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REUSE OF STANDING DYE BATH OF REACTIVE DYEING WITH NYLON & SILK

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ABSTRACT

The effluent from textile dyeing industry have negative impact on environment pollution. Most of the industry use reactive dye and this dye produce effluent after dyeing. In this work, the dye bath of reactive dyeing used again without draining them. Because of the hydrolysis of residual reactive dyes due to the fixation conditions and because of relatively large amounts of dyes and salts left in the effluent. Two reactive dyes are Reactive Red & Reactive Yellow and Two materials: Nylon, Silk as well as Silk fiber & Nylon Yarn, were examined. It is shown that when using suitable dyeing conditions such that by controlling pH and temperature hydrolyzed reactive dye baths could be reused for silk and nylon dyeing with very good wash and moderate colorfastness.

KEYWORDS: Reactive dye, Reuse, Dye bath, Nylon, Silk.

1. INTRODUCTION

A major environmental problem of textile effluent is from the dyeing waste water, Colorants, heavy metals, and high concentrations of salts are all water pollutants. [1] To decrease the concentration of these chemicals in the effluent discharged, the major effort is on the removal of toxic materials from the effluent. [2][3][4] Another approach is that the reuse of dye bath has more and more attention in recent years. Dye bath reuse not only reduces the amount of toxicity of dyeing effluent but also saves the expenses the dyes, chemicals, and energy considerably.

Although a dye bath is a complex system with many variables not easily controlled the same for reuse, excellent batch-to batch shade uniformity could be achieved. It was reported that the multi shade reuse was also feasible in addition to single shade reuse, but the buildup of finishes and other extractable impurities from the fiber may limit the reusing cycles due to the possible interference of these chemicals with dyes and other dye bath additives. [5][6] Reactive dyes are one of the most commonly used dyes because of their excellent wash-fastness and convenience in application. [7][8] The affinity of reactive dyes to cellulose is not very high. Therefore, lots of salt (e.g. 50-100 g/l) is, used to improve dye sorption. However, the fixation of reactive dyes is not high, with a yield of 50-90%. In other words, up to 50% of the dyes are left in the bath after dyeing. Both high concentrations of salt and dyes left in the bath cause pollution. [9][10][11] As a matter of fact, it was reported that "reactive dyes pose the main problem in color cleanup". It is not an exaggeration to state that without solving the problems of reactive dye bath reuse, dye bath reuse technology is incomplete.

From the below data we can see the comparative effluent loss that left on the dye bath:

Sl. No	Dye Application class	Fiber	Degree of Fixation (%)	Loss to effluent (%)
1	Acid	Polyamide	89-95	5-20
2	Basic	Acrylic	90-100	0-5

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3	Direct	Cellulose	70-90	5-30
5	Disperse	Polyester	90-100	0-10
6	Metal complex	Wool	90-98	2-10
7	Reactive	Cellulose	50-90	10-50
8	Sulfur	Cellulose	60-90	10-40
9	Vat	Cellulose	80-95	5-20

So, from the above data, its sure that there is maximum dye left in the dye bath in case of Reactive dye. So, an effort is must and essential to make ready for reuse and keep the environment safe and healthy as well as lives on it.

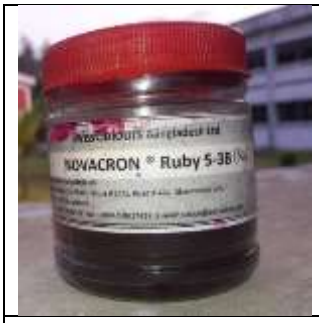
Our target was to reuse the left dye bath of reactive dye without adding or subtracting any chemicals by controlling the pH which was firstly in Alkaline medium, but we reduced it in Slightly Acidic medium for dyeing purpose. As all acid dyes are negatively charged in the aqueous solution. [12][13] Except the fiber reactive group(s), reactive dyes are similar to acid dyes. Therefore, it is possible to use the hydrolyzed reactive dyes to dye nylon, protein and any other goods which could carry positive charges under dyeing conditions. The objective of this work is to explore the possibility of reusing the bath with hydrolyzed reactive dyes to dye nylon and silk materials.

2. MATERIALS AND METHODS

Materials: Two materials in four different forms are used here. These are: a) Silk yarn, b) Silk fabric, c) Nylon yarn & d) Nylon fabric.

			
a) Silk yarn	***b) Silk fabric***	***c) Nylon yarn***	***d) Nylon fabric.***

For the dyeing purpose the following two brands dye are used: There are two different types of Reactive dye of Swiss colours have been used. 1. Reactive Red & 2. Reactive Yellow.

	
1. Reactive Red	***2. Reactive Yellow***

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Instruments: The following instruments are used for testing & completing the desired work. These are: pH Meter, Beaker, Measuring cylinder, Steel tube, Dropper, Gas Burner.

Fig: solution is in Acidic condition

Fig: solution is in Alkaline condition

Method:
At first, we need to hydrolyze the reactive dye bath where 10-50% reactive dye left on it. By using the following recipe, we dyed the cotton fabric with a reactive dye.

Reactive Dye ---------- 1% owf
Sodium chloride-------- 15 gm/l
Sodium bi carbonate----- 5 gm/l
Wetting agent ---------- 0.5 gm/l
Sequestering agent------- 0.5 gm//l
Temperature---------- 60℃
M:L ratio---------- 1:20

After completing the dyeing procedure, we just removed the fabric from the left solution of dyeing system. Then we added the water on it if there was too short liquor than our expected level. Then we checked the pH of the standing dye bath of reactive dyeing system by pH meter. When we firstly checked the pH then we found that it was in the alkaline medium (Level of 9-10). But according to the above description and dyeing condition we needed to kept the pH of the dye bath near about 4.5-5 by the appropriate addition of Acetic acid that will lower the pH of the dye bath.

After keeping the pH value of the dye bath in the required level. Then we have started the re-dyeing procedure by using just final dye bath that we got.

The dyeing process is carried out under the following requirements:

1. Temperature: 90℃
2. Time: 40-60 mins

Completed the task described above then we needed to wash out the unfix dye that could attach with the surface of the treated material without any bond or attraction. lower the unfix dye on the surface of the treated material higher its wash fastness. So, Soaping is done to remove the unfixed dye on the surface of material.
The above procedure is applied on four tested materials in reactive dyebath.

3. RESULTS AND DISCUSSION

Results:
Silk Yarn: According to the described method, we firstly tested the silk yarn. Silk is normally protein fiber that has the attraction to the hydrolyzed reactive dye bath as like as acid dye. So, our very first target was to apply the above process on silk yarn. For that purpose, we made the dye bath of cotton fabric by the above described recipe and it was carried as like the normal dyeing of cotton to get the hydrolyzed reactive dye bath. As our normal dyeing procedure is over then we got the hydrolyzed reactive dye bath. then it is must to control the pH

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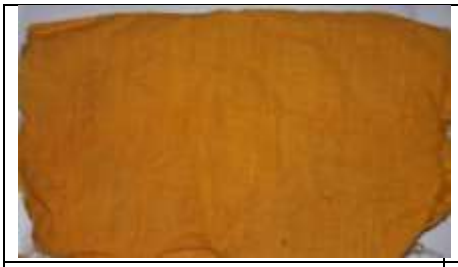
for using this bath for the further use to dye our project material. With the help of pH meter and gradually addition of the acetic we brought the pH in acidic medium acid as the primary pH of the dye bath was in alkaline condition. then the dyeing by hydrolyzed reactive dye bath is carried and after that soaping is also done.

		
Dyed silk yarn by using left dye bath	***Dyed cotton fabric by Reactive Red***	***Hydrolyzed dyed silk yarn after soaping***

Silk Fabric: Applying the same process and procedure as well as recipe also we found the following:

		
Dyed cotton fabric by Reactive Yellow	***Dyed silk fabric by using left dye bath***	***Hydrolyzed dyed silk fabric after soaping***

We can see from the above figure; the silk fabric has a moderate wash fastness.
Nylon Yarn: Applying the same process and procedure as well as recipe we got the following results:

		
Dyed cotton fabric by Reactive Red	***Dyed Nylon Yarn by using left dye bath***	***Hydrolyzed dyed Nylon yarn after soaping***

From the above figure we can see the reactive dye bath used for dyeing nylon yarn. Here the wash fastness of nylon yarn after soaping is poor to moderate.

Nylon Fabric: Same process and procedure as well as recipe that we mentioned above is followed here. The result that we found is like bellow:

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Dyed cotton fabric by Reactive Red	***Dyed Nylon Fabric by using left dye bath***	***Hydrolyzed dyed Nylon Fabric after soaping***

Analyzing the above sample that we got by applying our previously designed method, we can say that the nylon fabric has much more good wash fatness than all of those and also have the good substantivity toward the hydrolyzed reactive dye bath.

Discussion:
From the beginning of our experiment it was our target not to partially using the reactive dye bath as like only salt, alkali or others chemical but to using the dye bath completely without adding or changing anything, just controlling the pH of the dye bath. As lots of environmental and human issues are associated with the dyeing effluent that left from the industrial waste. So, in this project our target was to use the hydrolyzed dye bath for those materials which has some fixation and attraction toward hydrolyzed reactive dye. According to this statement, we used the silk and nylon in their yarn and fabric form and dyed them by two brand reactive dye that is reactive red and reactive yellow of swiss color. In case of our test we would not get the satisfactory result with the final product that we made. Here we firstly dyed the silk materials with the hydrolyzed reactive dye bath. But it was not so good and the wash fastness properties also poor to moderate. In case of nylon we got the better result than the silk materials. Hydrolyzed reactive dyed nylon materials was much more better wash fastness than the silk materials that is near about to moderate.

The main problem of this dyeing procedure is not to find the required dye shade that we want. So, we could use this process only for light shade and for local product as it is very hard to get the shade as like the fresh reactive dyeing. In addition, we can topping the hydrolyzed dyed materials to get the exact shade although it requires further fresh dye which we could reuse again.

In recent years it is very concerning that the effluent that is left from the dye bath highly hazardous for environment. Especially for water and human health. So more technology and work should be employed on this topic for finding a perfect reusing technology of reactive dyeing process as the reactive dye is the most widely used in Bangladesh as well as around the whole world for its better wash fastness, availability and cheap rate of cost.

4. CONCLUSION

Nylon and silk were dyed by using the left dye bath of cotton reactive dyeing that has moderate to good wash fastness. Here the nylon gives more good result than the silk materials. The suitable batch dyeing conditions were 90 degree Celsius or higher, for one hour at pH 4.5-5. Electrolytes left after initial cotton dyeing decreased dye sorption. The sensitivity of salt to dye sorption dependent on fiber structure and dye properties. The effect of salt on dyeing nylon was more than that the silk. Adjusting the liquor ratio could decrease the salt effect and modify shade depth of the goods. After such reuse if the dye left was negligible, the bath could be reused for cotton dyeing to save salt and water. Although reuse of hydrolyzed reactive dyes is not as convenient as using acid dyes directly, especially when conventional reactive dyeing and acid dyeing are not in the same plant, is study shows the possibility of complete reuse of a reactive dye bath. To solve the transportation problem, hydrolyzed reactive dyes could be concentrated first through adsorption, filtration and other methods. At such

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time these concentrated dyes could be sent to acid dyeing facilities for reuse. The colorless dye bath left after such concentration could be reused for successive reactive dyeing.

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