Effect of alkali concentration on viscose dyeing of PV blended fabric with Reactive dye

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Abstract

Reactive dyestuffs can be applied by various traditional processes but these consume a considerable amount of energy, water and chemicals. Due to increasing demand for woven fabrics, energy and chemicals consumed in reactive dyeing are increased. It has become necessary to look for energy efficient techniques which use less energy, water, chemicals etc. Use of more water in washing requirements leads to more effluent and effluent disposal becomes more concern. This paper is mainly focusing on basic principle and recommended dyes for cold pad batch process. In this process, the reactivity of the dyestuff is exploited together with the dyeing behavior of the fabric in such a way that optimum color yields can be achieved by using optimum concentration of alkali.

Keywords- reactive dyes, viscose, polyester, PV, CPB, colour value, CDR.

1. Introduction

The reaction between reactive dye and cotton fiber cannot be possible in absence of alkali. Amount of alkali is the key factor in fixation of reactive dye. Though water is the competitor for reaction with the dye, but cellulose fiber takes part in the reaction for most of the time. It is because the substantivity of a reactive dye to fiber is much greater than the attraction of it to the water [1]. But all the reactive dyes do not have the same range of substantivity and reactivity. Higher reactivity of a dye can spoil the dyeing due to hydrolysis [2]. Reactive dye gets its reactivity in presence of alkali and it can be increased with higher temperature. Reactivity is compulsory for these dyeing, but for a perfect dyeing it should have a limit. One of the main problems in dyeing with many reactive dyes is their low fixation level, often which is less than 70% of the original dye that reacts with fiber [3]. This results huge dye concentrations in effluent. So a proper utilization of parameters should be understood first before going to the bulk process. Dalal and Desai [4] studied with some bi-functional reactive dyes and found those in medium to good substantivity range. Sultana and Uddin [5] had observed good fixation properties for Drimarine dyes by testing dyed samples in absorbance and reflectance spectroscopy.

Several researchers studied on the influence of dyeing parameters on dyeing with reactive dye. This paper tried to describe the influence of two dyeing parameters, alkali and temperature (who are mainly responsible for dye fixation) on three types of reactive dye. They were compared not only the by the fixation% but also studied with the color coordinates found from reflectance spectroscopy so that results can be obtained from a different viewpoint. Bi-functional reactive dyes are known for better exhaustion and fixation properties as they have higher probability to be attracted to the fiber due to double reactive group. They also double their chance to react with fiber and stay in it as an integral part. FCP dyes contain two different halogen groups- fluorine and chlorine. Among the halogens from fluorine to iodine, the chlorine group is favored commercially as its reactivity is moderate among those four. Fluoride group has least reactivity as its bond energy is far higher than chloride

Reactive Systems

The four characteristic features of a typical reactive dye molecule are:
1) Thechromophore grouping, contributing the colour and much of the substantivity for cellulose;
2) The reactive system, enabling the dye to react with the hydroxy groups in cellulose;
3) A bridging group that links the reactive system to the chromophore;
4) One or more solubilizing groups, usually sulphonic acid substituentsattached to the chromophoric grouping.

In a few cases the reactive grouping is attached directly to the chromophore and most reactive systems contain a heterocyclic ring that contributes some substantivity for cellulose. The nature of the bridging group and other substituents on the heterocyclic ring greatly influences the reactivity and other dyeing characteristics of such dyes [1] The sulphatoethy lsulphone precursor of the vinyl sulphone reactive group contributes significantly to the aqueous solubility of reactive dyes of this type. Many reagents can be used to acetate cellulose when it is partially ionized under alkaline conditions but in the production of reactive dyes of commercialinterest numerous factors other than the chemistry of such reactions have to betaken into account
[2] Some of the most important are the following:
(1) Economy – any reactive system selected as the basis of a range of dyes mustenable them to be produced at acceptable cost.
(2) Availability – the system selected must be free from patent restrictions,health hazards or other limitations to exploitation.

(3) Facility – it must be possible to attach the reactive system to the dye chromophoric groupings readily in manufacture.
(4) Storage stability – the dye containing the reactive groups must be stable to storage under ambient conditions.

2. EXPERIMENTAL METHODS

Materials
Material used for the experiment is P/V blended fabric. The fabric taken for experiment was singed, desized, scoured and heat set i.e. ready for dyeing. P/V Blend (48 % polyester and 52% viscose) was used for study.

Machines and laboratory instruments
1. Mathis padder –Manufacture: Werner Mathis AG, Switzerland.
2. Spectrophotometer –Manufacture: Data color, USA

Methods
Dyeing: Initially polyester portion of the fabric sample was dyed on production level by pad-dry thermo-fix method. Different recipes were used to produce different shades.
For polyester dyeing, fabric was padded through bath containing

Disperse dye	x g/l
Dispersing agent	3 g/l
Antimigrating agent	6 g/l
Sequestering agent	2 g/l
Wetting agent	1.5 g/l
Citric acid	0.5 g/l

Then fabric was padded at 70% expression and then thermo-fixed at 210^{o}C for one min. After dyeing of polyester the samples were reduction cleared with 2 g/l sodium hydrosulphite and 2 g/l sodium hydroxide at 60^{o}C for 10 min, washed and neutralized.
Then viscose part of blended fabrics was dyed in laboratory by cold pad batch method. Polyester dyed fabric samples were padded through required concentration of dyes, 20 g/l soda ash and different concentration of sodium hydroxide at 70 % expression. After padding, samples were kept for 12 to 16 hours for dye fixation. After the fixation of the dye, cold wash and then hot wash was given. Finally samples were soaped using 2 g/l non-ionic soap solution 95^{0}C for 15 min. and then washed and dried.
Five shades were produced using different recipes of disperse and reactive dyes. The recipes used for the study are given below.

Shade and Recipes

Recipe	For Polyester	For Viscose
Shade A	Dianix Yellow Brown S2R 3.92 g/l Dianix Rubine S2G 30.92 g/l Painil Blue S2R 0.14 g/l 0.14 g/l	Jackofix Ultra Yellow CE 8.0 g/l Bodactive Carmine Bnc 28.0 g/l Jackofix Blue CE 0.7 g/l
Shade B	Dianix Yellow Brown S2R 6.0 g/l 6.00 g/l Dianix Rubine S2G 20.3 g/l 20.3 g/l	Jackofix Ultra Yellow CE- 16.00 g/l Jackofix Red Eco- 36.50 g/l Jackofix Blue CE- 0.60 g/l
Shade C	Dianix Yellow Brown S2R 11.5 g/l Dianix Rubine S2G 20.9 g/l Painil Blue S2R 2.3 g/l	Jackofix Ultra Yellow CE- 9.00 g/l Remzol Ultra Red RGB- 40.00 g/l Jackofix Blue CE- 4.275 g/l
Shade D	Dianix Yellow Brown S2R 11.8 g/l Dianix Rubine S2G 16.0 g/l Painil Blue S2R 4.0 g/l	Jackofix Ultra Yellow CE- 13.40 g/l Remzol Ultra Red RGB- 26.60 g/l Jackofix Blue CE- 9.90 g/l
Shade E	Dianix Yellow Brown S2R 5.6 g/l Dianix Rubine S2G 13.46 g/l Painil Blue S2R 2.3 g/l	Jackofix Ultra Yellow CE- 11.50 g/l Remzol Ultra Red RGB- 21.00 g/l Jackofix Blue CE- 5.58 g/l

3. RESULTS AND DISCUSSION

Initially polyester portion of the fabric sample was dyed on production level by pad-dry thermo-fix method and then viscose part of blended fabrics was dyed in laboratory by cold pad batch method. Five shades were produced using different recipes. After dyeing samples were evaluated for colour difference and colour strength. Dyeing in the presence of soda ash only was taken as a standard.

The effect of various concentrations of sodium hydroxide in reactive bath composition for the shade A on colour yield of dyed samples is shown in Table I and presented in Figure 1.

Table I: Effect of concentration of alkali on dyeing of P/V blends for shade A

Sr. No.	Alkali concentration.	DL*	Da*	Db*	DE*	Colour Strength
1	20 g/l soda	-	-	-	-	100
2	20 g/l soda + 1 g/l caustic	0.06	-0	-0.34	0.36	98.20
3	20 g/l soda + 2 g/l caustic	-0.21	-0	-0.01	0.29	101.42
4	20 g/l soda+ 4 g/l caustic	-0.59	-0	-0.36	1.09	102.70

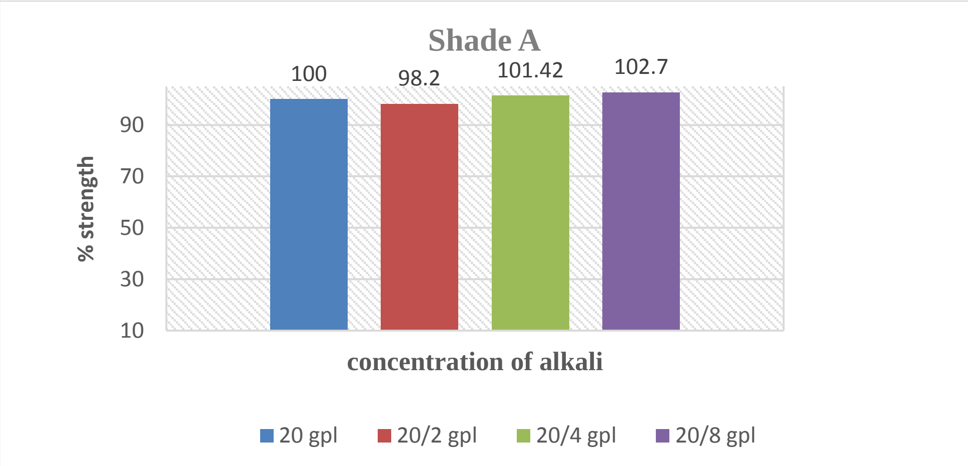

Figure 1: Effect of alkali concentration on dyeing of PV Blend for shade A

Form Table I, it was observed that the addition of caustic in padding bath showed the increase in colour strength of dyed samples. As concentration of caustic increased, the colour strengths of the dyed samples increased. The increase in colour strength in the presence of alkali may be due to the suitable alkaline conditions for the fixation of reactive dyes and swelling of viscose.

Table II: Effect of concentration of alkali on dyeing of P/V blends for shade B

Sr. No.	Alkali concentration.	DL*	Da*	Db*	DE*	Colour Strength
1	20 g/l soda	-	-	-	-	100
2	20 g/l soda + 1 g/l caustic	-1.37	-0	0.90	1.77	113.48
3	20 g/l soda + 2 g/l caustic	-1.57	-0	1.31	2.17	116.60
4	20 g/l soda + 4 g/l caustic	-1.67	-0	1.74Y	2.54	118.14

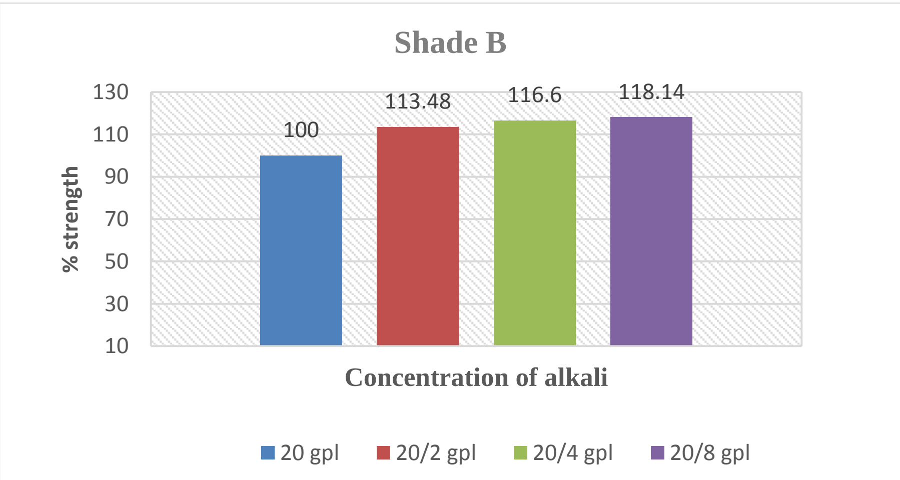

Fig 2: Effect of different alkali concentration on PV Blend for shade B

The PV blended samples were dyed with changing the recipe to produce shade B and the results of evaluation for colour difference, colour strength are given in Table II.

From Table II and Figure 2, it was observed that the same trend was noticed as incase of shade A. Here the increase in colour values were higher at higher concentration of alkali. At 4 g/l concentration of alkali there was about 18% increase in the colour value. Thus, for shade B, the concentration of dyes was higher and the higher concentration may require stronger alkaline conditions.

Table III: Effect of concentration of Alkali on dyeing of P/V blends for shade C

Sr. No.	Alkali concentration	DL*	Da*	Db*	DE*	Colour Strength
1	20 g/l soda	-	-	-	-	100
2	20 g/l soda + 1 g/l caustic	-0.48	-0	0.20	0.56	104.96
3	20 g/l soda + 2 g/l caustic	-1.77	-1	0.47	2.44	115.14
4	20 g/l soda + 4 g/l caustic	-2.11	-2	0.28	3.03	117.19

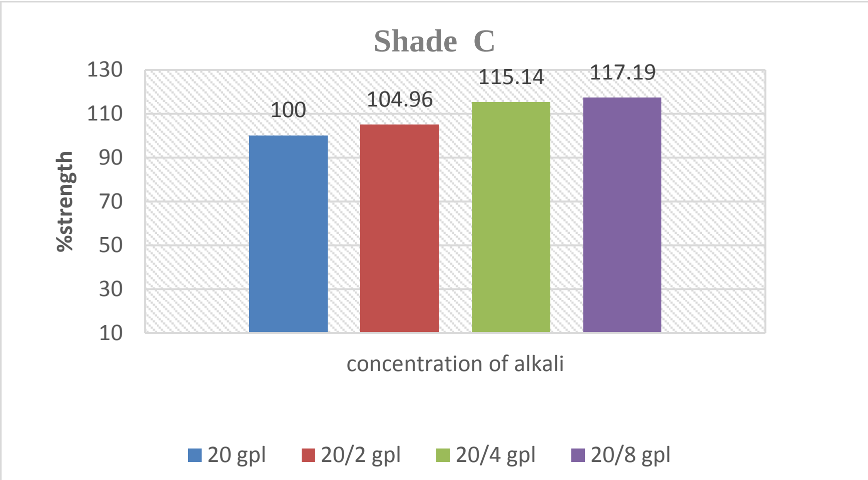

Fig 3: Effect of different alkali concentration on PV Blend for shade C

Table III and Figure 3 shows the influence of alkali concentration on dyeing of shade C. It was noticed that the alkali concentration has favorable on colour values. However the concentration above optimum concentration would be detrimental as the hydrolysis of dyes may increases.

Table IV: Effect of concentration of Alkali on dyeing of P/V blends for shade D

Sr. No.	Alkali concentration	DL*	Da*	Db*	DE*	Colour Strength
1	20 g/l soda	-	-	-	-	100
2	20 g/l soda + 1 g/l caustic	-0.55	-0	-0.06	0.70	104.37
3	20 g/l soda + 2 g/l caustic	-1.21	-0	0.13	1.47	110.58
4	20 g/l soda + 4 g/l caustic	-1.88	-2	-0.20	2.76	115.54

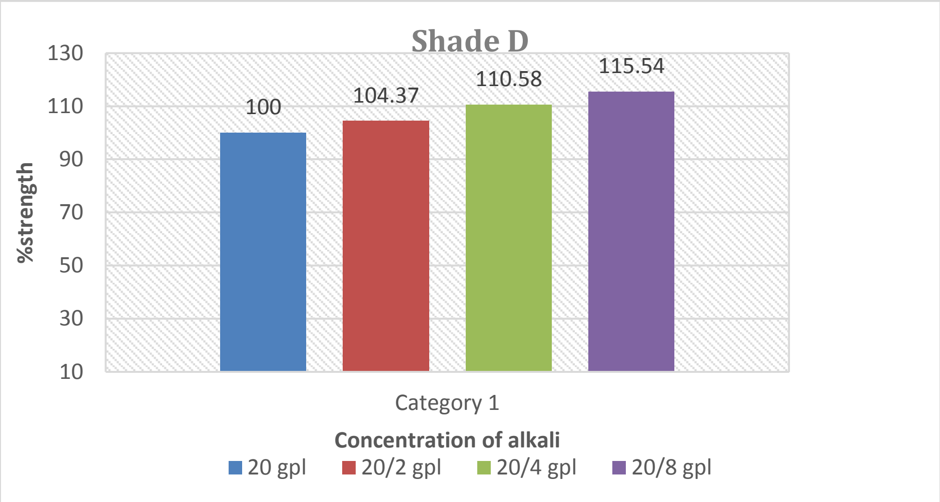

Fig 4: Effect of different alkali concentration on PV Blend for shade D

From Table IV, it was observed that addition of caustic in padding bath showed the increase in colour strength for the shade D. Again the increase in depth of colour may be contributed to the swelling of viscose and optimum alkaline conditions during dyeing.

Table V: Effect of concentration of Alkali on dyeing of P/V blends for shade E

Sr. No.	Alkali concentration.	DL*	Da*	Db*	DE*	Colour Strength
1	20 g/l soda	-	-	-	-	100
2	20 g/l soda + 1 g/l caustic	-0.38	-0	-0.11	0.59	102.49
3	20 g/l soda + 2 g/l caustic	-1.23	-1	-0.27	1.64	109.17
4	20 g/l soda + 4 g/l caustic	-1.51	-1	-0.08	1.95	112.07

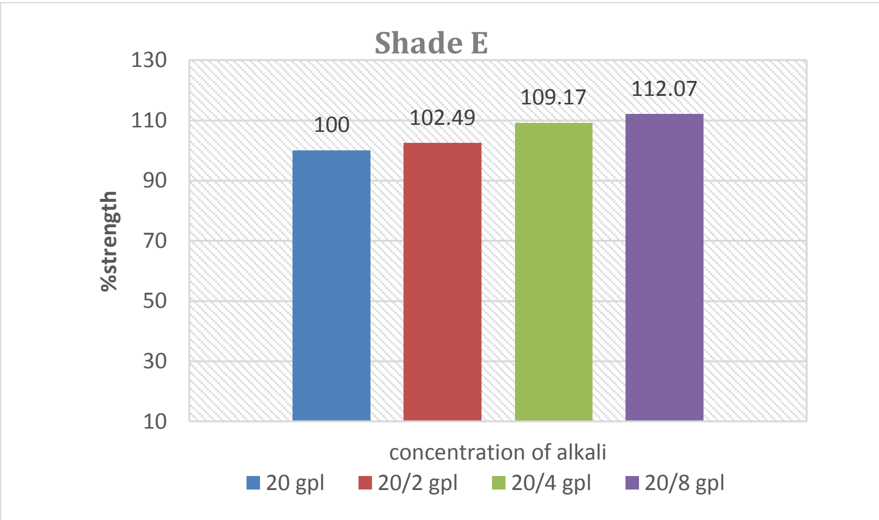

Fig 5: Effect of different alkali concentration on PV Blend for shade E

Table V and Figure 5 shows the effect of concentration of sodium hydroxide in viscose dyeing with reactive dyes for the shade E. Here the same trend was observed as in case of other shades studied above.

4. CONCLUSION

Reactive dyes are fixed by adding alkali in dye bath. Normally sodium carbonate and sodium hydroxide is used for the fixation of reactive dyes. Higher alkalinity may leads to the more hydrolisation of dye. So sodium carbonate alone or addition of some sodium hydroxide can be used to get maximum fixation. Alkali increases the fixation percent up to a certain level. All the dyeings in presence of sodium carbonate and sodium hydroxide showed higher colour strength compared to dyeing in the presence of sodium carbonate alone. The little amount of sodium hydroxide may help to maximum fixation of dyes. Little amount of sodium hydroxide has profound effect on increase in colour value. Normally the addition of strong alkali is beneficial in case of darker shades than the lighter shades. This little amount of alkali can save considerable amount of dyes.

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