
			Dry	Wet
4	1 g/l	12.219	5	4/5
	2 g/l	12.303	5	4/5
	3 g/l	12.33	5	4
	4 g/l	12.514	5	4/5

Table 4.16. Color Strength, Rubbing Test of Process-2 Samples Dyed with 5% (2.5%D+2.5%R) Disperse/Reactive Dye

Shade%	Oxidation Clearing with H ₂ O ₂	K/S value	Rubbing Test	
			Dry	Wet
5	1 g/l	13.353	5	4
	2 g/l	13.609	5	4
	3 g/l	13.881	5	3/4
	4 g/l	13.65	5	3/4

Table 4.17. Wash Fastness Rating of Process-2 Samples Dyed with Disperse/Reactive Dye

Shade %	Oxidation Clearing with H ₂ O ₂	Di-acetate	Cotton	Nylon	Polyester	Acrylic	Wool
2	1 g/l	3	4	3	4	4	4/5
	2 g/l	3/4	4	3/4	4	4	4/5
	3 g/l	4	4	3/4	4	4	4/5
	4 g/l	3/4	4	3/4	4	4	4/5
3	1 g/l	3/4	4	3	4	4	4/5
	2 g/l	3/4	4	3/4	4	4	4/5
	3 g/l	3/4	4	3/4	4	4	4/5
	4 g/l	3	4	3	4	4	4/5
4	1 g/l	3/4	4	3	4	4	4/5
	2 g/l	3/4	4	3	4	4	4/5
	3 g/l	3/4	4	3/4	4	4	4/5
	4 g/l	3/4	4	3/4	4	4	4/5
5	1 g/l	3/4	4	3/4	4	4	4/5
	2 g/l	3/4	4	3/4	4	4	4/5
	3 g/l	3/4	4	3/4	4	4	4
	4 g/l	3/4	4	3/4	4	4	4

From the results it has been clear that, after reactive dyeing color strength increased with increasing shade percentage but it remains nearly similar for different concentration of H₂O₂. From rubbing fastness (wet) results, 2%, 3% oxidation cleared samples showed good to excellent. For 4% shade OC-3 g/l showed good, others showed good to excellent. For 5% shade OC-1 g/l, OC-2 g/l showed good to excellent and other samples showed fair to good rating. Excellent dry rubbing fastness results found for all oxidation cleared samples. The wash fastness results show that, di-acetate and nylon are the most highly stained among the six fibre types.

Table 4.18. Change in color of Process-2 Samples Dyed with Disperse/Reactive Dye

Shade %	Oxidation Clearing with H ₂ O ₂	Change in Color
2	1 g/l	4
	2 g/l	4
	3 g/l	4/5
	4 g/l	4
3	1 g/l	4
	2 g/l	4
	3 g/l	4
	4 g/l	4
4	1 g/l	4
	2 g/l	3/4
	3 g/l	3/4
	4 g/l	4
5	1 g/l	3/4
	2 g/l	3
	3 g/l	3/4
	4 g/l	3/4

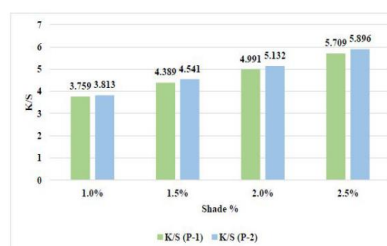
The results show that, by increasing the depth of the shades, change in color of the dyed samples decreases.

4.4. Comparison of Process-1 and Process-2 Samples

4.4.1. Comparison of Disperse Dyed Samples

Table 4.19 : Comparison of Process-1 (P-1) and Process-2(p-2) disperse dyed Samples

Shade%	K/S value (P-1)	K/S value (P-2)
1	3.759	3.813
1.5	4.389	4.541
2	4.991	5.132
2.5	5.709	5.896

**Figure 4.7 :** Graphical Representation of K/S of Process-1 (P-1) and Process-2(p-2) Disperse Dyed Samples

From the results, it can be seen that K/S value is increasing with increasing shade percentage. It is also clear that K/S value of process-1 and process-2 samples remain quite similar.

4.4.2. Comparison of Reduction Cleared/Oxidation Cleared Samples

Table 4. 20 : Comparison of Process-1 and Process-2 Reduction cleared/Oxidation Cleared Samples Dyed with 1% Disperse Dye

Shade%	Processes	Chemical Concentration	K/S value	Strength Loss%	Rubbing Test		
					Dry	Wet	
1	Process-1	Na ₂ S ₂ O ₄ (2 g/l)	3.494	1.10	5	5	
	Process-2	H ₂ O ₂	(1 g/l)	3.601	1.06	5	5
			(2 g/l)	3.596	2.01	5	5
			(3 g/l)	3.54	3.11	5	5
			(4 g/l)	3.515	6.91	5	5

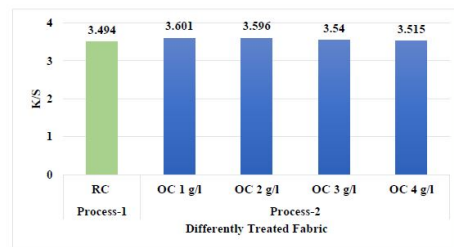


Figure 4. 8 : Graphical Representation of K/S of Process-1 and Process-2 Reduction Cleared (RC)/Oxidation Cleared (OC) Samples Dyed with 1% Disperse Dye

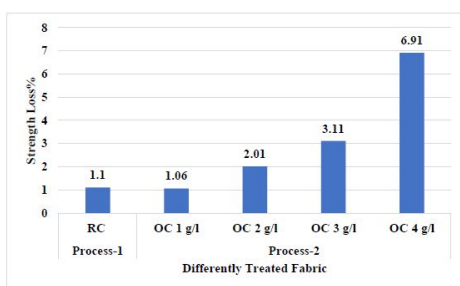


Figure 4. 9 : Graphical Representation of Strength Loss (%) of Process-1 and Process-2 Reduction Cleared (RC)/Oxidation Cleared (OC) Samples Dyed with 1% Disperse Dye

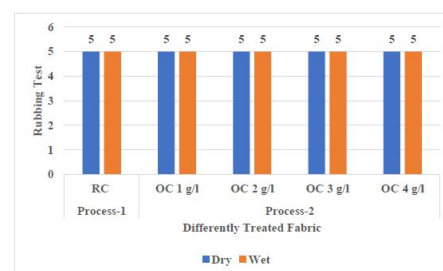


Figure 4. 10 : Graphical Representation of Rubbing Test of Process-1 and Process-2 Reduction Cleared (RC)/Oxidation Cleared (OC) Samples Dyed with 1% Disperse Dye

Table 4. 21 : Comparison of Process-1 and Process-2 Reduction cleared/Oxidation Cleared Samples Dyed with 1.5% Disperse Dye

Shade%	Processes	Chemical Concentration	K/S value	Strength Loss%	Rubbing Test		
					Dry	Wet	
1.5	Process-1	Na ₂ S ₂ O ₄ (2 g/l)	3.991	1.12	5	5	
	Process-2	H ₂ O ₂	(1 g/l)	4.332	1.08	5	5
			(2 g/l)	4.231	2.15	5	5
			(3 g/l)	4.147	3.23	5	5
			(4 g/l)	4.119	7.68	5	5

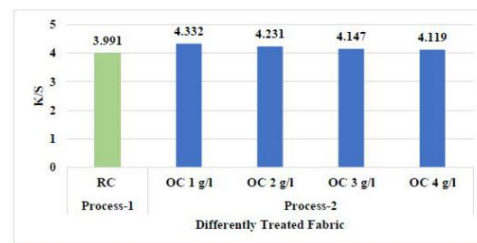


Figure 4. 11 : Graphical Representation of K/S of Process-1 and Process-2 Reduction Cleared (RC)/Oxidation Cleared (OC) Samples Dyed with 1.5% Disperse Dye

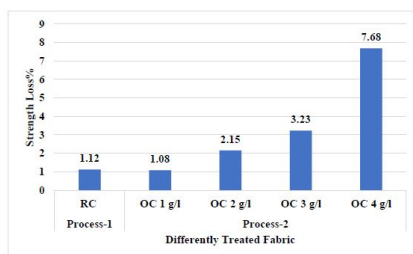


Figure 4. 12 : Graphical Representation of Strength Loss (%) of Process-1 and Process-2 Reduction Cleared (RC)/Oxidation Cleared (OC) Samples Dyed with 1.5% Disperse Dye

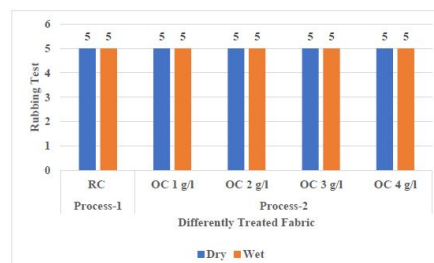


Figure 4. 13 : Graphical Representation of K/S of Process-1 and Process-2 Reduction Cleared (RC)/Oxidation Cleared (OC) Samples Dyed with 1.5% Disperse Dye

Table 4. 22 : Comparison of Process-1 and Process-2 Reduction cleared/Oxidation Cleared Samples Dyed with 2% Disperse Dye

Shade%	Processes	Chemical Concentration	K/S value	Strength Loss %	Rubbing Test		
					Dry	Wet	
2	Process-1	Na ₂ S ₂ O ₄ (2 g/l)	4.441	1.09	5	5	
	Process-2	H ₂ O ₂	(1 g/l)	4.700	1.09	5	5
			(2 g/l)	4.689	3.26	5	5
			(3 g/l)	4.600	4.35	5	5
			(4 g/l)	4.539	8.35	5	5

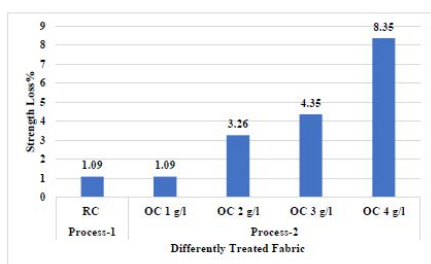


Figure 4. 15 : Graphical Representation of Strength Loss (%) of Process-1 and Process-2 Reduction Cleared (RC)/Oxidation Cleared (OC) Samples Dyed with 2% Disperse Dye

Table 4. 23 : Comparison of Process-1 and Process-2 Reduction cleared/Oxidation Cleared Samples Dyed with 2.5% Disperse Dye

Shade%	Processes	Chemical Concentration	K/S value	Strength Loss %	Rubbing Test		
					Dry	Wet	
2.5	Process-1	Na ₂ S ₂ O ₄ (2 g/l)	5.020	1.17	5	5	
	Process-2	H ₂ O ₂	(1 g/l)	5.400	1.26	5	5
			(2 g/l)	5.365	3.52	5	5
			(3 g/l)	5.225	5.02	5	5
			(4 g/l)	5.139	8.51	5	5

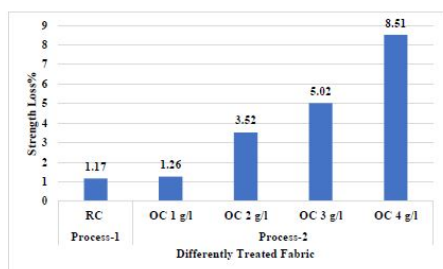


Figure 4. 18 : Graphical Representation of Strength Loss (%) of Process-1 and Process-2 Reduction Cleared (RC)/Oxidation Cleared (OC) Samples Dyed with 2.5% Disperse Dye

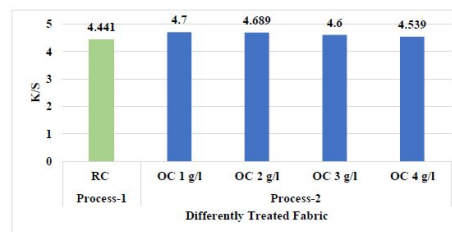


Figure 4. 14 : Graphical Representation of K/S of Process-1 and Process-2 Reduction Cleared (RC)/Oxidation Cleared (OC) Samples Dyed with 2% Disperse Dye

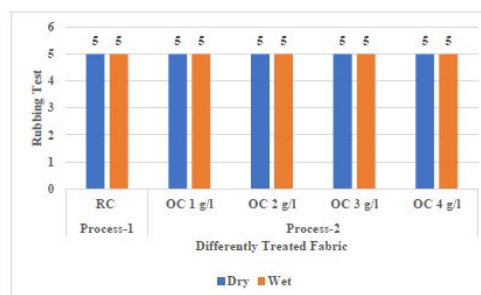


Figure 4. 16: Graphical Representation of K/S of Process-1 and Process-2 Reduction Cleared (RC)/Oxidation Cleared (OC) Samples Dyed with 2% Disperse Dye

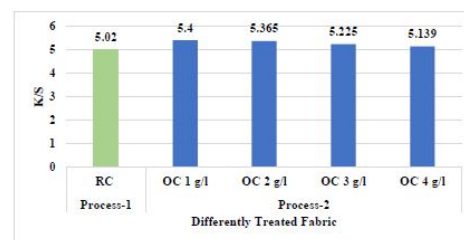


Figure 4. 17 : Graphical Representation of K/S of Process-1 and Process-2 Reduction Cleared (RC)/Oxidation Cleared (OC) Samples Dyed with 2.5% Disperse Dye

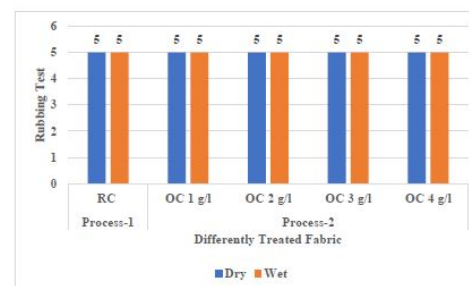


Figure 4. 19: Graphical Representation of K/S of Process-1 and Process-2 Reduction Cleared (RC)/Oxidation Cleared (OC) Samples Dyed with 2.5% Disperse Dye

From the results, it has been clear that by the increased concentration of H₂O₂ the K/S value decreased as well as strength loss (%) increased. It can be explained that as peroxide concentration increased more surface dye removed that is why K/S value decreased. On the other hand, strength reduced due to using H₂O₂ as oxidizing agent which can damage fabric.

Excellent dry and wet rubbing fastness rating found for all shade percentage.

4.4.3. Comparison of Disperse/Reactive Dyed Samples

Table 4. 24 : Comparison of Process-1 and Process-2 Samples Dyed with 2%(1%D+1%R) Disperse/Reactive Dye

Shade %	Processes	Chemical Concentration	K/S value	Rubbing Test		
				Dry	Wet	
2	Process-1	Na ₂ S ₂ O ₄ (2 g/l)	5.96	5	4/5	
	Process-2	H ₂ O ₂	(1 g/l)	7.4	5	4/5
			(2 g/l)	7.333	5	4/5
			(3 g/l)	7.51	5	4/5
			(4 g/l)	7.702	5	4/5

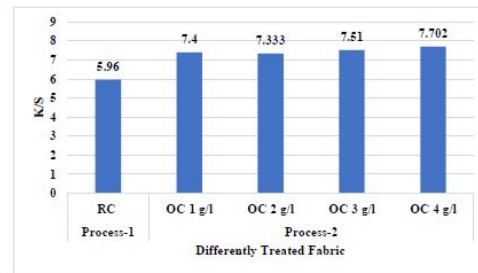


Figure 4. 20 : Graphical Representation of K/S of Process-1 and Process-2 Reduction Cleared (RC)/Oxidation Cleared (OC) Samples Dyed with 2%(1%D+1%R) Disperse/Reactive Dye

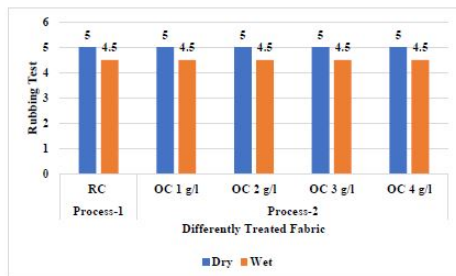


Figure 4. 21 : Graphical Representation of Rubbing Test Rating of Process-1 and Process-2 Reduction Cleared (RC)/Oxidation Cleared (OC) Samples Dyed with 2%(1%D+1%R) Disperse/Reactive Dye

Table 4. 25 : Comparison of Process-1 and Process-2 Samples Dyed with 3%(1.5%D+1.5%R) Disperse/Reactive Dye

Shade%	Processes	Chemical Concentration	K/S value	Rubbing Test		
				Dry	Wet	
3	Process-1	Na ₂ S ₂ O ₄ (2 g/l)	8.446	5	4/5	
	Process-2	H ₂ O ₂	(1 g/l)	10.555	5	4/5
			(2 g/l)	10.364	5	4/5
			(3 g/l)	10.288	5	4/5
			(4 g/l)	10.497	5	4/5

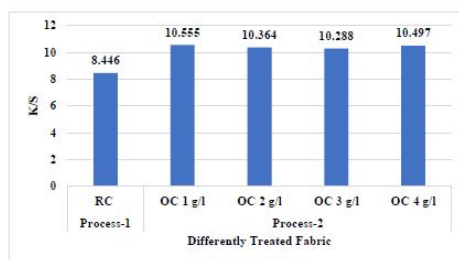


Figure 4. 22 : Graphical Representation of K/S of Process-1 and Process-2 Reduction Cleared (RC)/Oxidation Cleared (OC) Samples Dyed with 3%(1.5%D+1.5%R) Disperse/Reactive Dye

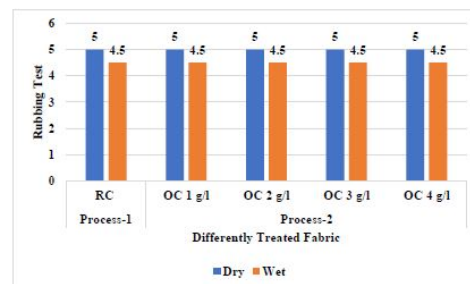


Figure 4. 23 : Graphical Representation of Rubbing Test Rating of Process-1 and Process-2 Reduction Cleared (RC)/Oxidation Cleared (OC) Samples Dyed with 3%(1.5%D+1.5%R) Disperse/Reactive Dye

Table 4. 26 : Comparison of Process-1 and Process-2 Samples Dyed with 4%(2%D+2%R) Disperse/Reactive Dye

Shade%	Processes	Chemical Concentration	K/S value	Rubbing Test		
				Dry	Wet	
4	Process-1	Na ₂ S ₂ O ₄ (2 g/l)	10.272	5	4/5	
	Process-2	H ₂ O ₂	(1 g/l)	12.219	5	4/5
			(2 g/l)	12.303	5	4/5
			(3 g/l)	12.33	5	4
			(4 g/l)	12.514	5	4/5

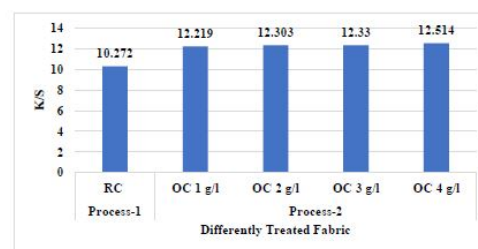


Figure 4. 24 : Graphical Representation of K/S of Process-1 and Process-2 Reduction Cleared (RC)/Oxidation Cleared (OC) Samples Dyed with 4%(2%D+2%R) Disperse/Reactive Dye

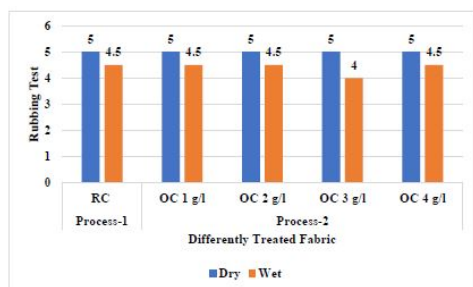


Figure 4.25 : Graphical Representation of Rubbing Test Rating of Process-1 and Process-2 Reduction Cleared (RC)/Oxidation Cleared (OC) Samples Dyed with 4%(2%D+2%R) Disperse/Reactive Dye

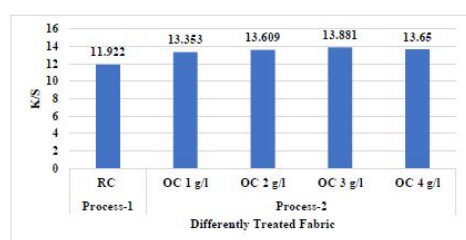


Figure 4.26 : Graphical Representation of K/S of Process-1 and Process-2 Reduction Cleared (RC)/Oxidation Cleared (OC) Samples Dyed with 5%(2.5%D+2.5%R) Disperse/Reactive Dye

Table 4.27 : Comparison of Process-1 and Process-2 Samples Dyed with 5%(2.5%D+2.5%R) Disperse/Reactive Dye

Shade%	Processes	Chemical Concentration	K/S value	Rubbing Test		
				Dry	Wet	
5	Process-1	Na ₂ S ₂ O ₄ (2 g/l)	11.922	5	4/5	
	Process-2	H ₂ O ₂	(1 g/l)	13.353	5	4
			(2 g/l)	13.609	5	4
			(3 g/l)	13.881	5	3/4
			(4 g/l)	13.65	5	3/4

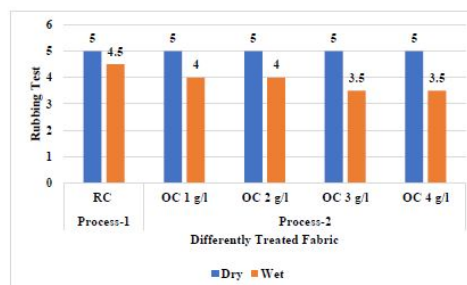


Figure 4.27 : Graphical Representation of Rubbing Test Rating of Process-1 and Process-2 Reduction Cleared (RC)/Oxidation Cleared (OC) Samples Dyed with 5%(2.5%D+2.5%R) Disperse/Reactive Dye

The results show that, K/S value increased with the increased shade percentage and also color strength is higher in process-2 samples comparing to process-1 samples. This is because in process-2 absorbency increased as a result color strength got higher. From the results of wet rubbing fastness it was found that, for 2%, 3% shade process-1 and process-2 samples showed good to excellent result. For 4% shade OC-3 g/l showed good rating and others showed good to excellent result but process-1 sample showed good to excellent result. For 5% shade, OC-1 g/l, OC-2g/l showed good rating but others showed fair to good rating and process-1 sample showed good to excellent rating.

Table 4.28 : Comparison of Wash Fastness Rating of Process-1 and Process-2 samples

Process-1							
Shade %	Di-acetate	Bleached Cotton	Nylon	Polyester	Acrylic	Wool	
2	4	4/5	4	4/5	4/5	5	
3	3/4	4/5	3/4	4/5	4/5	5	
4	3/4	4/5	3/4	4/5	4/5	4/5	
5	3	4/5	3	4/5	4/5	4/5	
Process-2							
Shade %	Oxidation Clearing with H ₂ O ₂	Di-acetate	Bleached Cotton	Nylon	Polyester	Acrylic	Wool
2	1 g/l	3	4	3	4	4	4/5
	2 g/l	3/4	4	3/4	4	4	4/5
	3 g/l	4	4	3/4	4	4	4/5
	4 g/l	3/4	4	3/4	4	4	4/5
3	1 g/l	3/4	4	3	4	4	4/5
	2 g/l	3/4	4	3/4	4	4	4/5
	3 g/l	3/4	4	3/4	4	4	4/5
	4 g/l	3	4	3	4	4	4/5
4	1 g/l	3/4	4	3	4	4	4/5
	2 g/l	3/4	4	3	4	4	4/5
	3 g/l	3/4	4	3/4	4	4	4/5
	4 g/l	3/4	4	3/4	4	4	4/5
5	1 g/l	3/4	4	3/4	4	4	4/5
	2 g/l	3/4	4	3/4	4	4	4/5
	3 g/l	3/4	4	3/4	4	4	4
	4 g/l	3/4	4	3/4	4	4	4

The results show that acetate and nylon are the most highly stained among the six fibre types. This can be explained on the basis that acetate, nylon were stained for using disperse dyes in polyester dyeing and cotton and wool stained for using reactive dye in cotton part dyeing.

Table 4. 29 : Comparison of Change in Color of Process-1 and Process-2 samples

Process-1		
Shade %	Change in Color	
2	4/5	
3	4	
4	3/4	
5	3	
Process-2		
Shade %	Oxidation Clearing with H_2O_2 (g/l)	Change in Color
2	1	4
	2	4
	3	4/5
	4	4
3	1	4
	2	4
	3	4
	4	4
4	1	4
	2	3/4
	3	3/4
	4	4
5	1	3/4
	2	3
	3	3/4
	4	3/4

The results show that, by increasing the shade percentage, fastness rating is decreasing.

5. Conclusions

In traditional process, the surface deposits of disperse dye is removed by reduction clearing. Reduction clearing has adverse effect on environment. Sodium dithionate is an inorganic compound and not bio-degradable. As, sodium dithionate is not bio-degradable, its presence in the effluent increases the COD of water. In this study, oxidation clearing with H_2O_2 was done as an alternative to reduction clearing. From different research work it has been found that, in oxidation process, ecological advantages were significant and further advantage is that pre-treatment can be eliminated.

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