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Dyeing of cotton yarn by using recycled salt

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Abstract

NaCl as exhausting agent and alkali as fixing agent plays an important role in cotton dyeing. Thus, the salt used in dyeing, the waste water coming out after dyeing has excess salt. In doing so it causes various types of pollution and environmental damage. For small scale industries, this study reports on the dyeing between commonly used NaCl and recycled salt by dyeing the waste water that comes out from it. Thus recycled salt [ATFD salt] effluent coming out of dyeing is decolorized using various methods and its final process is ATFD .In this ATFD process, the salt present in the waste water is filtered .We have used this salt in the study and compared it to ATFD salt which is generally used in dyeing, the strength colour fastness of the colour in the yarn in dyeing, the quality of waste water coming out from them ,the amount of NaCl purity in this salt has also been said. Also, it has been said in the study about the dyeing by using various methods to reduce or increase the amount of this salt. It is important to say that it is economical and environmentally optimal by using recycled.

Keywords: Dyeing, NaCl, ATFD salt, Effluent.

1. Introduction

Recycling plays a major role in our daily lives, Thus the materials we use every day. Whether they are natural or synthetic end up being recycled and renewed ,recycling means that waste materials take on a new form during recycling .they are used as other things .thus the water we use is recycled and reused .industrial effluents contain many chemicals ,if they are released without treatment ,they affect the environment and ground water, using that impure water causes many problems in human body like lung damage, liver damage ,cancer etc. a lot of this waste water is released from textile industries .India is a major textile manufacturing country with 197 composite mills and 3244 semi composite process mills [1].All the textile industries used dyes on the fabrics which leads to the attractiveness of the customers, many classes of dyes are available like direct, vat, sulphur and reactive dyes [2].Erode district is one of the most cancers affected area in

Tamil Nādu where they are many dye factories, tanneries and chemical factories in which dye factories play a major role[3]In this modern era, colour has become very attractive, acceptance and important to the textile products[4].Leather, synthetic fibres and natural fibres are dyed in the dye factories and the pH, TDS and BOD, COD levels in the effluent are uncontrolled in these dye factories. The textile industries are produced the cotton fabric a lot, because cotton fabric have no harm to skin and healthy comfortable and can be wearing are season anytime [5]. Too much Chemicals are used to dye these cotton fabrics, all though these are dyed with natural dyes, the colour and colour fastness varies according to the nature also dying with natural dyes many disadvantages. The common drawbacks of natural dyes are non-uniform shade, non-producible, poor colour fastness and lakh of scientific information on the chemistry of dying and standardise dyeing methods [6]. Considering these reasons, synthetic dyes were invented. These synthetic dyes were invented in 1856.As an alternative to natural dyes, these synthetic dyes have some advantages, good colour fastness, reproducibility of shade, brilliance of colour and easily to use [7].Beside a wide range of available colours, higher reproducibility and improved quality of dying could be achieved at lower specific cost[8].The raw material of this synthetic dyes is non-renewable while the materials for the natural dyes are renewable and biodegradable[9].Textile industries use approximately 1.3 million tonnes of dyes and pigments in production. It's worth $ 23 billion, all of which manufactured synthetically [10]. Typically, direct and reactive molecules have charges and there for material has also negative charges on its surface. Salt decreases the repulsion of negative, negative charge and thence improve exhaustion [11]. NaCl and Na2Co3 are used in this Cotton dying, NaCl is used as a nursing exhausting agent to exhaust the dye colour in the dye bath and Na2Co3 is used as a fixing agent to fix the colour fabric [12]. Salt consists of small cubes tightly sue along through ionic bonding of the metallic element and chloride ions [13]. Salt increases the exhaustion and attraction between the dye molecule and textile material. Salt used in cotton dyeing is high in effluent after dyeing, there is a high amount of electrolyte and unfixed dyes which pollute the environment. This salt cannot be exhausted or destroyed [14]. Each year the global textile industry discharge 40,000 – 50,000 tonnes of dye into our rivers and more than 2,00,000 tons of salt [15]. Textile waste water are the strong colour, basic and acidic pH, high chemical oxygen demand and biochemical oxygen demand, high suspended solids and considerable number of heavy metals [16]. which has negative effect on the human health [17]. Some industries use method like coagulation, filtration, reverse osmosis, brine concentrator, ultra filtration, evaporator, crystallizing etc. To treat such affect waste water to remove the colour, pH, BOD, COD, suspended solids, heavy metals in the waste water and finally in the ATFD process, salt is extracted from the water [18]. As mentioned above, due to the fact that salt cannot be exhausted and destroyed and their requirement is essential in cotton dyeing. So, with the aim of recycling and reuse using ATFD salt as a substitute for NaCl (exhausting agent) using ATFD salt also reduces the need for NaCl in the environment. And their dyeing performance, economical cost, colour strength also very optimal.

2. Materials and Methods

2.1 Materials

100 % cotton RFD (ready for Dyeing, already process with scouring and bleaching) 10 s, 20 s,40 s, 60 s Count yarn was used in the project work.

Properties /count	10 s	20 s	40 s	60 s
Actual count	10.11	19.055	38.82	61.795
Count CV%	1.84	1.10	0.72	1.46
CSP	3049	2888	2879	2785
Elongation	5.73	5.19	4.46	3.78
Strength	301.29	151.59	74.16	45.07

2.2 Chemicals

Salt (NaCl), Soda (Na2Co3), ATFD salt, Acetic acid (CH 3 COOH), SERAFIL SBS were used for dyeing.

2.3 Dyes and Shades

Dyes	Shades
Reactive Sky-blue N	0.1%
Reactive Yellow CE	0.25%
Reactive Black DSDN	2.0%
Reactive Deep cherry	3.0%

Shades of these four types of dyes were used to dye all the four count yarns. Thus, each count yarn was dyed in four different Shades (dyes).

2.4 Dyeing Procedure

Yarn count:100%cotton 10s,20s,40s,60s count yarns

Dyes: Yellow CE, Sky blue N, Black DSDN, Deep Cherry.
Bath weight:10 g
M:L ratio: 1:6
Total liquor:60 cc

Recipe for salt and soda requirement based on dyes

Depth of shades	Dyes	Salt (GPL)	Soda (GPL)	Soap (GPL)	Acetic acid
Light shades	0.1%	10 GPL	10 GPL	0.5GPL	2.0 g/l
	0.25%	20 GPL	12.5 GPL	0.5 GPL	
Dark Shades	2.0%	60 GPL	20 GPL	1.0+0.5 GPL	3.5 g/l
	3.0%	75 GPL	20 GPL	1.0+0.5 GPL	

General dyes calculation formula

$$\text{Required dye solution} = \frac{\text{Material weight X recipe amount \%(shade)}}{\text{Stock solution \%}}$$

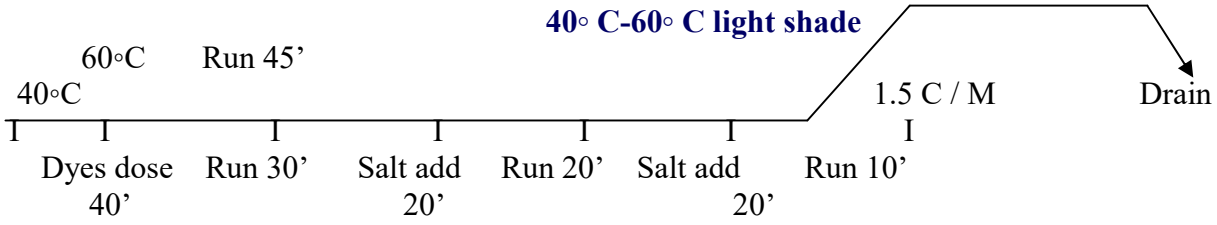
General chemical calculation formula

$$\text{Required chemical} = \frac{\text{Total liquor X Chemical amount (gm/l)}}{\text{1000 X Conc. of stock \% of chemical}}$$

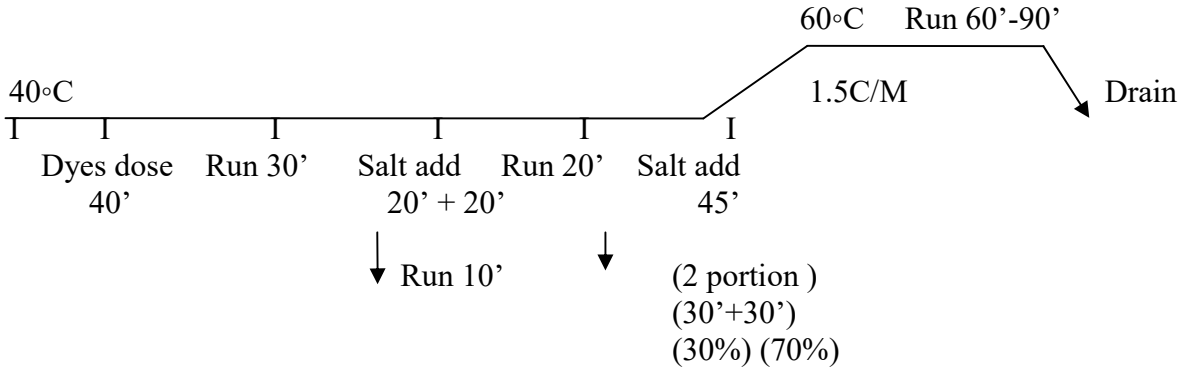
2.5 Dyeing

In this dyeing process, each type of count yarn was prepared with four types of dye bath and according to their shade, two types of dyeing program was done for both sides as light (or) dark. The dying program was carried out at 40º C to 60º C. In this study dying was done using NaCl which is generally used as exhausting agent in cotton dyeing and in contrast in this study ATFD salt was used. While using ATFD salt it was equal in mass amounts (1/2,3/4,1,1 ¼,1 ½) in increasing and decreasing ratio. For dye fixation soda was added and 60-90 minutes program held. And after used soaping agent to soaping the yarn and further process. For example, if the amount of NaCl salt used for 0.1%dye concentration is 0.6 gm. Then the ratio of ATFD salt used in this study (1/2,3/4,1,1 ¼ ,1 ½)is 0.2 g,0.4g,0.6g,0.8g,1.0 g.

40◦ C-60◦ C light shade



40◦ C-60◦ C Dark shade



2.6 Surface colour measurement

The condition the yarn samples were evaluating using a Data colour 800 spectrometer and associated software with 10 ºLAV observer using D65 illuminate for surface colour strength (K/S) values. The K/S value was determined by the Kubelka Munk equation.

$$K/s = \frac{(1-R\lambda max)2}{2R\lambda max} = \alpha Cd$$

K-coefficient of absorption
S - coefficient of scattering
Cd- concentration of due

Rλmax - surface reflectance value of the sample at a particular wavelength.

2.7 Fasteners testing

Wet and dry rubbing fastness test is determining the degree of colour which may be transferred from the surface of coloured fabric to a specific test cloth for rubbing. These tests of dyed samples were evaluated according to ISO 105 X12: 2016 test method using a manual crock meter rub fastness instrument.

Wash fastness, A specimen in contact with specific adjacent fabric or fabric or fabric is laundered, rinsed and dried. The sample is treated

for a short time in a chemical bath at suitable conditions. Abrasive action is accomplished by using liquor ratio and appropriable number of steel balls. The colour change of the sample and the staining of the adjacent fabric are evaluated by the grey scale. The colour fastness of dye sample to washing was evaluated according to ISO 105 C06 A2S: 2010 and the test method using a washing fastness instrument. And the colour fastness to water, perspiration was evaluated according to the ISO 105 E01: 2013 and ISO 105 E04: 2013.

3. Results and Discussion

3.1 ATFD salt purity

NaCl purity of ATFD salt used in this study, we can find their purity by following formula, 20 g ATFD salt has taken for purity test, pH-10.34, TDS-39,300 and Total Hardness-212.

$$\text{Salt purity} = \frac{\text{Volume of AgNo3 X Normality of Ag No3 X AgNo3 molecular weight X Fact}}{\text{(Weight of samples in grams X 1000}} \text{ X } 100$$

$$= \frac{18 \text{ X } 0.1 \text{ X } 58.44 \text{X} 125}{20 \text{ X} 1000} \text{ X } 100$$

= 65.74% purity of the ATFD salt used in this study

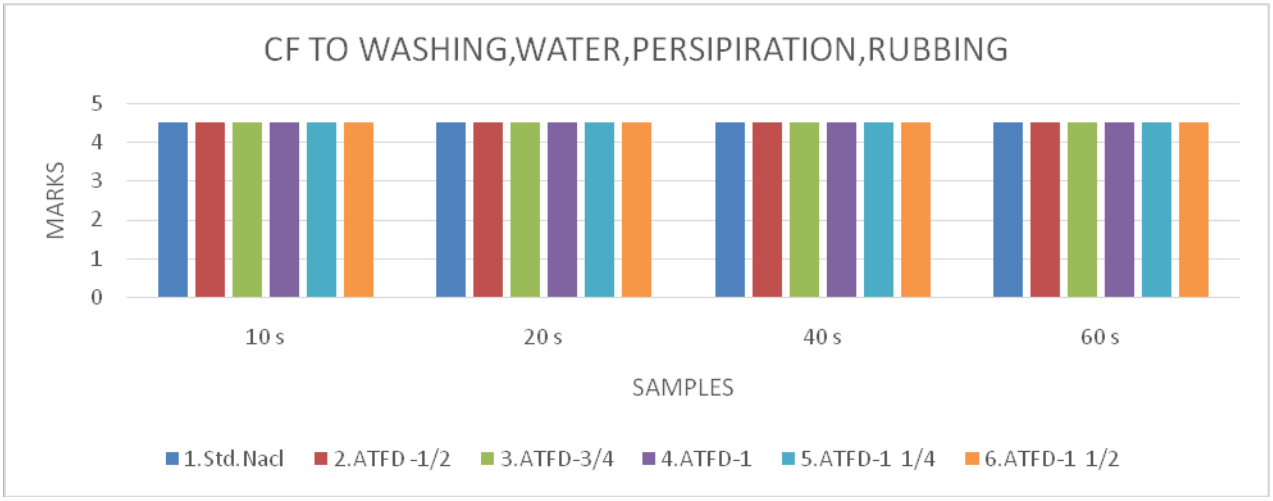
Thus, the salt in purity of ATFD is 33% lower than the purity in NaCl salt. When this 65.74% ATFD salt is dyed in mass equal to NaCl, its color strength, they differ greatly from the standard. So, considering them, these dyeing were done to see the difference when using ATFD salt mass equal to NaCl mass, increasing and decreasing. When used in such way, the difference in color strength is greater when using less than the mass of NaCl. That is, the difference in color strength is less when ATFD salt is equal to NaCl and when ATFD salt is used with more mass than NaCl salt.

3.2 Colour Fastness

In this colour fastness test, the concentration of different types of salt subjected to dyes, the type of salt, the type of dyes, the type of yarns is based on the marks obtained in this test as follows,

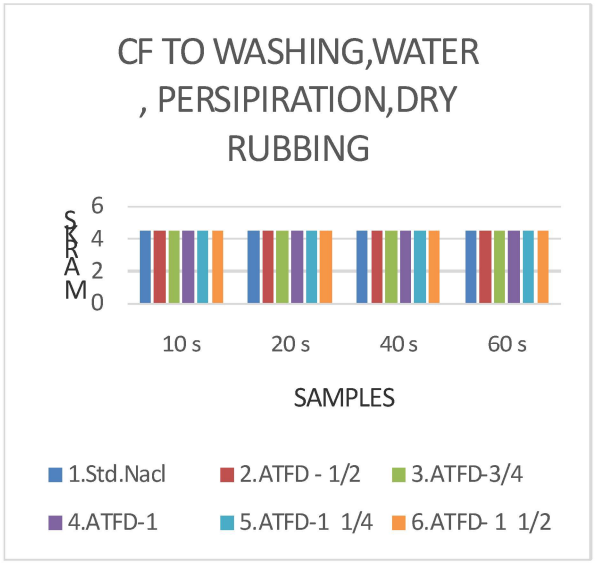
Yellow CE (0.1 %), Sky blue N (0.25 %), Black DSDN (2.0%)

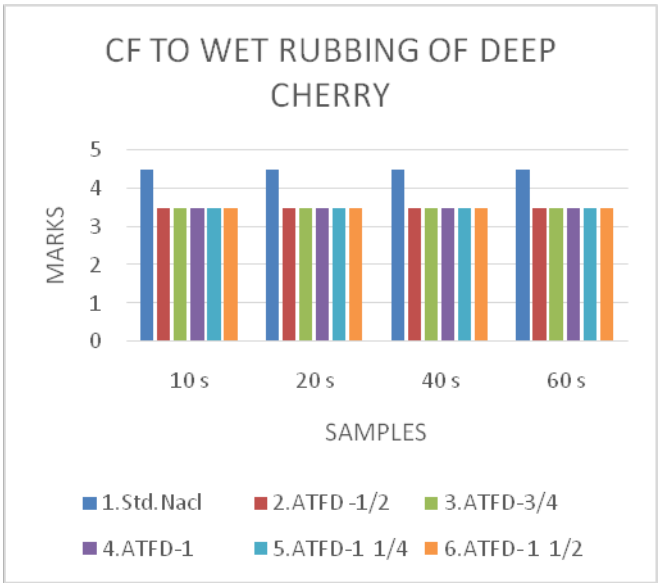
count	Color fastness to					
	Washing	Water	Per. To acid	Per. To Alkali	Dry rubbing	Wet rubbing
10s (1-6) trails	4-5	4-5	4-5	4-5	4-5	4-5
20 s (1-6) trails	4-5	4-5	4-5	4-5	4-5	4-5
40 s (1-6) trails	4-5	4-5	4-5	4-5	4-5	4-5
60 s (1-6) trails	4-5	4-5	4-5	4-5	4-5	4-5



Deep cherry (3.0%)

count	Color fastness to					
	Washing	Water	Per. To acid	Per. To Alkali	Dry rubbing	Wet rubbing
10s (1-6) trails	4-5	4-5	4-5	4-5	4-5	3-4
20 s (1-6) trails	4-5	4-5	4-5	4-5	4-5	3-4
40 s (1-6) trails	4-5	4-5	4-5	4-5	4-5	3-4
60 s (1-6) trails	4-5	4-5	4-5	4-5	4-5	3-4





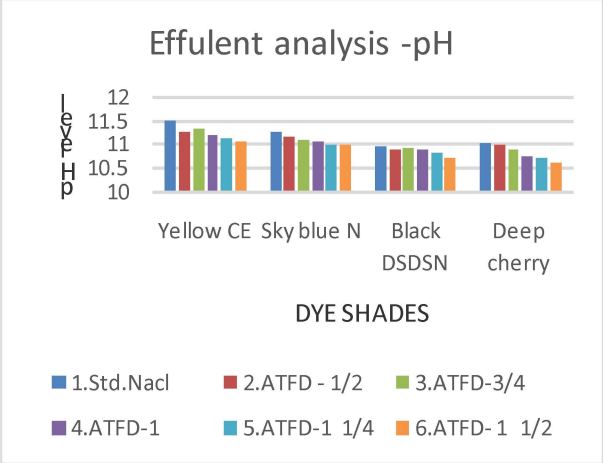
The NaCl salt commonly used in dyes and the ATFD salt used as a substitute for NaCl in this study and subjected to the dyes using various concentrations by reducing and increasing its weight ,were subjected to the colour fastness test washing ,water ,perspiration to acid and alkali and dry rubbing ,wet rubbing scored up to 4-5 color fastness of all types of yarns were subjected to four types of dye concentrations .In this dry rub and wet rub and dyed in yellow CE, Black DSDN ,sky blue N the yarns got 4-5 marks .In this the yarn dyeing in deep cherry dye was dry rub scored between 4-5 and wet scored between 3-4 .Based on the scores obtained from this color fastness test ,in general the scores obtained by using the NaCl salt used in dyes and the ATFD salt used as an alternative to dyes are found to be more than 80% equal to the scores obtained from the yarn using NaCl .Thus ,when we use ATFD salt ,it gives equal marks to NaCl.

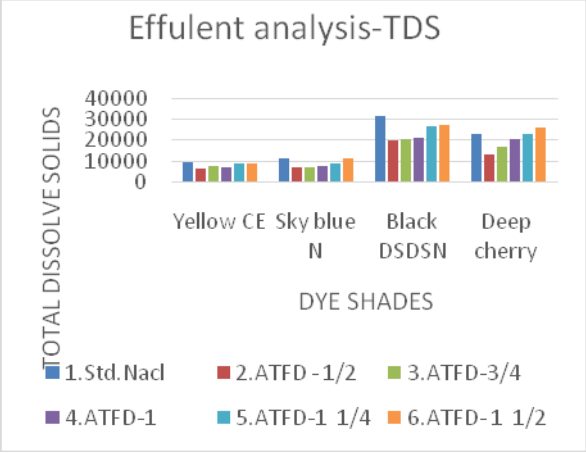
3.3 Effluent analysis

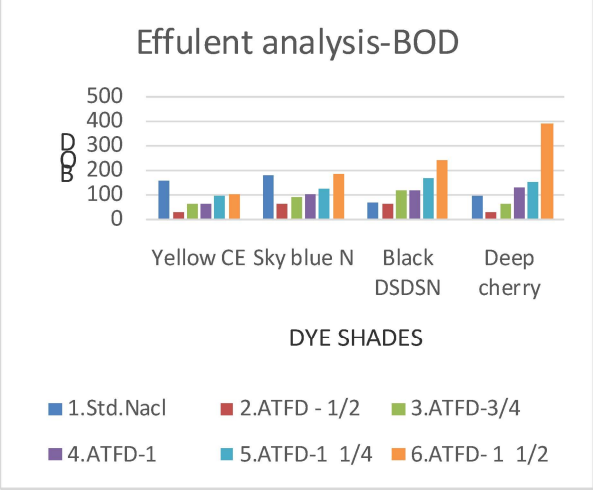
In the dye effluent test, the quality of waste water coming out after undergoing dyeing was carried out in this study. It was found in the study that the quality of the dye waste water varied depending on the type of salt used in the dyeing solution and their weight. The first finding was that when the pH was calculated, the dye effluent produced using NaCl salt. which is commonly used in dyeing was found to be higher than the pH of the dye effluent using ATFD salt. ATFD dye bath dye effluent pH was found to be between 10-11. The amount of TDS present in them was found to be less in ATFD salt used dye solution effluent than NaCl used dye solution effluent water. Also, BOD is higher than that of dye solution effluent's typically use NaCl used in dyeing. In contrast to them in this study the BOD value of ATFD salt dye bath wastewater used for dyeing was found to be lower (low dye concentrations) and higher (high dye concentrations). It was found that the COD value of the effluent only, as the concentration of the ATFD salt increased, the COD value of the effluent was equal to and higher than the dye effluent COD value of the NaCl used dye bath. Dye effluent to see the dye up take percentage in the yarn, when looking at the absorbance, the dye effluent absorbance dyed using ATFD salt and the absorbance of NaCl used waste water have been calculated at the same level of dye up take. Also, while looking at its total hardness, the value of ATFD dye effluent was found higher than NaCl.

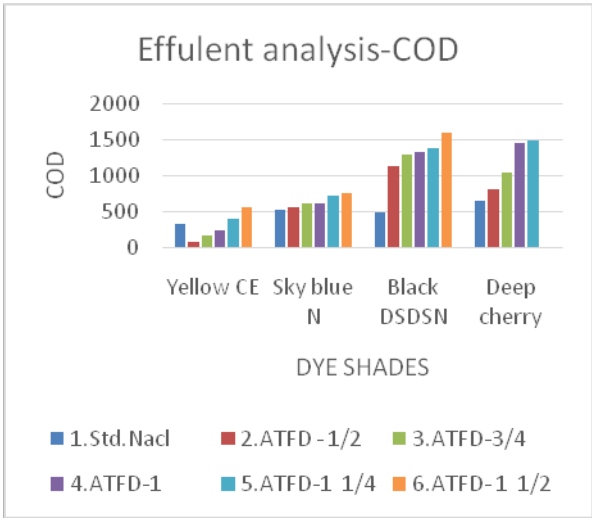
Dye shades	Salt Concentration (trails)	Effluent analysis				
		pH	TDS	BOD	COD	TH
Yellow CE (0.1 %)	1. std. NaCl- 1	11.83	9,120	160	320	30
	2.ATFD- ½	11.28	5,900	28	80	50
	3.ATFD - ¾	11.36	7,170	64	160	60
	4.ATFD- 1	11.20	6,670	64	240	60
	5.ATFD-1 ¼	11.15	8,670	96	400	80
	6.ATFD-1 ½	11.06	8,830	100	560	80
Sky blue N (0.25 %)	1. std. NaCl- 1	11.26	10,900	180	520	20
	2.ATFD- ½	11.18	6,480	64	560	50
	3.ATFD - ¾	11.09	6,680	90	600	60
	4.ATFD- 1	11.08	7,520	103	600	70
	5.ATFD-1 ¼	11.00	8,630	125	720	80
	6.ATFD-1 ½	10.99	10,800	183	760	80

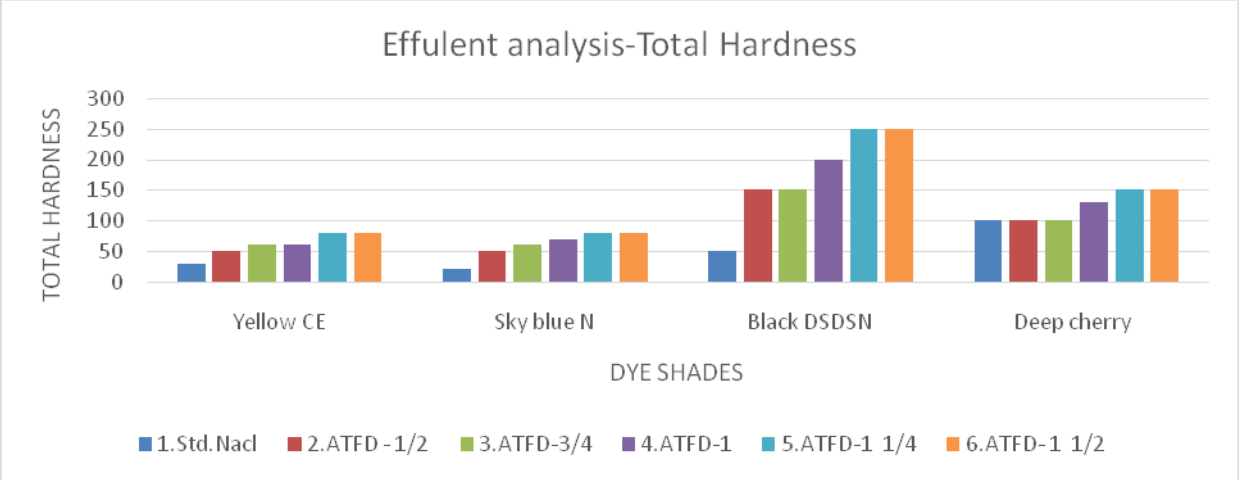
Black DSDN (2.0%)	1. std. NaCl- 1	10.97	31,200	67	480	50
	2.ATFD- ½	10.88	19,800	60	1120	150
	3.ATFD - ¾	10.92	20,100	120	1280	150
	4.ATFD- 1	10.90	21,200	120	1320	200
	5.ATFD-1 ¼	10.83	26,600	170	1380	250
	6.ATFD-1 ½	10.71	27,100	240	1600	250
Deep cheery (3.0%)	1. std. NaCl- 1	11.05	22,800	96	640	100
	2.ATFD- ½	11.00	13,200	31	800	100
	3.ATFD - ¾	10.89	16,800	60	1040	100
	4.ATFD- 1	10.77	20,300	128	1440	130
	5.ATFD-1 ¼	10.71	22,500	150	1480	150
	6.ATFD-1 ½	10.62	25,800	390	1720	150











3.4 CCM Report

In this CCM report, DE value of ATFD sample yarn compared to NaCl sample yarn was more than 60 percent. In this, the DE value of the sample yarn of ATFD salt mass equal to the mass in NaCl is highly convergent. Also, ATFD salt is used in low amount and there is same with DE value of NaCl sample.

DYE SHADE	SAMPLE.NO	DL*/ISL	Da*	Db*	Dc*/CSC	DH*/SH	DE CMC
Yellow CE (0.1%)	2.ATFD- ½	-0.12	0.89	2.25	1.16	-0.57	1.30
	3.ATFD - ¾	-0.34	-0.86	-0.87	-0.47	0.70	0.90
	4.ATFD- 1	-0.00	0.12	1.57	0.78	0.03	0.78
	5.ATFD-1 ¼	-0.32	0.10	-0.96	-0.48	0.01	0.57
	6.ATFD-1 ½	0.06	-0.31	-0.46	-0.24	0.24	0.34
Sky blue N (0.25%)	2.ATFD- ½	-0.79	0.70	-1.75	0.75	0.92	1.42
	3.ATFD - ¾	-0.75	0.63	-1.78	0.77	0.88	1.39
	4.ATFD- 1	-0.17	-0.41	1.02	-0.42	-0.56	0.72
	5.ATFD-1 ¼	-0.18	0.14	-1.06	0.50	0.35	0.63
	6.ATFD-1 ½	-0.06	0.56	-0.61	0.21	0.56	0.60
Black DSDN (2.0%)	2.ATFD- ½	1.99	-0.74	0.61	0.82	0.74	2.27
	3.ATFD - ¾	0.72	-0.52	-0.35	0.49	-0.55	1.03
	4.ATFD- 1	0.80	-0.27	-0.41	0.49	-0.23	0.96
	5.ATFD-1 ¼	0.16	-0.40	-0.13	-0.23	-0.47	0.55
	6.ATFD-1 ½	-0.09	-0.32	-0.12	0.19	-0.37	0.43
Deep Cheery (3.0%)	2.ATFD- ½	-0.84	-0.87	0.19	-0.32	0.27	0.94
	3.ATFD - ¾	0.74	0.48	-0.37	0.15	-0.31	0.82
	4.ATFD- 1	0.57	-0.21	-0.87	-0.17	-0.51	0.79
	5.ATFD-1 ¼	-0.37	-1.17	-0.61	-0.52	-0.19	0.67
	6.ATFD-1 ½	0.06	-0.45	-0.52	-0.23	-0.25	0.35

Based on the data available in this CCM report. ATFD sample yarn color strength is slightly different when compared to NaCl sample using ATFD salt in weight equal to NaCl salt and more than that in dyeing. Also, color strength varies greatly when ATFD salt is used in less than equal mass of NaCl. In this only in deep cherry shades, all ATFD samples obtained using ATFD salt concentration level are less than tolerance of colour strength (<1) when compared with NaCl sample.

3.5 Economical cost

On an average ,500 grams of NaCl is sold for Rs.250 .After dyeing them ,excess electrolyte is released into the waste water to activate the dye .Thus every time fresh NaCl is procured to activate and used in dyeing .A significant amount of money is saved when using ATFD salt meets at least more than 60% of the demand for NaCl through the objective of recycling and reuse .In case of dyeing by small scale industries according to their economic development by using this salt the amount spent on NaCl which is usually used for dyeing is reduced by 40% to 70%.

4. Conclusion

Thus, in this study ATFD salt is used as a substitute for NaCl in cotton dyeing. When these are recycled and reused, dyeing reduces the need for fresh NaCl. In dyeing cotton using these, the color fastness scores obtained from theme are more than 80%and have obtained good scores. Analyzing the quality of effluent from dyeing using ATFD salt, it is higher than NaCl. Also, color strength is good and using these saves a certain amount of money. These reduces the need for fresh NaCl by 40%-70%. These are economically very beneficial for small scale industries.

References

1. Tiwari.M, S.P. Shukla, D. Mohan, D.S. Bhargava and G.C. Kisku,2015(a). Cenosperes as an adsorbent for the removal of disperse dyes. Advances in environmental chemistry.
2. T. Kurbus, M.A.Majcen Le and D.B. Voncina, DYES PIGMENTS,58,245(2003).
3. Keerthana 1998, Erode,SCRIBD and https:// Indian express.com,11 February 2009.
4. Dr. Bajirao,B.Ahire,Natural dye extractions from selected plants, extraction and mordant application to dyeing cotton fabric, International journal of research ,volume 7,October-2018.
5. M.Kumaresan, P.N.Palanisamy, P.E. Kumar, Dyeing of silk fabric with eco-friendly natural dyes obtained from *Spathodea campanulate* and Cordia *sebestena* :A comparison, Asian Journal of Chemistry : volume.25, No.15(2013), 8513-8516.
6. M.Kumaresan,P.N.Palanisamy,P .E.Kumar, Application of eco-friendly natural dye on silk using combination of mordants, International journal of chemistry research ,volume 2,issue 1,2011.
7. M. Kumaresan, comparison of fastness properties of dyed cotton fabric with ecofriendly natural dyes obtained from *Achras Sapota* and *Cordia Sebestena*, Journal of environmental nanotechnology, volume 3, No.1, pp.60-66.
8. M. Iqbal, A.Panhwar ,K.Ahamed, A.KAndharo, R.Suhana, J.Mughal, Z.Solangi, Textile dyeing of cotton and wool textile material with natural dyes extracted from bluish purple grapes , Bulgarian chemical communications ,volume 54,issue 1,2022.
9. Kannanmarikani, UmaSangareswari, Kannan, Rajarathinam Kanniappan, Assessment of dyeing properties and quality parameters of natural dye extracted from *Lawsonia inermis* , Pelagia Research library, European journal of experimental Biology ,2015,5(7);62-70.
10. Iqbal and E.A Naseem, A symmetric bio reduction of activated Carbon-Caron double bonds using Shewan Ella yellow enzyme (SYE-4) as novel enoate reductase, Tetrahedron ,2012.68(37): p.7619-7623.

11. M. D Eman Talukden, M.D. Kamruzzman, Mithon Majumde, MD.Shakhwat Hossain Rony, Monoroma Hossian,Santanu Das, Effects of salt concentration on the dyeing of various cotton fabrics with reactive dyes, International Journal of textile science 2017,(6):7-14.
12. Aspland J. R, Textile dyeing and coloration. Textile Hub 2006,1(3): p.265-274.
13. R. Jeyaramakrishnan, R. Ugamoorthi, Dr. Ramarethinam, Efficient recycling and reusing of salt from textile effluent, Pestology, vol. XLll, No.8.August 2018.
14. Shayam Barhanpurkar, Prabhakar Bhat, Alok Kumar, Roli Purwar, Studies of *Banana SAP* used as mordant for natural dye, international journal on Textile Engineering and Processes, volume.1, issue 4, ocotober2015.
15. S.S Pandey, N.B. Singh, S.P. Shukla, M. Tiwari,Removal of lead and copper from textile wastewater using Egg shells ,Iranian Journal of Energy and Environment (8)3:202-209,2017.
16. Maria Harja, Gabriela Bumea, Daniel Bucur, Recent advances in removal of Congo red dye by adsorption using an industrial waste, Nature portfolio, Scientific Reports, (2022).
17. Nancey Hafez, Purification of Pharmaceutical waste water resulting from herbal plants by Zero Liquid Discharge Techniques (ZLD), International Trends in Science and Technology, May 2021.

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