American Journal of Engineering Research (AJER)
e-ISSN : 2320-0847 p-ISSN : 2320-0936
Volume-03, Issue-12, pp-62-68
www.ajer.org

Research Paper Open Access

Investigation on Effluent Characteristics of Organic Cotton Fabric Dyeing With Eco-Friendly Remazol Reactive Dyes

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ABSTRACT : *Environmental sustainability is the major concern in the age of modern world. For textile and apparel sector, this has been a burning issue for many related concerned bodies. The pretreatment and dyeing process of greige fabrics results in large volume of effluents that has harmful effect on environment. In this study, the ecological parameters of the effluents obtained from scouring and dyeing of 100% organic cotton single jersey knitted fabrics with environmentally low impact Remazol series reactive dyes adopting exhaust dyeing method was investigated. The effluents collected for investigating the ecological parameters include chemical oxygen demand (COD), biological oxygen demand (BOD), total dissolved solids (TDS), total suspended solids (TSS), dissolved oxygen (DO) and alkalinity. The results show that the use of the low impact reactive dyes has greater ecological advantages as it reduces the COD, BOD, TDS, TSS, p^H values and increases the DO values of effluents. Organic cotton itself being eco-friendly along with Remazol series sustainable dyes provides the better ecological results. Hence, the results indicated that wet processing of organic cotton knitted fabric with eco-friendly and low impact reactive dyes provide better ecological advantages.*

KEYWORDS : *Organic cotton, Eco-friendly dyes, Knitted fabrics, Effluents, Wet processing.*

I. INTRODUCTION

The textile industry plays an important role in the economy of Bangladesh. Textile industry involves wide range of raw materials and processes to engineer the required shape and properties of the final product. Out of various activities in textile industry, chemical processing contributes about 70% of pollution [1]. Waste stream generated in this industry is essentially based on water-based effluent generated in the various activities of wet processing of textiles. The main cause of generation of this effluent is the use of huge volume of water either in the actual chemical processing or during re-processing in preparatory, dyeing, printing and finishing [2]. Gray fabrics, after its manufacturing, are subjected to several wet processes such as pretreatment process involving demineralization, scouring, bleaching and mercerization etc. The pretreated fabric is then dyed using textile dyes and finished by softener padding. The pretreatment and dying process results in large volume of effluent that has harmful effect on environment [3]. Generally, textile effluent is colored with high pH, temperature, biological oxygen demand (BOD), chemical oxygen demand (COD), total dissolve solid (TDS) and total suspended solid (TSS) along with low dissolved oxygen (DO) [4]. Color is imparted to textile effluents because of the various dyes and pigments used to color the fabric. The presence of dyes in the waste waters will cause severe damage to the aquatic biology [12]. This is because dyes have a synthetic origin and a complex molecular structure which makes them more stable and difficult to be biodegraded [5]. It is well known that cotton mills consume large volume of water for various processes such as sizing, desizing, and scouring, bleaching, mercerization, dyeing, printing, finishing and ultimately washing. Due to the nature of various chemical processing of textiles, large volumes of waste water with numerous pollutants are discharged. But where is the real problem?

The fact is that the effluent generated in different steps is well beyond the standard and thus it is highly polluted and dangerous [6]. Thus a study on different measures which can be adopted to minimize the environmental impact of effluents discharged from textile chemical processing industries to protect and safeguard our surroundings from possible pollution problem which has been the focus point of many recent investigations [7]. In recent years, different approaches have been discussed to tackle man made environmental hazards. Clean technology, eco-mark and green chemistry are some of the most highlighted practices in preventing and or reducing the adverse effect on our surroundings [8]. Thus, the present study aim to investigate the ecological parameters of effluents obtained from scouring and dyeing the 100% organic cotton single jersey knitted fabric with eco-friendly Remazol series low impact reactive dyes of DySter. The effluent parameters studied includes COD, BOD, TDS, TSS, DO and Alkalinity.

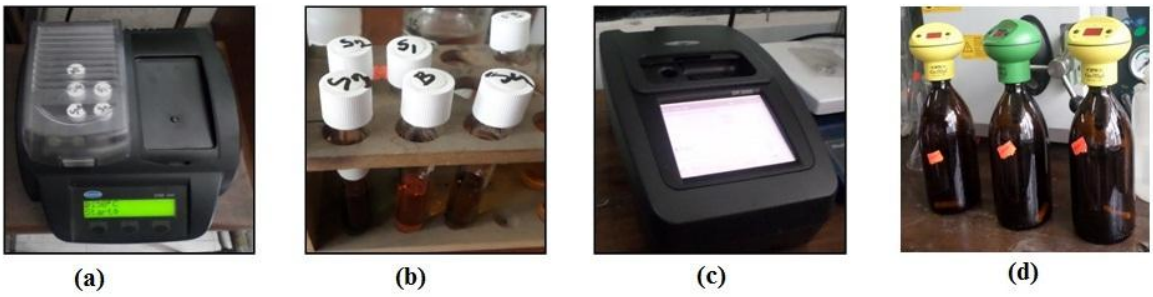
II. MATERIALS AND METHODOLOGY

2.1 Dyeing Organic Cotton Knitted Fabrics: For the study, the selected samples were fixed with standard procedure and dye recipe. The selected sample were discussed with Dystar executive, to obtain recipe based on low impact reactive dyes such as Remazol, Remazol ultra RGB series of dyes. The lab dyeing trails were done using HTHP lab dyeing machine with 10 gm single jersey organic cotton RFD knitted fabric samples. Dyeing method in this study uses low impact reactive dyes, along with others various eco-friendly dyes & chemicals. The Parameters and recipe for dyeing is presented in Tables 1 and Table 2 respectively.

Table 1: Parameters for scouring, dyeing and aftertreatment of organic cotton S/J knitted fabric

Materials Details	Process name	L:R/pH	Req. Temp ×Time
Fabric type: S/J Greige GSM: 160 Color: Black Materials weight: 1 kg	Scouring	1:6/6.0-10.5	60°C ×1hr 50 min (30+20+15+45)
	Dyeing	1:7/9.5-11	50°C x 30 min
	After Treatment	1:6	After Treatment

During the lab dyeing process, effluent from scouring and dyeing process was collected and investigated for ecological parameters such as Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Dissolved Oxygen (DO) and Alkalinity with the help of COD Reactor, COD Vial, UV Spectrophotometer, BOD Oxitop are shown in Figure 1.



(a) (b) (c) (d)

Figure 1: (a) COD Reactor, (b) COD Vial, (c) UV Spectrophotometer, (d) BOD Oxitop

Table 2: Recipe for Pretreatment, dyeing and aftertreatment of organic cotton S/J knitted fabric

	Amount in g/l or %	Dyes/Chemicals
Pretreatment	0.7	ALO (Wetting Agent/Detergent)
	0.25	ST-700 (Peroxide Stabilizer)
	1.5	ALBA C (Anti-creasing Agent)
	2	CAUSTIC
	2.5	H_2O_2
	1.5	A.ACID
	0.08	T-100 (Peroxide Killer)
	0.40%	Prima Green Eco scour
	0.40%	Prima Fast Gold RSL
Dyeing	0.5	SECURON-540 (Sequestering Agent)
	1	SECURON (Sequestering Agent)
	0.5	ALBA C (Anti-creasing Agent)
	0.5	RDLB (Leveling Agent)
	1.719250%	Remazol Ultra yellow RGBN
	1.326000%	Remazol Ultra Red RGB
	4.550000%	Remazol Deep Black RGBN
	90	SALT
	5	SODA
	1.75	CAUSTIC
After treatment	1.5	A.ACID
	1.5	CS (Softener Cationic)

2.2 Determination of Chemical Oxygen Demand (COD): The COD is used as a measure of oxygen equivalent of organic matter content of sample that is susceptible to oxidation by strong chemical oxidant for sample from a specific source. It is the measure of both biologically oxidizable and biologically inert organic matter [9]. The apparatus used in COD measurement were COD Reactor (Figure 1, a); Micro pipette, Beaker, COD Vial (Figure 1, b); UV Spectrophotometer (Figure 1, c). First effluents were taken in COD vial. Then the vial was kept in COD reactor at 150^0C for 2 hours. Then the vial was put off from COD reactor and cooled in normal temperature. After that the sample was tested in UV spectrophotometer with respect to the fresh COD vial to get COD value.

2.3 Determination of Biological Oxygen Demand (BOD): The BOD is a measure of the quantity of oxygen used by microorganisms in the oxidation of organic matter [10]. The basic principle involves the estimation of dissolved oxygen uptake of sample and blank initially and after incubation for 3 days at 270C. To standardize the measurement of BOD the incubation period and temperature were as period: 5 days and temperature 20ºC respectively. Firstly pure distilled water saturated with oxygen was taken in BOD Oxitop (Figure 1, d). 5ml of polluted water+25ml of pure water were taken in another BOD Oxitop. Then the both oxitop was kept for five days in BOD incubator at 20ºC. Next dissolved oxygen of pure water and dilute impure water were measured after 5 days to get BOD values.

2.4 Determination of Total dissolved Solid (TDS) and Total Suspended Solid (TSS): Total solid (TS) refers to the matter that remains as residue upon evaporation and drying at 103-105^0C [11].The total solid includes total suspended solid (TSS)-the portion of the total solid retained by filter (Figure 2, a) and total dissolved solid (TDS)-the portion that passes through the filter. A clean glass beaker was taken (which was kept at 103ºC in an oven for 1 hour) of 150 ml capacity and also the weight of the beaker was taken. Then 100 ml of the sample was poured into the beaker. After that the beaker was placed in an oven maintained at 103ºC for 24 hours. Then cooling the beaker weight of the beaker was taken. Weight of the solid (Figure 2, b) was found by subtracting this value from the weight of clean beaker.

Total Solids, TS (mg/l) = (mg of solids in the beaker×1000)/volume of sample
TDS (mg/l) = (mg of solids in the beaker×1000)/volume of sample
Total suspended solid, TSS (mg/Lt) = TS (mg/L) – TDS (mg/L)

2.5 Determination of Dissolved Oxygen and P^H: Waste water is taken in a beaker, DO port, and pH ports were set to multi meter (Figure 2, c) for determining pH, DO and Conductivity respectively. Then the port was dipped into the waste water and kept for few seconds until the result was shown in the display. DO (mg/L) and conductivity (mS/cm) values were found directly from multi meter.

(a) (b) (c)

Figure 2: (a) Funnel & Filter Paper, (b) Dried Sample, (c) Multi-meter

III. RESULTS AND DISCUSSIONS

It is easily noticeable from various data, for almost all processes the effluent parameters exceeded the Bangladesh standards to a great extent. The ecological parameters of the effluent obtained from dyeing of bio-scoured and dyeing of organic cotton single jersey fabrics with environmentally low impact textile reactive dyes was investigated. The dyes used include low impact (Remazol RGB series) reactive dyes of DyStar branded along with others non RSL chemicals and auxiliaries certified by Oeko-Tex. The results show that the use of the low impact reactive dyes has greater ecological advantages as it reduces the COD, BOD, TSS, TDS and pH of the effluent considerably. It also shows higher amount of DO and balanced pH values with a tolerable pH limit. Further, the use of good branded and Oeko-Tex certified chemicals and auxiliaries also provide better results for effluents whereas these ecological parameters are of highly environment pollutant for others for regular dyeing process available in most of the industries. Physico-chemical characteristics of effluents of organic cotton fabric after bio-scouring and after dyeing are represented at Table 3 and 4 respectively.

3.1 Chemical Oxygen Demand (COD): The COD (mg O/l) values of the effluent for dyeing of the scoured and dyed fabrics are presented in Figure 3. The results show that the COD of the effluent does from scouring and dyeing stages of fabrics is combatively less and only 3 to 4 times higher than the standard limit by DOE where as these values are many times higher in case of regular dyeing. Hence, the dyeing of organic cotton fabric with the low impact dyes can reduce the COD of the effluent compared to that of dyeing with the regular dyes.

3.2 Biological Oxygen demand (BOD): The BOD (mg O/l) values for dyeing process of the scoured and dyed fabrics are presented in Figure 4. The results show that the BOD of the dye bath effluent for the dyeing process with low impact reactive dyes is less i.e. 200 mg/L & 582 mg/L for dyeing and scouring respectively. Hence, dyeing of organic cotton fabric with low impact reactive dyes can reduce the BOD of effluent to a large extent as comparatively.

3.3 Total Dissolved Solids (TDS) and Total Suspended Solids (TSS): The TDS (mg/l) and TSS (mg/l) values for the dyeing and scouring of fabrics of organic cotton are presented in Figure 5 and Figure 6. The results show that the TDS and TSS values of the effluents obtained less compared to that of others regular dyeing process. This is due to low impact and eco-friendly dyes used in the dyeing process. In general, it is observed that TSS of the effluents obtained from the dyeing and scouring process of the fabrics with eco-friendly dyes chemicals is 1.72 and 2.56 times higher and for TDS this value for dyeing is 1710 mg/L which is within the limit and 3130 mg/L i.e. only 2 times higher compared to that of DOE standard.

3.4 Dissolved Oxygen (DO) and pH: The dissolved oxygen (DO) and pH values are presented in figure 7 and 8 respectively which shows that the DO values are increased for dying and within the limit by Bangladesh standard with a balanced pH for both scouring and dying process with eco-friendly dyes and chemicals.

Table 3: Physico-chemical characteristics of effluents of organic cotton fabric after bio-scouring

Effluents Content	Pollutant Nature	Tested Results	DoE Standard
ALO (Wetting Agent) ST-700 (Peroxide Stabilizer) ALBA C (Anti-creasing Agent) CAUSTIC, H_2O_2, A.ACID T-100 (Peroxide Killer) Prima Green Eco scour (Enzyme) Prima Fast Gold RSL (Enzyme) SECURON (Sequestering Agent)	BOD in mg/L	582	50
	COD in mg/L	965	200
	DO in mg/L	4.34	4.4-8.0
	TDS in mg/L	3130	2100
	TSS in mg/L	384	150
	pH	11.14	6-9

Table 4: Physico-chemical characteristics of effluents of organic cotton fabric after dyeing

Effluents Content in Dyeing stages	Pollutant Nature	Tested Results	DOE Standard
SECURON (Sequestering Agent) ALBA C (Anti-creasing Agent) RDLB (Leveling Agent) Reactive Dyes: Remazol Ultra yellow RGBN Remazol Ultra yellow RGBN Remazol Ultra yellow RGBN SALT, SODA, CAUSTIC	BOD in mg/L	200	50
	COD in mg/L	650	200
	DO in mg/L	5.15	4.4-8.0
	TDS in mg/L	1710	2100
	TSS in mg/L	258	150
	pH	9.5	6-9

3.5 Graphical Presentation of Effluents Tested Results

Figure 3: COD values of effluents after scouring & dyeing of organic cotton

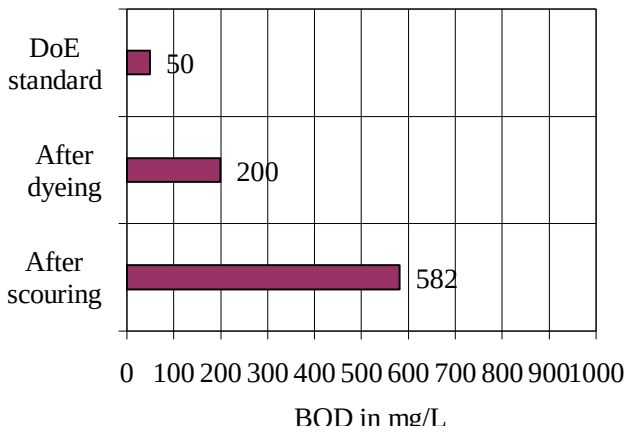


Figure 4: BOD values of effluents after scouring & dyeing of organic cotton fabric

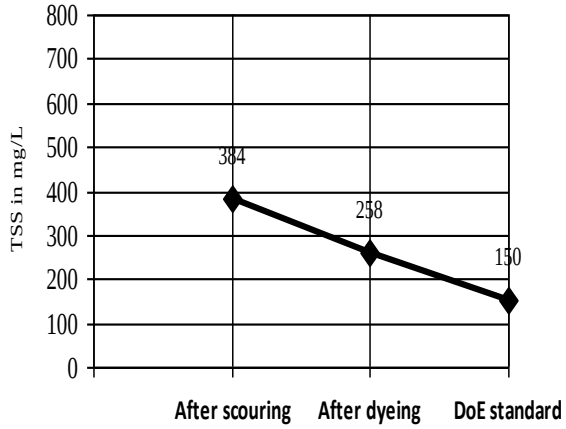


Figure 5: TSS values of effluents after scouring & dyeing of organic cotton

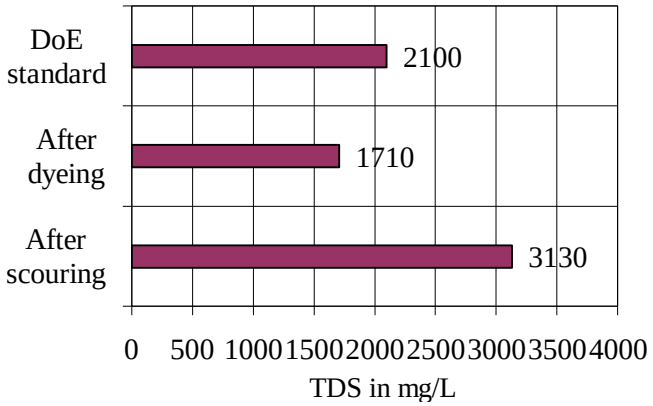


Figure 6: TDS values of effluents after scouring & dyeing of organic cotton

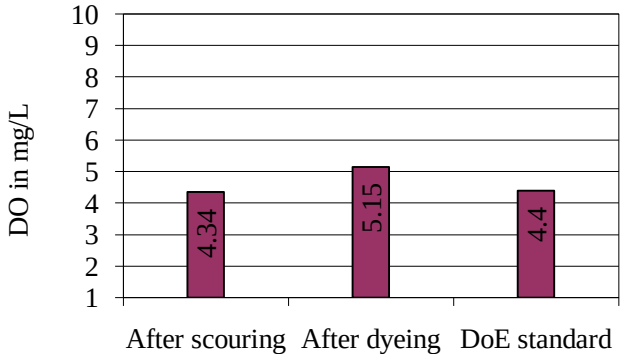


Figure 7: DO values of effluents after scouring & dyeing of organic cotton

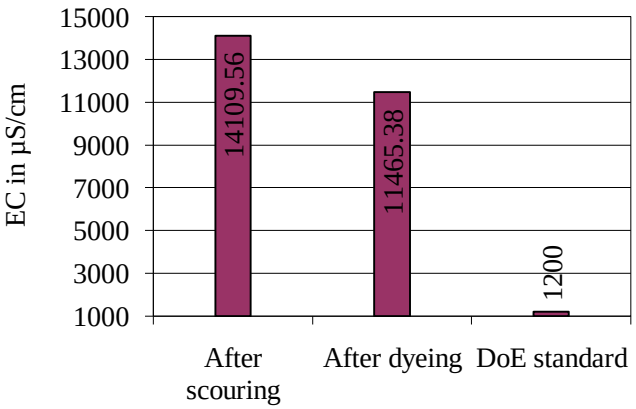


Figure 8: EC values of effluents after scouring & dyeing of organic cotton

IV. CONCLUSION

The textile industry is highly water intensive and one of the major contributor in environment pollution especially water in Bangladesh. In general, the results show that the use of the low impact reactive dyes has greater ecological advantages as it reduces the COD, BOD, TDS, TSS, and increase the DO and balanced pH values of the effluent considerably. Further, the fabric made from organic cotton itself also reduces the COD, BOD, TSS and TDS values. Besides, significantly increases the DO values maintaining tolerable pH values of the effluents. Finally it can be concluded that if various verified eco-friendly dyes and chemicals are used widely in wet processing, the environment pollution could be minimized to a greater extent.

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