Cost Efficiency Process of Reactive Dyeing in the Utilization Cotton Material of the Dyeing Production

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Abstract: We are capable of the disavow the presence and significance of alkali of dyeing of cotton material with reactive dyes as it's crucial to preserve the dyeing situation in the medium of alkali. In the presentpaintings deals with the fixation of reactive dyes via the assist of alkalis in generating black shade for cotton knit fabric. The comparative impact of single alkali (soda ash) and the mixed alkali such as (soda ash + sodium hydroxide) is evaluated according to coloration fastness (wash fastness, rubbing fastness), coloration energy, Lightness distinction (DL*) , fixation%, fabric electricity, PH of the dye bathtub . Spectrophotometer evaluation becomes conducted and the fixation at specific color % became determined through the usage of laptop color matching system. If combined alkali is used alternatively of unmarried alkali to upraise the PH of the dye bathtub then it reduces the alkali fee and its wash fastness, rubbing fastness , color electricity, fixation% are better than single alkali however it decreased the material bursting electricity little bit. Improving fixation and minimizing the dyeing cost is the ambition of this study.

Keywords: Mixed alkali, single alkali, reactive dye, deep shade, fixation%, color strength.

1. Introduction

For thewide range of application and better fastness properties reactive are the superior for cotton fabric. Through the application of reactive dye fifty percent of cellulosic fabric are colored. Share of reactive dyes amongst all textile dyes is 29%. Reactive dyes are used at the huge rate in the wet processing industries of Bangladesh. Application of alkali accelerates the reaction between cellulosic fiber and reactive dye that ash and multiple alkalissuch as soda ash, caustic soda was investigated. In Bangladesh, soda ash is commonly used to upraise the pH of the dye bath and in a case of deep shade combined alkali (soda ash + sodium hydroxide) is used. Combined alkali gives cost consumption for deep shade rather than producing deep shade through soda ash. Blended alkali is price powerful system within the application reactive dye for cellulosic cloth. Soda ash give less fixation in case of reactive dye[1]. Fixation stages for reactive dyes, when doing deep dyeing, can be as excessive as 70%[2]. Exams in several factories in Bangladesh have shown that currently fixation degrees from 40-65%, some five-30% beneath the feasible most. If the fixation% is improved then the dyeing price will be reduced. On this have a look at NOVACRON® brilliantBlack R (Huntsman, UK) was used. Make strong covalent bond .As a result bond between dye molecule carbon atom and hydroxyl group of cellulosic fiber is create. In this study fixation of reactive dye in the presence of single alkali like soda.

Due to the formation of covalent bond between the dye particle and fiber which makes reactive dye chemically firmed into fiber Reactive dye is a class of fantastically colored organic materials, mainly applied for tinting Textiles that connect themselves to their substrates by using a chemical force.As a

consequence dye particle and fiber make linkage through covalent bond that forms a covalent bond between the molecule of dye and that of the fiber. The dyestuff as a consequence will become a part of the fiber and is a lot less in all likelihood to be eliminated by washing them are dyestuffs that adhere through adsorption. The first actual fiber-reactive dyes were designed for cellulose fibers, and are nevertheless used typically in this way. In theory, fiber-reactive dyes had been advanced for other fibers, but these are not yet realistic commercially. The dyes contain a reactive organization that, whilst implemented to a fiber in a weakly alkaline dye bathtub, form a chemical bond with the fiber. Reactive dyes can also be used to dye wool and nylon, in the latter case they may be applied below weakly acidic situations.

Reactive corporations are of foremost sorts. The ones reacting with cellulose via nucleophilic substitution of a labile chlorine, fluorine, methyl sulphone or nicotinyl leaving group activated with the aid of an adjacent nitrogen atom in a heterocyclic ring.Those reacting with cellulose through nucleophilic addition to a carbon–carbon double bond, typically activated by means of an adjoining electron-attracting sulphone organization. This kind of vinyl sulphone institution is usually generated inside the dyebath with the aid of elimination of sulphate ion from a 2-sulphatoethylsulphone precursor institution with alkali[3].

Then, the suitable alkali is introduced to the dyebath to increase its pH. This initiates the preferred dye–fiber reaction. The hydroxyl groups in cellulose are weakly acidic and absorption of hydroxide ions reasons some dissociation, forming cellulosate ions. It’s far these that react with the dye by usingnucleophilic addition or substitution In preferred, the decrease the reactivity of the reactive group of the dye in the direction of the alkaline cellulose, the better the final dyeing temperature and the higher the very last pH of the dyebath. Unfortunately, underneath the alkaline conditions vital for the dye–fiber response, hydroxide ions additionally react with the reactive institution of the dye in a whole lot the same way as the cellulosate ion.This produces the hydrolyzed dye, that's incapable of reaction with the fiber. Hydrolysis of the dye is slower than the reaction with the alkaline cotton but it is sizable and reduces the efficiency of the fixation process[4] . After dyeing, any unreacted and hydrolyzed dye present within the cotton ought to be removed by means of thorough washing. This guarantees that no shade will bleed from the cotton on subsequent washing at some point of use. The better the substantively of the reactive dye for the cotton, the more hard it's far to wash out unfixed dye from the fabric.

2. Materials

Mymun fabric confined DBL institution, Bangladesh providesthe cordial guide with the aid of providing 100 percentage scoured and bleached cotton knit s/J fabric of GSM 130. Dye stuff NOVACRON® high-quality Black R (Huntsman, united kingdom) is used for dyeing ,levelling agent is ALBATEX® DBC (Huntsman, UK),electrolyte is Glauber's salt ($Na_2SO4.10\ H_2O$),soda ash and caustic soda to govern dye tub pH, acetic acid , ERIOPON®R LIQ (Huntsman, UK))as a terrible detergent and ALBA®fix ECO (Huntsman, UK).) as fixing agent.

3. Method

In this comparative examine, identical bath scoured bleached cloth became dyed with handiest NOVACRON® wonderful Black R and the amount of the usage of Glauber’s salt as electrolyte became taken from the technical statistics sheet of dye supplier . This observe works with 5%, 7%, 9% & 12% shade .at the beginning five% color became produced by using single alkali (the amount of soda ash

become taken from the technical facts sheet of dye provider) and then 3 sample of 5% color is produced by means of using combined alkali of its three volumetric aggregate that is Mix1 = 6g/l Na2CO3 & 1.58 g/l NaOH, Mix2 = 6g/l Na2CO3 & 2.5 g/l NaOH ,Mix3= 6 g/l Na2CO3 & 1.78 g/l NaOH .Then four dyed sample for 6% shade were gone for spectral analysis with the spectrophotometer is used to evaluate 5 percent dyed sample then compared mix1 , mix 2 , mix 3 according to standard . Equal way dyed samples are as compared to 7%, 9%, 12% color in terms of dye fixation and the best combined alkali (among mix1, mix 2, mix 3) is chosen. Then accordingto coloration fastness (wash fastness, rubbing fastness), color energy, fixation%, Mix1, Mix2, Mix3 is analyzed with a standard. In this observe, the quantity of soda ash or mixed alkali isn't always extended with the growing coloration % and the electrolyte additionally identical for 5%, 7%, 9%, 12% color. For single alkali technique Black R, 20 g/l soda ash and six g/l soda ash and 2.5 g/l caustic soda for deeper shade in blended alkali technique. Different amount of Reactive dyes= 5%,7%,9%,12% owf ,Wetting agent= 1.5g/l, Leveling agent= 1.5g/l,Anti-creasing agent= 1.5g/l, Salt(NaCL)= 51g/single Alkali (soda ash)=20g/mixed Alkali(soda ash+ caustic soda)Mix1 = 6g/l Na2CO3 & 1.58 g/l NaOH, Mix2 = 6g/l Na2CO3 & 2.5 g/l NaOH ,Mix3= 6 g/l Na2CO3 & 1.78 g/l NaOH is used at 61^0 C for 61 min.

3.1.Dyeing method

Identical bathtub scoured and bleached sample (5 gm) changed into dyed with NOVACRON® remarkable Black R for 5%, 7%, 9%, and 12% color. Mathis LABOMAT laboratory dyeing gadget became used with 1:10 liquor ratio for the duration of this examine. The fabric became entered at room temperature. 1.5 g/l ALBATEX® DBC (Huntsman, united kingdom), dye solution, a hundred one g/l glauber's salt have been delivered and the temperature became raised to 61^0C and run 46 min after which the dye pot turned into removed from the Mathis LABOMAT for alkali dosing (soda ash or combined alkali) and then temperature turned into raised to 61^0C and run 61 minute. The material became rinsed at 51^0C temperature for 11minutes; Neutralized with 1.5 g/l acetic acid for 11 minutes and soaping changed into carried out with 2.2g/l ERIOPON®R LIQ (anionic surfactant agent; Huntsman, United Kingdom) at 97^0C for 31 min.

3.2.Determination of fastness

Wash fastness test have become conduct in termsof ISO a hundred and five-C03 approach. Washing solution containing 5g/l Metter soap (anionic), 2g/l soda ash. The specimen became the dealwith at 60^0C for a half-hour. And then it turned into dried. Rubbing fastness test has become conduct in termsof ISO a hundred and five-X12 approach.

3.3.Determinationof bursting strength

The bursting power takes a look at modified into finished in step with the use of hydraulic diaphragm bursting tester.

3.4.Determinationof color strength

The reflectance value of a specimen for the wavelength of 400nm – 700nm with 10 nm intervals was found using Data color 600® spectrophotometer. By using this reflectance value into the Kubelka Munk`s equation we can get the color strength (K/S).

$$\text{Color Strength, K/S}=\frac{(1-R)2}{2R}$$

3.5.Determination of fixation %

To determine the fixation% the dyed fabric (such as SD, M2 for 5% shade) was cut into two pieces at the end of dyeing one piece was left in open air and other pieces were neutralized with acetic acid, cold rinsed for 10 minutes, treated with 2 g/l ERIOPON®R LIQ (anionic surfactant *agent*; Huntsman, UK) at 98^0C for 30 minutes hot wash was done for 10 minutes and then dried in open air. The reflectance of each fabric sample was measured through Data color 600® spectrophotometer. This study is done with black color and the reflectance of standard black is 0 and the reflectance of standard white is 1.

So reflectance is lower for the higher fixation of black dyes. For black dyed fabric, the fixation can be calculated as

$$F\%=\frac{K1/S1}{K2/S2}x100\%$$

Where the color energy of the washed indicate K1/S1 and unwashed dyed sample indicate K2/S2.

3.6.Determination of Lightness difference (DL*)

Lightness (L*) turned into measured with the help of Datacolor six hundred® spectrophotometers. L*= 0 for pure black and L*=100 for natural white. And the lightness difference, DL*= L*trail – L*fashionable.In this look at, SD of 5% color turned into taken as wellknown and Mix1, Mix2, Mix3 of equal color % have been taken as a trail to get DL*. The same method turned into followed for 7%, 9%, 12% shade.

3.7.Determination of p^H

P^H changed into measured with the help of METTLER TOLEDO's p^Hmeter for a lab. For reactive dye fixation, the pH requirement might around 10.5 to 11.5. On this examine, $_pH$ of the dye bath after alkali dosing turned into measured. And the $_pH$of soda ash and mixed alkali answer are also measured.

4. Results and analysis

4.1.Cost analysis

Alkali Requirement		**Cost of Alkali (Tk./litre)**		
		Soda Ash	Caustic soda	total
SD	Soda 20	20x19/1000 =0.38	----------	.38
M1	Soda 6 g/L+1.58 g/l soda ash	(5x19)/1000 = 0.09	1.5x43)/1000 = 0.06	.15
M2	Soda 6 g/L +2.5 g/l soda ash	5x19)/1000 = 0.09	2x43)/1000 = 0.08	.17
M3	Soda 6 g/L+1.78 g/l soda ash	(5x19)/1000 = 0.095	1.75x43)/1000 0.075	.13

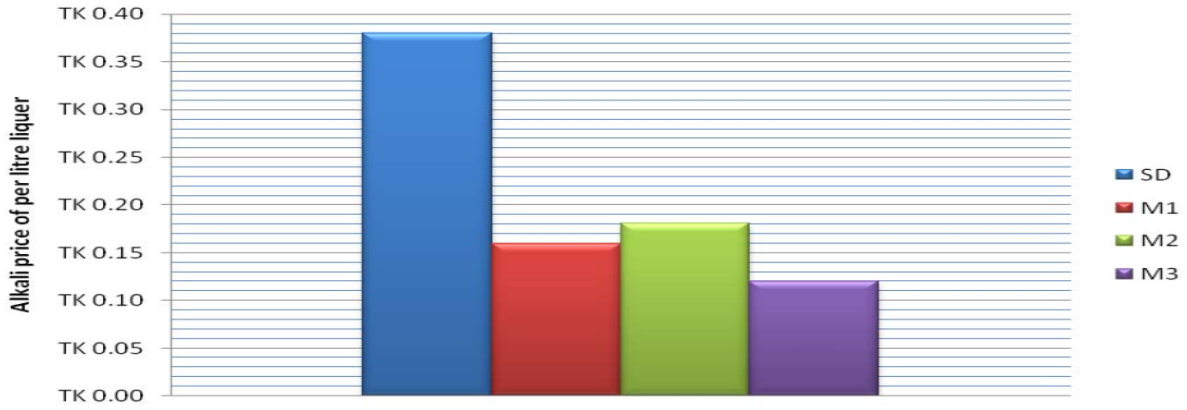

Figure 1: Alkali price per liter for SD, M1, M2, and M3.

Themarket rate of Soda ash TK 19 consistent with Kg. and for Caustic soda TK 43per Kg.And this fact was gathered from DBL group, in October, 2011. The market charge is modified frequently however it isn't range an excessive amount of right here,the alkali rate is proven for SD, M1, M2, M3 and the liquor is 1 litter. For SD 20g/l soda ash become used and its fee became better than mixed alkali. For M1 6 g/l soda ash and 1.58g/l caustic soda become used to upraise the pH and the rate became second lowest some of the mixed alkalis. For M2 6g/l soda ash and 2.5g/l caustic soda turn out to be used and the charge has come to be a maximum of the combined alkali. For M3 6 g/l soda ash and 1.78 g/l caustic soda changed into used and the alkali fee became the lowest. Mixed alkali reduces the alkali cost during reactive dyeing with cotton fabric. Single alkali cost is twice than blended alkali Mixed alkali unable to impose significant effect of enhancing dyeing shade.

4.2.pH of the dye bath after alkali dosing

Fig.02 shows that pH of SD was decreasing with the increasing shade%. And mixed alkali upraises the pH very effectively. The dye bath PH should be between 10.5-11.5 pHwith increasing dyeing concentration we have to increase the amount of alkali.

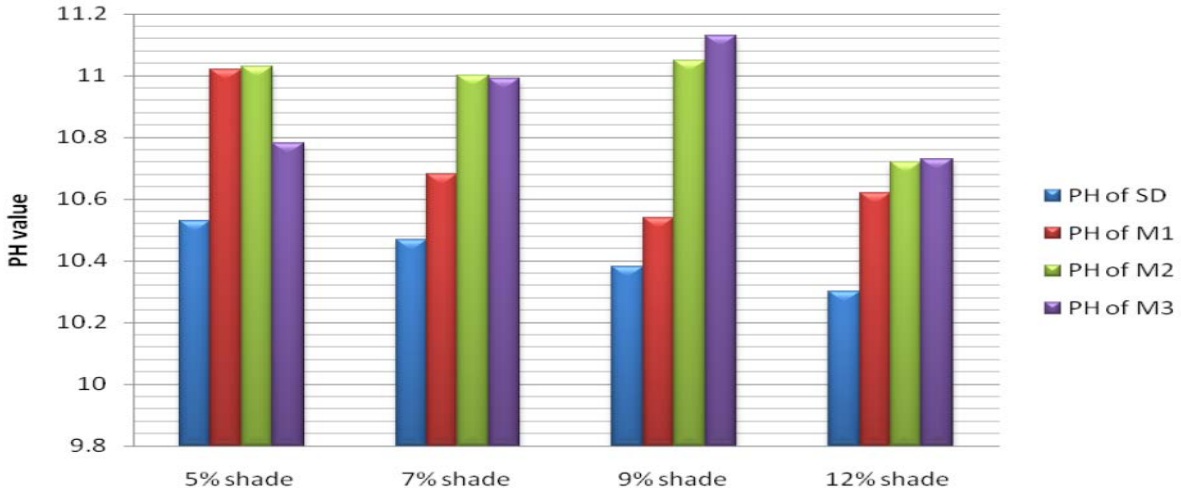

Figure 2: pH of the SD, M1, M2, M3 dye bath after alkali dosing.

4.3.Bursting strength analysis

Shade (%)	Alkali(pound/square inch)			
	SD	M1	M2	M3
5	87	80	85	84
7	80	76	78	80
9	85	76	81	76
12	84	81	76	59

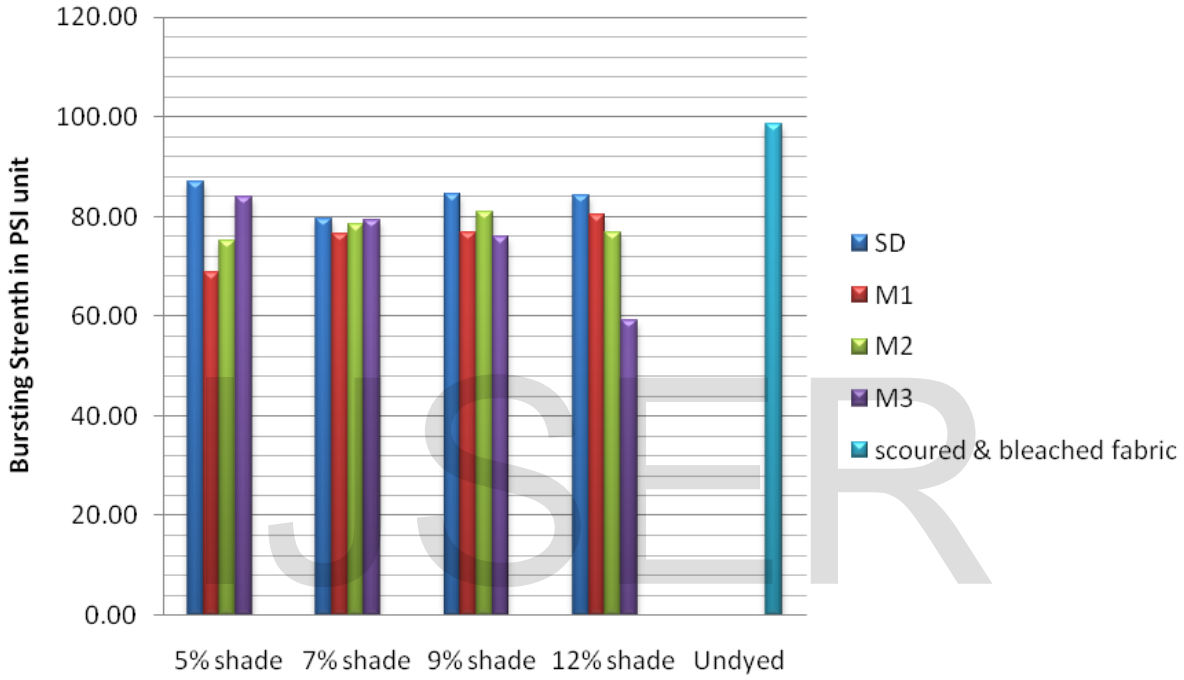

Figure 3: Bursting strength test result of SD, M1, M2, M3 and undyed scoured bleached sample in PSI (pound/square inch).

Fig.03 shows that, the dyed sample had lower bursting strength than the undyed sample. Alkali had reduced the bursting strength of the sample. The bursting strength of SD was higher than M1, M2, and M3. Its mean mixed alkali had decreased the bursting strength more than the single alkali.

4.4.Lightness difference (DL*) analysis

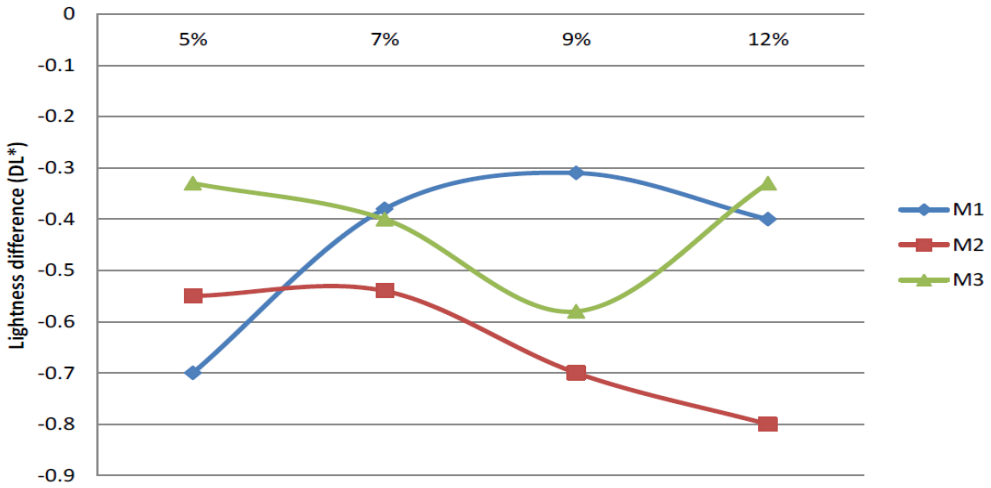

Figure 4: Lightness difference (DL*) of M1,M2,M3 for 5% ,7%, 9%, 12% shade & SD is taken as standard for their respective shade%. D65 10 Degree is used as illuminant.

All the result of DL* is negative. Its mean M1, M2, M3 are darker than SD. In a case of black dyes darker means more dyes were fixed with the fiber. In case of M1, it makes an arc and for 5% shade it was much darker. In a case of M2,the lightness difference (DL*) for 7%, 9%, 12% shade was highest among M1, M3.Its mean it was darker than SD for 7%, 9%, 12% shade. For M3, darkness was gradually increased to 5%, 7% and 9% shade, but for 12% shade it was slightly dark. From this Lightness difference (DL*) analysis in comparison among M1, M2, M3 it could be said that M2 produce much darker shade than SD. And in this study, M2 was taken for further more tests to compare with SD.

4.5.Assessment of color fastness to Rubbing

Specimen name	**Shade% of the specimen**	**Rubbing fastness**	
		Dry	Wet
SD	5	4-5	3
M2	5	4-5	3-4
SD	7	4-5	2-3
M2	7	4-5	3
SD	9	4-5	2
M2	9	5	3
SD	12	4-5	2-3
M2	12	5	2-3

Table 1: Staining on fabric (100% bleached cotton) for SD and M2 in different shade%. Method: ISO 105 - X 12: 1987, Here, 5= Excellent, 4=Good, 3=Fair, 2=Significant staining, 1=Deep staining.

According to table 1 from the evaluation of all color it is clear that mix 2 gives good rubbing fastness because of formation of covalent bond.

4.6.Assessment of color fastness to Washing:

Specimen name	Shade% of the specimen	CA	CO	PA	PAN	PES	WO
SD	5	5	4	5	5	5	4-5
M2	5	5	4	5	5	5	4-5
SD	7	5	3-4	5	5	5	4-5
M2	7	5	4	5	5	5	4-5
SD	9	5	3-4	5	5	5	4-5
M2	9	5	3-4	5	5	5	4-5
SD	12	5	3-4	5	5	5	4-5
M2	12	5	3-4	5	5	5	4-5

Table 2: Staining on multi fiber for SD and M2 in different shade%. Method: ISO 105-C03: 1989.

Here, CA = Cotton Acrylic, CO = Cotton, PA = Poly Acrylic, PES = Polyester, PAN = Poly Acrylonitrile, WO = Wool are the reference multifiber; 5= Excellent, 4=Good, 3=Fair, 2=Significant staining, 1=Deep staining.

In this assessment, there has been no stain on PA, PAN and PES. And for WO (wool) it turned into accurate to exceptional for all specimens. For CO (cotton) stain, SD and M2 had desirable fastness high-quality for 5% color. And for 7% shade, SD`s fastness first-rate was honest to excellent; M2`s fastness satisfactory turned into correct. All the specimen of 9% and 12% color had fair to top fastness high-quality. From this evaluation, it may be stated that, the wash fastness of SD and M2 was relatively identical for exceptional color%. However, for 7% coloration M2 possess desirable fastness residences than SD.

4.7.Color strength (K/S) analysis

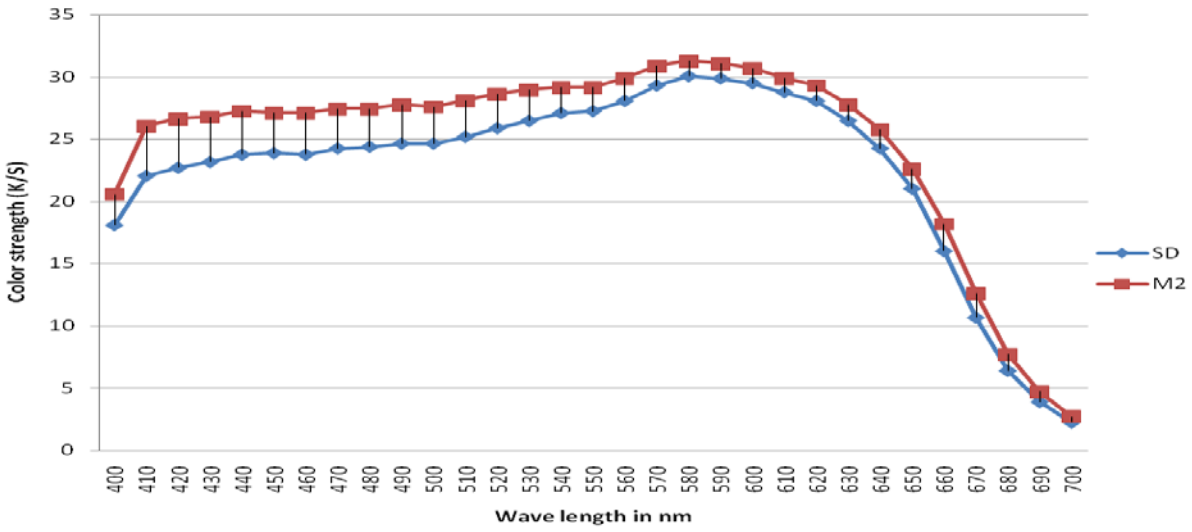

Figure 5: comparative color strength (K/S) for 5% shade of SD and M2

Figure-5 shows that the coloration energy (k/S) of four hundred to seven-hundred nm wavelength for D65 10 Deg light supply. And here color power is figure-five indicates that the shade electricity (k/S) of 400 to 700 nm wave duration for D65 10 Deg light supply. And here color power is measured for 5% self-color of NOVACRON® remarkable Black R. The shade power (k/S) of M2 is higher than SD for every wave period (400 -seven hundred nm). Its mean mix alkali increases the color power for 5% color.

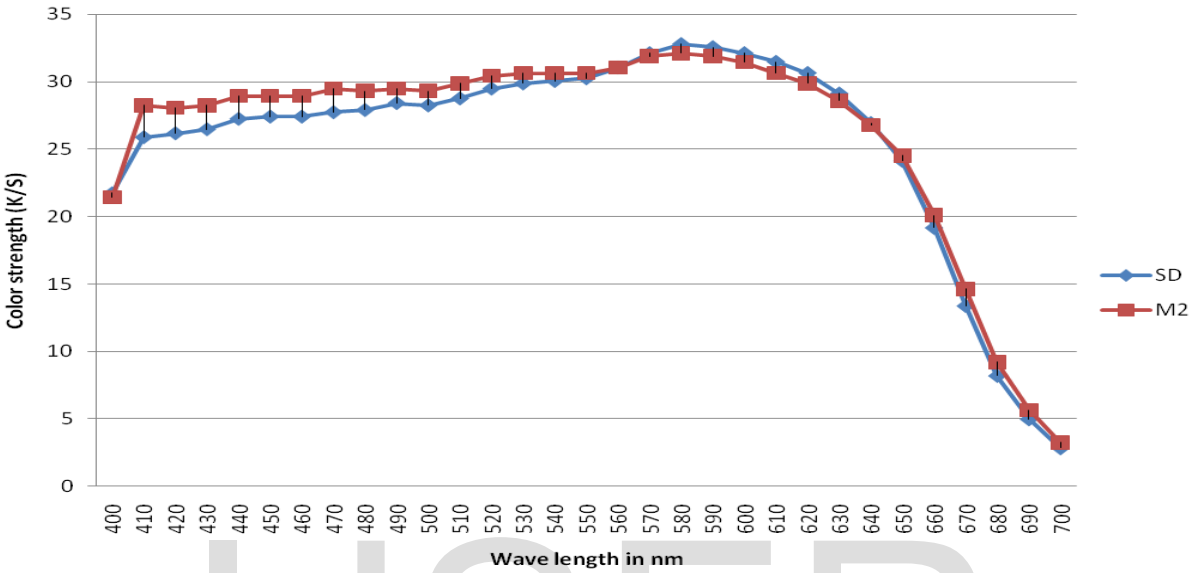

Figure 6: comparative color strength (K/S) for 7% shade of SD and M2

Figure-6 shows that the coloration energy (k/S) of four hundred to seven-hundred nm wave length for D65 10 Degree light supply. And here color power is measured for 7% self-color of NOVACRON® first-rate Black R. The color energy (k/S) of M2 is better than SD but for 580nm to 630nm wavelength the coloration strength of SD is barely high.

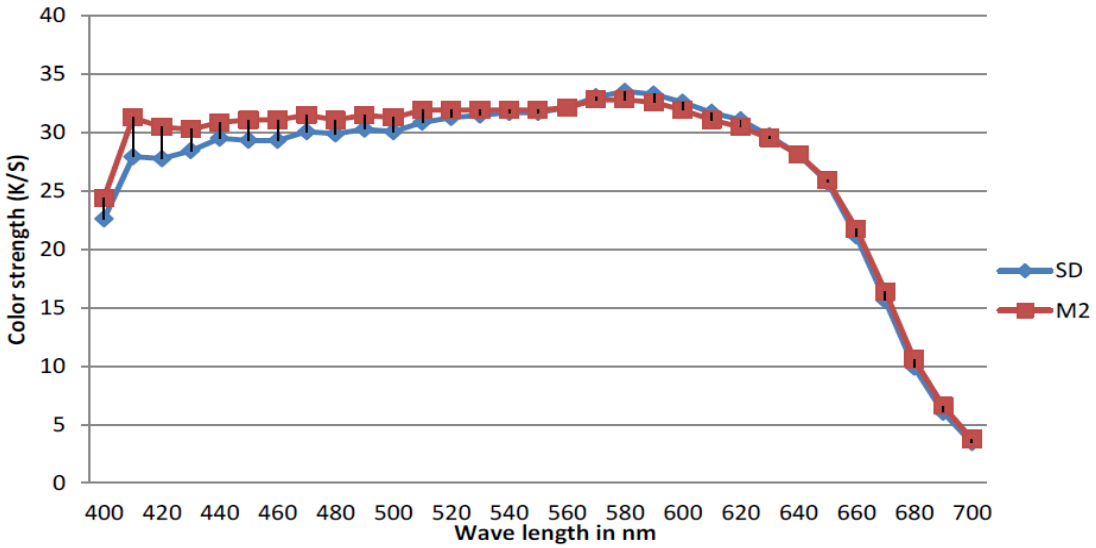

Figure 7: comparative color strength (K/S) for 9% shade of SD and M2

Figure-7 shows that the shade energy (k/S) of 400 to seven-hundred nm wave duration for D65 10 Deglight source. And here coloration energy is measured for 9% self-coloration of NOVACRON® brilliant Black R. The color strength (k/S) of M2 is higher than SD however for 580nm to 630nm wavelength the color strength of SD is slightly high.

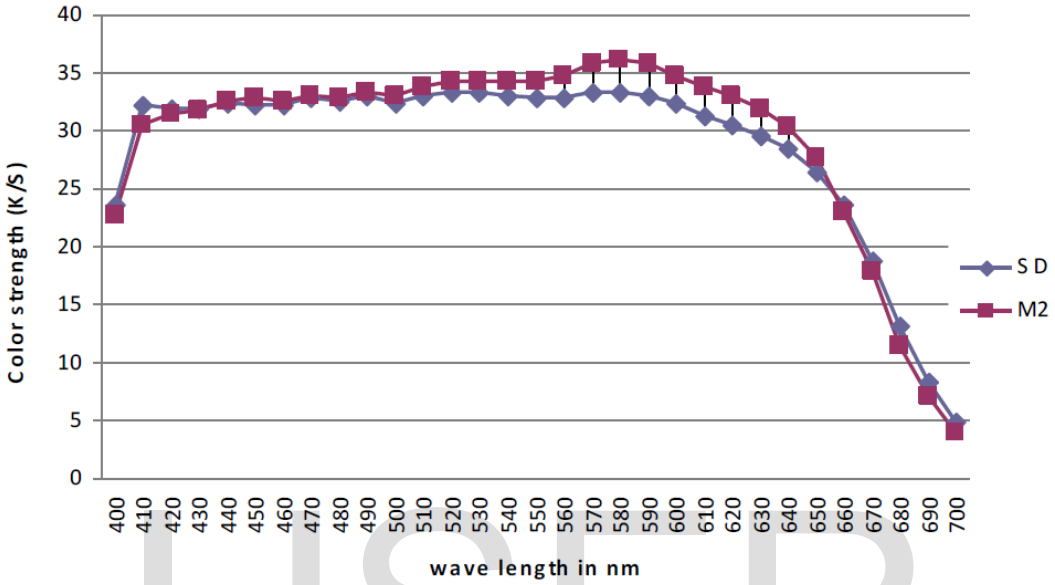

Figure 8: comparative color strength (K/S) for 12% shade of SD and M2

Figure-8 suggests that the coloration strength (K/S) of 400 to 700 nm wave duration for D65 10 Deg mild supply. And here color power is measured for 12% self-shade of NOVACRON® remarkable Black R. The color strength (k/S) of M2 is higher than SD for every wave duration (four hundred-seven hundred nm). Its imply mix alkali increases the shade energy for 12% color.

4.8.Assessment of Fixation%

Shade% of the specimen	**Specimen name**	Fixation (%)
SD	5	93.75
M2	5	97.19
SD	7	94. 43
M2	7	95.16
SD	9	95. 81
M2	9	98. 66
SD	12	98. 05
M2	12	97. 95

Table 3: Fixation% of SD and M2 for different dye concentration or shade% at 410 nm wave length of the light source (D65 10 Degree).

Table03 suggests the fixation% of SD and M2. The dye fixation of M2 turned into better than SD. The dye tub pH of SD was decrease than M2. However, the fixation of SD turned into not awful either. So it may be stated that during terms of dye fixation combined alkali (soda ash + sodium hydroxide) technique become better than single alkali (soda ash) technique. On this fixation assessment, the reflectance of 410 nm wavelength of D65 10 Degree turned into used. those statistics simplest gave an approximate fixation price as there were hydrolyzed as well as unfixed dyes gift within the cloth which could not be washed off.

5. Conclusion

On this comparative examine single alkali and mixed alkali approach was justified in phrases of price, color fastness, fixation%, shade power, cloth energy. And mixed alkali indicates better bring about all component. In traditional exhaust dyeing approach for generating deep color, we use a huge quantity of soda ash (single alkali method).Bit if we use combined alkali than we can reduce the half of value of alkali. Despite the fact that in a case of wash fastness and rubbing fastness it posse's better high-quality and the dye fixation with the fiber is likewise higher but it decreased the cloth electricity little bit.

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