Problems In Processing Of Synthetic Fabrics And Their Remedies

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Abstract

Polyester has been one of the most popular fibers, second to cotton as measured by production tonnage in recent years. The technical merits and commercial veracity of the fiber production system has led to successful product development and applications.In this paper an attempt has been made to overcome the problem of dye ability of polyester by replacing acetic acid which is used to maintain slightly acidic pH. This organic acid increases the BOD value which hampers the marine life. Also this acid has bad odour and harmful effects on the persons who comes in contact with it.The various salts were used to replace the acetic acid which is creates problem of effluent. Ammonium chloride and Ammonium sulphate gives comparable results with less quantity of the chemicals.

Keywords: - Acetic acid, Dyeability, Ammonium chloride.

1. Introduction

Polyester fiber has conquered the leading position among the synthetics because of its excellent properties such as high strength, abrasion resistance and wrinkle-free characteristics. Due to its hydrophobic and oleophilic nature, its moisture transporting behavior is very poor. Moreover, it has unnatural hand and unfamiliar skin contact sensation and pleasant thermal sensation, lack of moisture absorbency and adsorption properties. Due to this it is easily soiled and accumulates static charge, so not comfortable as natural fiber or fabrics, to overcome some of these problems and to improve the property of polyester, it is modified in two ways.

i. Polymer modification :

   a) By introducing acidic groups in the polymer chain having basic dyeability.

   b) By incorporating some monomers which lowers Tg for low temperature dyeability.

ii. Modification of fabric :

   a) Modification of fabrics by means of treating with alkali (NaOH).

Environmental requirement related legislation and strict eco-regulations in international market served as a major driving force for innovation in both the dye manufacturing and dye application industries. Environmental consideration has great impact on the production and coloration of synthesis fibers.

Polyester fiber is having very compact and crystalline structure with no definite dye sites. For, this disperse dyes are used for dyeing of polyester fiber from a stable aqueous dye dispersion. Polyester fiber has high Tg and its dyeing is always carried above its glass transitional temperature.

Generally dyeing of polyester using disperse dyes is carried out under acidic pH. This acidic pH is maintained by using the organic acid like acetic acid. This organic acid increases the BOD value which hampers the marine life. Also this acid has bad odour and harmful effects on the persons who comes in contact with it.

2. Materials and Methods

2.1 Fabric-

100% Polyester plain woven mill bleached fabric having the following specifications has been used in this study.

$$\frac{150\ D \times 150 D}{60 \times 52} \qquad 47" \ Width$$

2.2 Chemicals & Auxiliaries

Ammonium Chloride, AmmoniumSulphate, Magnesium Sulphate, Sodium Sulphate, Sodium Chloride and Ammonium Acetate. All these chemicals are of LR Grade.

2.3 Dyes

Coralene Navy ELX ,Coralene Yellow 5R,Coralene Yellow SG H/E,Coralene Scarlet RR

2.4 Method

Conventional method of dyeing on HTHP

3. Testing and Analysis

The following tests have been carried for analyzing the properties of dyed fabric.

1. Indices, K/S value and colour strength have been determined by using Macbeth Coloureye®3000. Spectrophotometer with Colorlab Software.
2. Colour fastness to light has been determined as per AATCC test method 16-1998.
3. Fastness to washing has been evaluated according to AATCC test method 61-1989.

4. RESULTS AND DISCUSSION

PART - I

Table No. 4.1-Effect of Water and various salts on properties of dyeing with Low Molecular weight Azo based Disperse Dye (Coralene Navy ELX)

Sr. No	Name of Salt	Dye % Shade	Strength in %	K/S	Wash Fastness				Light Fastness
					Cotton		Polyester		
					AATCC	ISO 105	AATCC	ISO 105	
1.	Standard (Acetic Acid)	0.5	100	22.4542	4	4	4-5	4	6
		1	100	27.0063	4	4	4	4	6
		2	100	30.8357	4	4	4	4	6
		5	100	33.0032	4	4	3	3	6
2.	Water	0.5	100.105	22.2779	4	4	4	4	6
		1	98.616	26.5325	4	4	4	4	6
		2	100.890	29.6001	4	4	4	4	6
		5	99.509	32.8413	3-4	3	3	3	6
3.	Ammonium Chloride	0.5	99.243	22.3843	4	4	4	4	6
		1	99.146	26.7757	4	4	4	4	6
		2	99.065	30.5475	4	4	4	4	6
		5	97.703	32.7451	4	4	3	3	6
4.	Ammonium Sulphate	0.5	100.372	22.5377	4	4	4	4	6
		1	99.919	26.9843	3-4	3	4	4	6
		2	99.089	30.7546	4	4	3	4	6
		5	99.893	32.9681	4	4	3-4	4	6
5.	Ammonium Acetate	0.5	101.160	22.7146	4	4	4	4	6
		1	100.623	27.1744	4	4	4	4	6
		2	106.376	32.8018	4	4	3-4	4	6
		5	99.442	32.9190	3	3	3	3	6

Table 4.1 indicates the results of colour value and fastness properties for Coralene Navy ELX, a Low Molecular weight Azo based disperse dye by varying different chemicals during dyeing. When water is used in place of acetic acid, the depth of the shade has been found to be marginally less when compared with the depth obtained by standard acetic acid. This is evident from K/S values. The washing fastness results are found to be same for all depths and comparable with those samples dyed with acetic acid. The similar trend is found in light fastness values.

Ammonium Chloride when used for 0.5%, 1% and 2% shades, the colour strength in terms of K/S values are found to be 22.3843, 26.7757, 30.5475 respectively and the K/S values for acetic acid for 0.5%, 1% and 2% are 22.4542, 27.0063, 30.8357 respectively. This indicates there is no significant difference in colour value. The K/S value for 5% shade for Ammonium Chloride is found to be 32.7451 and for Acetic acid 33.0032. At higher depth with Ammonium Chloride there is slight increase in colour value. The fastness for washing and light are found to be same.

Ammonium Sulphate when used in place of acetic acid, the depth of the shade has been found to be almost same as that of depth obtained by standard acetic acid. This is evident from K/S values. The fastness for washing and light are found to be same for all depths and comparable with those samples dyed with acetic acid.

Ammonium Acetate when used in place of acetic acid, the depth of the shade has been found to be almost same as that of depth obtained by standard acetic acid. This is evident from K/S values. The fastness for washing and light are found to be same for all depths and comparable with those samples dyed with acetic acid.

The salts of mineral acid gives comparable K/S values and this may be due to the slightly higher pH values as against K/S values obtained by acetic acid. Ammonium acetate gives good results due to the evolution of acetic acid at higher temperature during dyeing.

Table No. 4.2 -Effect of Water and various salts onproperties of dyeing with Low Molecular weight Azo based Disperse Dye (Coralene Yellow 5R)

Sr.No	Name of Salt	Dye % Shade	Strength in %	K/S	Wash Fastness				Light Fastness
					Cotton		Polyester		
					AATCC	ISO 105	AATCC	ISO 105	
1.	Standard (Acetic Acid)	0.5	100	9.3817	4	4	4	4	6
		1	100	12.7582	3	3	4	4	6
		2	100	15.8613	4	4	4	4	6
		5	100	19.0655	4	4	4	4	6
2.	Water	0.5	94.884	8.9018	4	4	4	4	6
		1	95.535	12.1885	4	4	4	4	6
		2	95.116	15.0867	4	4	4	4	6
		5	96.850	18.4650	4	4	4	4	6
3.	Ammonium Chloride	0.5	102.958	9.5592	3-4	3	4	4	6
		1	99.848	12.7389	4	4	4	4	6
		2	99.752	15.8220	4	4	4	4	6
		5	103.099	19.6563	3-4	3	4-5	4	6
4.	Ammonium Sulphate	0.5	86.361	9.1022	4	4	4	4	6
		1	101.358	12.9315	4	4	4	4	6
		2	100.169	15.8882	4	4	4	4	6
		5	99.330	18.9379	4	4	4	4	6
5.	Ammonium Acetate	0.5	100.302	9.4101	4	4	4	4	6
		1	99.879	12.428	4	4	4	4	6
		2	99.437	15.9721	4	4	4	4	6
		5	99.133	18.9802	4	4	4	4	6

Table 4.2 indicates the values of colour value and fastness properties for Coralene Yellow 5R, a Low Molecular weight Azo based disperse dye by varying different chemicals during dyeing. When Water is used in place of acetic acid for 0.5%, 1%, 2% and 5% shades, the colour strength in terms of K/S values are found to be 8.9018, 12.1885, 15.0867 and 18.4650 respectively and the K/S values for acetic acid are found to be 9.3817, 12.7582, 15.8613 and 19.0655 respectively. This indicates that for all the shades with water there is slight lowering of colour value. But the fastness properties of washing and light are found to be same.

Ammonium Chloride when used in place of acetic acid, the depth of the shade has been found to be almost same as that of depth obtained by standard acetic acid. This is evident from K/S values. The fastness for washing and light are found to be same for all depths and comparable with those samples dyed with acetic acid.

Ammonium Sulphate when used for 1%, 2% and 5% shades, the colour strength in term K/S values are found to be 12.9315, 15.8882 and 18.9379 respectively and the K/S values for acetic

acid for 1%, 2% and 5% are 12.7582, 15.8613 and 19.0655 respectively. This indicates there is no significant difference in colour value. The K/S value for 0.5% shade for Ammonium Sulphate is found to be 8.1022 and for Acetic acid 9.3817. At lower depth with Ammonium Chloride there is slight lowering of colour value. The fastness for washing and light are found to be same.

Ammonium Acetate when used in place of acetic acid, the depth of the shade has been found to be almost same as that of depth obtained by standard acetic acid. This is evident from K/S values. The fastness for washing and light are found to be same for all depths and comparable with those samples dyed with acetic acid.

Table No. 4.3- Effect of Water and various salts on properties of dyeing with High Molecular weight Azo based Disperse Dye (Coralene Yellow SG H/c)

Sr. No	Name of Salt	Dye % Shade	Strength in %	K/S	Wash Fastness				Light Fastness
					Cotton		Polyester		
					AATCC	ISO 105	AATCC	ISO 105	
1.	**Standard (Acetic Acid)**	**0.5**	100	10.9907	4	4	4	4	6
		1	100	13.3479	4-5	4	4	4	6
		2	100	14.3874	3-4	3	4-5	4	6
		5	100	14.3231	4	4	4	4	6
2.	**Water**	**0.5**	103.921	10.4216	4	4	4	4	6
		1	99.331	13.1586	4	4	4	4	6
		2	101.251	14.0674	4	4	4	4	6
		5	102.474	13.6760	4	4	4	4	6
3.	**Ammonium Chloride**	**0.5**	107.276	10.7903	3-4	3	4-5	4	6
		1	104.082	13.8928	4	4	4	4	6
		2	99.349	14.3938	4	4	4	4	6
		5	101.474	14.5343	4	4	4	4	6
4.	**Ammonium Sulphate**	**0.5**	107.874	10.8561	4	4	4	4	6
		1	100.709	13.2426	3-4	4	4	4	6
		2	97.202	13.9848	4	4	4	4	6
		5	100.238	14.3572	4	4	4	4	6
5.	**Ammonium Acetate**	**0.5**	100.230	11.0159	4	4	4	4	6
		1	101.600	13.5615	3-4	3	4-5	4	6
		2	98.589	14.3843	4	4	4-5	4	6
		5	101.308	14.5105	4	4	4	4	6

The results obtained in Table 4.3 using water instead of acetic acid shows the same trend as discussed earlier. Ammonium Chloride when used for 0.5% and 1% shades, the colour strength in term K/S values are found to be 11.7903 and 13.8928 respectively and the K/S values for acetic acid for 0.5% and 1% are 10.9907 and 13.3479 respectively. This indicates there is an

increase in colour value as compared to standard. The K/S value for 2% and 5% shade for Ammonium Chloride is found to be 14.2938 and 14.5343 and for Acetic acid for 2% and 5% is 14.3874 and 14.3231. This shows that there is no significant difference in colour value. The fastness for washing and light are found to be same.

Ammonium Sulphate when used for 0.5% shade, the colour strength in terms of K/S value is found to be 11.8561 and the K/S value for acetic acid for 0.5% is 10.9907. This indicates there is an increase in colour value as compared to standard. The K/S value for 1%, 2% and 5% shade for Ammonium Sulphate are found to be 13.4426, 13.9848 and 14.3572 and for Acetic acid for 1%, 2% and 5% are 13.3479, 14.3874 and 14.3231. This shows that there is no significant difference in colour value. The fastness for washing and light are found to be same.

Ammonium Acetate when used in place of acetic acid, the depth of the shade has been found to be almost same as that of depth obtained by standard acetic acid. This is evident from K/S values. The fastness for washing and light are found to be same for all depths and comparable with those samples dyed with acetic acid.

Table No. 4.4 -Effect of Water and various salts on properties of dyeing with High Molecular weight Azo based Disperse Dye (Coralene Scarlet RR)

Sr. No	Name of Salt	Dye % Shade	Strength in %	K/S	Wash Fastness				Light Fastness
					Cotton		Polyester		
					AATCC	ISO 105	AATCC	ISO 105	
1.	Standard (Acetic Acid)	0.5	100	15.8995	4-5	4	4	4	6
		1	100	19.6631	3-4	3	4-5	4	6
		2	100	23.4613	4	4	4	4	6
		5	100	26.9707	4	4	4	4	6
2.	Water	0.5	103.384	15.4375	4	4	4	4	6
		1	103.872	18.4245	4	4	4	4	6
		2	103.221	23.2170	4	4	4	4	6
		5	101.985	26.5061	4	4	4	4	6
3.	Ammonium Chloride	0.5	94.563	15.6351	4	4	4	4	6
		1	102.524	19.1593	4	4	4	4	6
		2	101.069	23.4121	4	4	4	4	6
		5	103.724	26.9749	4-5	4	4	4	6
4.	Ammonium Sulphate	0.5	101.709	14.1713	4	4	4	4	6
		1	101.552	19.4682	4	4	4	4	6
		2	100.604	23.3031	4-5	4	4	4	6
		5	100.732	25.1682	4-5	4	4	4	6
5.	Ammonium Acetate	0.5	102.337	16.1710	4	4	4	4	6
		1	101.632	19.9841	4	4	4-5	4	6
		2	102.129	23.9609	4	4	4	4	6
		5	101.133	27.2761	4	4	3-4	4	6

The results of Table 4.4 indicates the colour value and fastness properties for Coralene Scarlet RR, a High molecular weight Azo based disperse dye by varying different chemicals during dyeing. When water is used for 0.5%, 1% and 2% shade the colour strength in terms of K/S value is found to be 15.4375, 18.4245 and 23.2170 respectively and the K/S value for acetic acid for 0.5%, 1% and 2% shade is 15.8995, 19.6631 and 23.4613 respectively. This indicates there is an increase in colour value as compared to standard. The K/S value 5% shade for water is found to be 26.5061 and for Acetic acid for 5% are 26.9707. This shows that there is no significant difference in colour value. The fastness for washing and light are found to be same.

Ammonium Chloride when used for 5% shade, the colour strength in terms of K/S value is found to be 26.9749 and the K/S value for acetic acid for 5% is 26.9707. This indicates there is an increase in colour value as compared to standard. The K/S value for 1% and 2% shade for Ammonium Chloride are found to be 20.1593 and 23.7121 and for Acetic acid for 1% and 2% are 19.1531 and 23.4121. This shows that there is no significant difference in colour value. For the 0.5 % shade for Ammonium Chloride the K/S value is 15.6351 and for acetic acid the K/S value is 15.8995. This indicates that at lower depth with Ammonium Chloride there is slight lowering of colour value. The fastness for washing and light are found to be same.

Ammonium Sulphate when used in place of acetic acid, the depth of the shade has been found to be almost same as that of depth obtained by standard acetic acid. This is evident from K/S values. The fastness for washing and light are found to be same for all depths and comparable with those samples dyed with acetic acid.

Ammonium Acetate when used in place of acetic acid, the depth of the shade has been found to be almost same as that of depth obtained by standard acetic acid. This is evident from K/S values. The fastness for washing and light are found to be same for all depths and comparable with those samples dyed with acetic acid.

4. Conclusion

From the results and analysis it may found that pollution free salt can be possible for dyeing of polyester with disperse dyeing. As pH of disperse dyeing requirement is about 4.5-5.5 and this can be possible with Ammonium chloride and Ammonium sulphate which is responsible for giving slightly higher pH value and is responsible for slight change or no change of colour value. Ammonium acetate also gives good results. Ammonium chloride seems to give comparable results. There is no change of fastness properties as far as washing and light fastness is concerned. Salts of mineral acid like Ammonium chloride and Ammonium sulphate do not affect the environment and health just like Acetic acid and the process becomes safer and eco-friendly.

5. References.

1. Soufien Dhouib, Abdelaziz Lallam & Fouzi Sakli, 'study of dyeing behavior of polyesterwith disperse dye', Textile research journal vol.76 (4)
2. Dr.G.Nalankilli, 'High Shrinkage polyester: part 2', Man Made Textiles in India, July-2004.
3. Vinay kumasr Midha,R Alagirusamy & V K Kothari 'studies on thermal properties of hollow polyester' , Asain Textile Journal, janury 2004.
4. Petra Recelj & Mariji Gorensek, Majda Zigon, 'the influence of stabilization under various conditions & treatment of polyester fabric on the extracted oligomer', Textile Research Journal vol .76(4).
5. Rakesh Goyal & C.N. Prabhu, 'polyester: with different angles-1 & 2', Colourage, November 2006.
6. U.J. Patil & C.D .Kane , 'Bending behavior of polyester fabric', Textile asia,December-2004.
7. J.P.M. Dorthmans, 'polyester industrial yarn development', Textile month, December 1988.
8. A text book of fibre science and technology by S. P. Mishra.
9. Processing of synthetic fibers and blends by Datye & Vaidy.
10. Article on Chemical modification of polyester [PET] by Aravin Prince.
11. Modification of some properties of poly(ethylene terephthalate fabric) Journal of the textile association, July-2004, page no 69-57.
12. N. Arun, 'Cationic Dyeable Polyester Fibre', MMTI June 1999.
13. Martin Ferus- Comelo 'Spectroscopic analyses of the state of disperse dyes in solution' Melliand International February 2008.
14. Dr. J. Hayavadana, R. Srinivasa Rao, D. divya & N. Srichadnana 'Study of mechanical properties of 100% Polyester' MMTI February 2009.
15. Amit K. Naskar, Kate Stevens, John M. Kennedy & Amod A. Ogale 'Morphology of polyester cords at different stages of simulated tire building' TRJ 2006.

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