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Reuse of Dye House Waste Water by Reverse Osmosis Process

A. B. M. Foisal[1], Suvro Dev Saha[2], A.K.M. Shafayet Khan[3] and Md. Abdullah al Noman[4]

[1]Department of Textile Engineering, Southeast University, Dhaka-1208, Bangladesh.
[2]Green Project W. S. T Limited, KC Tower, Uttara, Sector-13 Dhaka-1230, Bangladesh.
[3]Turag Garments & Hosiery Mills ltd, Zirani Bazar, Kashimpur, Bangladesh.
[4]Reedisha Knitex ltd. Dhanua, Nayanpur, Sreepur , Gazipur, Bangladesh.

Abstract

The aim of this work is to find out the possibilities of reusing discharge water from dye house of cotton knit fabric dyeing through reverse osmosis process. In this experiment, it is focused on the dyeing of 100% cotton single jersey knit fabric by using both ground water and RO (Reverse osmosis) processed clean water. This work is done at the Central Dyeing Laboratory of Grameen knitwear ltd. and Turag Garments & Hosiery Mills ltd. in Bangladesh. The quality parameters such as shade differences, spectrophotometric evaluation (DE value), wash fastness, rubbing fastness of the both dyed samples are compared and it has been found that the results are satisfactory for the 10 gm of fabric dyed with both type of water.

Keywords: *Reverse Osmosis, Dye House Waste Water, RO Clean Water.*

I. Introduction

The fresh water scarcity is a growing problem all over the world because only 1% of earth's water is fresh water available for human to drink (Pangarkar *et al.*, 2010). The US geological survey found that 96.5% of earth's water is located in seas and oceans and 1.7% of earth's water is located in the ice caps. The remaining percentage is made up of brackish water, slightly salty water found as surface water (Greenlee *et al.*, 2009), (Pangarkar *et al.*, 2011).

However, nearly 110 liters of ground water is needed to dye 1 kg cotton fabric and thus the water consumption of an average sized textile mill having capacity only 8 tons/day is about 880000 liters per day (Shaid *et al.*, 2013). The textile dyeing industries of Gazipur and Narayanganj generate large amount of effluents, sewage sludge and solid waste materials everyday which are being directly discharged into the surrounding channel, agricultural fields, irrigation channels, surface water and these finally enter in to Turag and Shitalakkhya River (Abir *et al.*, 2014), (Khan *et al.*, 2012). Hence, it is an urgent need for the wet processing industries to recycle the waste water and reuse it. Reverse osmosis (RO) is one of the best ways to recycle the waste water to reuse.

This technology is used for the treatment of water and hazardous waste, separation processes in the food, beverage and paper industry (Garud *et al.*, 2014). In this work, RO processed clean water from dye house of cotton knit fabric dyeing has been reused for the dyeing of knit fabric. Then the difference of the shades as well as dyeing performances of ground water to the RO clean water dyed cotton fabric samples are evaluated.

Reverse Osmosis has been successfully applied on a large scale throughout the world for the treatment of effluent and the polluted water. The Arab countries and some other affluent countries have the credit of successfully running such large scale plants without minding for the cost factor involved in such projects. Here the polluted effluent is treated using RO technology in order to remove the pollutants. Reverse osmosis membranes have a retention rate of 90% or more for most types of ionic compounds. Discoloration and elimination of chemical auxiliaries in dye house wastewater can be carried out in a single step by reverse osmosis. It permits the removal of all mineral salts, hydrolyzed reactive dyes, and chemical auxiliaries. It must be noted that higher the concentration of dissolved salt, the more important the osmotic pressure becomes; therefore, the greater the energy required for the separation process (Vijayageetha *et al.*, 2014).

***Corresponding Author:** A.B.M. Foisal, Department of Textile Engineering, Southeast University, Tejgaon, Dhaka-1208, Bangladesh, Email: *foisal_text@yahoo.com*

II. Materials and Methods

RO machine parameters

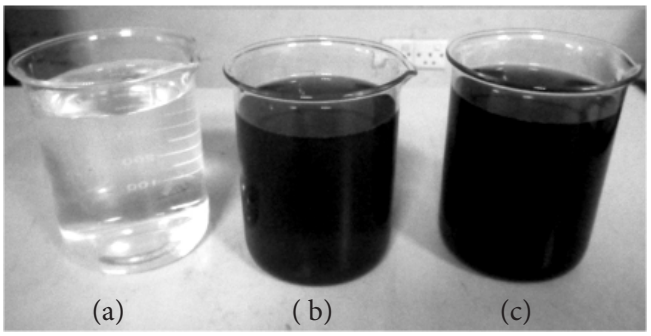
Table-4 shows the RO machine parameters. RO processed clean water is collected for dyeing of fabric samples.

Table 1: Machine details

Type:	**RO-100(300)**
Origin	China
Capacity of pure water	300L/h 25^{0}C
Input power	2.5 KW
Power supply	AC 220V 50Hz 18A
RO membrane	4040X2
Multi-phase pump	CDL2-160/2.0KW X 1
Beforehand filter	300X1650X2
Booster pump	BLC70/0.75KWX1
Active carbon	50 KG
Quartz sand	150 KG

Laboratory dyeing procedure for cotton fabric:

10 gm samples of 100% cotton knit single Jersey bleached fabric are dyed with RO clean water and ground water in different shades such as navy, pink and light rose. At first the samples are immersed into the dyeing pots of the laboratory dyeing machine. Then the dyeing pots are loaded with color solutions according to the recipe, salt, leveling agent (Albatex DBC 1 g/lt) and ground water and RO clean water seperately. The sample is dyed for 20 minutes at 60^{o}C then soda ash is added. The dyeing procedure is again continued for 20 minutes at same temperature. The samples are then rinsed wash, neutralized with Acetic acid (0.7 g/L), soaped at 90^{o}C for 10 minutes consequently washed and dried. Figure 1 shows RO clean water which has been used for this work.



a) RO Clean water

b) RO waste water

c) Water from Dyeing machine

Figure 1: Water collected from dyeing machine and processed through Reverse Osmosis (RO).

Comparison on shade variation

The shade difference of the samples has been evaluated by Verivide light box.

Color fastness to wash

Color fastness to wash is done by the ISO 105 C03 method. Single test of 10 cm x 4 cm with 4 g/L ECE (European Color fastness Establishment) reference detergent & 1 g/L sodium perborate solution in machine wash at 40^o C.

Colour fastness to Rubbing

This test is designed to determine the degree of color which may be transferred from the surface of a colored fabric to the specific test cloth for rubbing (dry and wet). M/c Name: Crock master, Method: ISO 105x12 has been used for rubbing test.

Spectrophotometric evaluation:

The spectrophothometric evaluation of the samples has been done by Data color 650^{TM}

III. Result and Discussions

A. Comparison on shade variation

Table 2 shows the shade (navy, pink, light rose) differences between ground water dyed and RO clean water dyed fabric samples. The shades are almost same and the differences are insignificant visually under color matching cabinet.

Table 2: Comparison on shade%

Shade	Recipe	Ground water dyed sample	RO clean water dyed sample
Navy	Novacron Yellow S3R - 0.8% Novacron Red S3B - 0.8% Sunfix Blue MFD- 4% Salt- 70 g/L Soda-20 g/L		
Pink	Novacron Yellow S3R - 0.06% Novacron Red S3B – 1.8 % Novacron Blue TSQC- 0.05% Salt- 40 g/L Soda-16 g/L		
Light rose	Remazol yellow RR - 0.03% Remazol Red RR– 0.04 % Remazol Blue RR– 0.01 % Salt- 20 g/L Soda-6 g/L		

B. Comparison of Colour fastness to wash:

Table 3 shows the staining of color on multifiber fabric due to wash of reactive dyed ground water and RO clean water dyed fabric samples. The wash fastness rating on bleached cotton in terms of ground water and RO clean water dyed samples for navy, pink and light rose shades are 4/5, 4 and 4/5 respectively. The grey scale rating lies between 4 and 5 for all shades colour staining on other fibers of multifiber fabric such as, cellulose acetate, poly amide 6.6, polyester, acrylic and wool. It indicates that the results are almost same and there are no significant differences for both samples.

Table 3: Comparison of wash fastness of three shades

Multifiber fabric	Navy		Pink		Light rose	
	Ground water sample	RO clean water sample	Ground water sample	RO clean water sample	Ground water sample	RO clean water sample
Cellulose Acetate	5	5	5	4/5	4/5	4/5
Bleached cotton	4/5	4/5	4	4	4/5	4/5
Polyamide (6.6)	5	4/5	4/5	4/5	4/5	4/5
Polyester	5	4/5	4/5	4/5	5	4/5
Acrylic	5	4/5	5	4	5	4/5
Wool worsted	4/5	4/5	4/5	4/5	4/5	4/5

C. Comparison of Colour Fastness to Rubbing

Table 4 shows the results of rubbing fastness of the samples of ground water and RO clean water dyed fabric samples. In case of navy shade ground water dyed fabric samples for the dry and wet rubbing fastness rating is 4/5 and 3 respectively. Similarly RO clean water dyed fabric's rating is 4/5 and 2/3 respectively. Then the ground water dyed sample for the dry and wet rubbing fastness rating is 4/5 and 2/3 and RO clean water dyed sample's dry and wet rubbing fastness rating was 4/5 and 2/3 for pink shade. At last, ground water dyed sample for the dry and wet rubbing fastness rating is 4/5. RO clean water dyed sample's dry and wet rubbing fastness rating is 4/5 and 4 for light rose shade. The rubbing fastness result may reveal that ground water dyed sample and RO clean water dyed samples have not been changed significantly in both samples.

Table 4: Comparison of rubbing fastness of three shades

Cotton fabric	Navy		Pink		Light rose	
	Ground water sample	RO clean water sample	Ground water sample	RO clean water sample	Ground water sample	RO clean water sample
Dry rub	4/5	4/5	4/5	4/5	4/5	4/5
Wet rub	3	2/3	2/3	2/3	4/5	4

Spectrophotometric evaluation:

Table 5 shows the lightness (DL*), Saturation (DC*) and Tone (DH*), CIE lab value for references (Da* and Db*), Total colour deviations (DE) values of ground water dyed and RO clean water dyed fabric samples. The spectrophotometric values under different light sources of CMC (Color matching committee) are seen that the samples of navy, pink and light rose's DE value lies below 1, which is the desired outcome of this work. The DE values for the samples under different light sources of spectrophotometer D65 and F11 are passed on evaluation since all the values are less than 1. The CMC DE values for navy shade are 0.36 and 0.51 under D65 and F11 light sources respectively. Similarly, for pink shade DE value is 0.36 and for light rose shade 0.42 and 0.45 under mentioned light sources respectively. All the samples are passed through CMC (Colour matching Committee).

Table 5: Spectrophotometric evaluation

Name of Shade	Light Source	DL*	Da*	Db*	Dc*	DH*	CMC DE	CMC decision
Navy	D65 10 deg	0.15	0.12	-0.27	0.27	0.13	0.36	pass
	F11 10 deg	0.16	0.11	-0.46	0.44	0.17	0.51	pass
Pink	D65 10 deg	0.54	0.37	-0.32	0.40	-0.29	0.36	pass
	F11 10 deg	0.51	0.25	-0.39	0.25	-0.39	0.36	pass
Light rose	D65 10 deg	-0.32	0.32	0.36	0.37	0.31	0.42	pass
	F11 10 deg	-0.30	0.30	0.41	0.37	0.34	0.45	pass

IV. Conclusions

In the present study, three different shades have been dyed with ground water and RO clean water. The Reusing of textile waste water by reverse osmosis in the same industry as process water is a way to minimize the waste generation and to reduce the consumption of natural resource. In general, waste water from a textile industry needs treatment before reusing it. This work shows that the possibility to reuse the treated water by reverse osmosis for dyeing purpose again. It has been done on small quantity of single jersey knit fabric samples. The shade variations and the dyeing performances such as wash and rubbing fastness, sprectro- photometric evaluation and CMC decisions are satisfactory. It requires more experiments by gradually increasing the amount of fabrics in terms of dyeing with both type of water.

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