**American Journal of Chemistry and Materials Science**
2018; 5(5): 78-84
http://www.openscienceonline.com/journal/ajcms

# A Sustainable Approach to Meeting the Quality of Product in Textile Dyeing Industry; Right First Time (RFT)

Md. Rasel[1, *], Mohammad Tofayel Ahmed[2], Mazadul Hasan[3], Asmot Ullah[3], Habibur Rahman Abir[3], Kazi Md Hasanul Haque[4], Md. Naime Hossain Bhuiyan[1]

[1]Department of Industrial & Production Engineering, Shahjalal University of Science and Technology, Sylhet, Bangladesh
[2]Department of Organic Material Science and Engineering, Pusan National University, Busan, Korea
[3]Department of Textile Engineering, Southeast University, Dhaka, Bangladesh
[4]Department of Wet Processing Engineering, National Institute of Textile Engineering and Research, Dhaka, Bangladesh

## Email address

raseltex888@gmail.com (Md. Rasel)
[*]Corresponding author

## To cite this article

Md. Rasel, Mohammad Tofayel Ahmed, Mazadul Hasan, Asmot Ullah, Habibur Rahman Abir, Kazi Md Hasanul Haque, Md. Naime Hossain Bhuiyan. A Sustainable Approach to Meeting the Quality of Product in Textile Dyeing Industry; Right First Time (RFT). *American Journal of Chemistry and Material Science*. Vol. 5, No. 5, 2018, pp. 78-84.

**Received**: August 13, 2018; **Accepted**: September 3, 2018; **Published**: October 10, 2018

## Abstract

Getting better quality shade within lead time is desired for dyeing industries. The aim of this study focuses on the Right First Time (RFT) implementation in a textile knit dyeing industry. This concept means that at each dyeing the target shade must be achieved the first time, hence not requiring re-dyeing or re-correction shade by adding dyes/chemical. We are going to proof that Re-dyeing or topping happen during dyeing due to neglect of stuff but most of the case re-dyeing happens for critical shade (for example turquoise shade) which shows loss of profit. In this study, RFT implementation carried out in case of dyeing of single jersey knitted fabric with turquoise shade by conventional knit dyeing process and emphasis on some vital points for the achievement of RFT where different actions were taken place rather than following of regular dyeing process. According to the CMC (color matching cabinet) report the shade of the RFT sample was very closer to buyer approved sample while the regular sample failed to meet the buyer requirement. Other relevant quality parameters (wash fastness, rubbing fastness and bursting strength) of the regular sample and RFT sample were also checked. RFT sample showed the proper quality in shade fulfilling buyer requirement with the designated time and the key points for ensuring RFT in textile dyeing industry were also analyzed.

## Keywords

RFT, Textile Dyeing, Quality, Lead-time

## 1. Introduction

Textiles have been an extremely important part of Bangladesh's economy for a very long time for a number of reasons [1]. Right First Time (RFT) means that in making a product, it is better to perform an operation correctly the first time rather than have to work on it again in order to correct mistakes. Firms need to make it right first time or they will have to face increased costs, lost time, lost sales and lost share of the market product development [2]. The production of textiles involves a step-by-step processing of the yarn. Dyeing is the final and the most vital step where defects and in that way the production cost can be controlled. Introduced in 1970, the Right-first-time (RFT) dyeing concept meant that at each dyeing the target shade is achieved the first time [3]. One major problem that most of the textile dyeing industry faces is the re-dyeing problem because the dyed fabric does not match the requirement of the customer. The re-dyeing of the fabric leads to the loss of many resources such as water, energy, chemical, dye-stuff, time etc.

The re-dyeing of fabric also leads to the increase of production cost. The extra time taken in re-dyeing has a negative impact on the lead time of the end-product (for example, garment). The lead time is the latency between the initiation and execution of a process. However, paying high cost to get the product that exceeds the sell period converts to huge loss to the retailer [4]. It has now reached a stage where there is an attitude prevailing in the business that achieving right-first-time production is both a real and a necessary objective [5]. The textile dyeing-houses are increasingly adopting the RFT dyeing to achieve shorter lead times and improving their profitability and competitiveness. Shade matching is the main task of dyeing section. Shade is the depth of color percentage. Shade is expressed in percentage of dye amount in unit weight of fabric [6]. Shade matching depends on the accuracy of the man's eye which is matched industrially in the light box. It is a visual process for this reason same shade may have difference comments from different person. So, dyeing expert or color expert is needed for this purpose [7].

Besides the manual shade matching system computer color matching system (CCMS) can help man to take decision about the shade of a specific sample [8-9]. The objective of this research was to analyze the key points to ensure Right-First-Time (RFT) in textile dyeing industry. Single jersey knitted fabrics was dyed with a critical shade (Turquoise) and its performance was evaluated. The shade accuracy, fastness properties (color fastness to wash and color fastness to rubbing) and bursting strength of the sample dyed by following RFT and non RFT sample were measured and compared.

## 2. Significant Points to Ensure RFT in Textile Dyeing

After confirmation of buyer's order or booking sheet from merchandising section, special plan was made for RFT follow up from knitting section, batch section, lab (both physical and chemical), Water Treatment Plant, dyeing & finishing section, quality section, cutting section, planning, garments sewing section, quality section, packaging section and delivery or shipment. Finally, the dyeing and quality section were followed for ensuring RFT in this study including experimental and visual investigation such as dye house water was checked by pH meter then titration was done for checking water hardness, sample fabric composition have been checked via sulfuric acid (70% conc.) solution and finally it was ensured that there was no other yarn or filament without 100% cotton because the sample fabric totally decomposed to solution. During this study total process was checked very carefully to ensure smooth flow of every processing step involved. Otherwise all the processes may need to be done from the very beginning again wasting lot of time and money. Finally, the desired result was obtained applying RFT.

In this study a dyeing process has been depicted which was undergone through RFT process and compared with the same dyeing process performed without following RFT procedure. To ensure RFT following points were scrutinized and due process was ensured for desired production.

1. Bleaching or whiteness.
2. Peroxide killing (pH).
3. Scouring fabric check for lab re-checks.
4. Dyeing start liquor ratio, pH, temperature & water hardness check.
5. Recipe especially dyes, salt, soda, leveling, anti-creasing, sequestering (pH, time, amount).
6. Exhaustion periods.
7. Alkali dossing after and before color dosing (amount, time, pH).
8. 1$^{st}$ sample check with CMC report.
9. Salt pH after color dossing (pH, dosing or transfer time, amount).
10. Color steam pH.
11. Color steam drain pH.
12. Before acid pH.
13. Final shade check with CMC reports.
14. After treatment (1$^{st}$ hot wash, rinse and neutralization).
15. Soaping bath (pH, time, temperature, & shade check).
16. Final shade or fixing shade CMC reports.
17. Salt gravity as per chart.

14. Acid pH.

19. Soda pH.
20. Dyes strength.
21. Enzyme (pH, time, temperature, amount)
22. pH meter calibration.
23. Electric balance
24. Machine parts checkup (dossing valve, pump)
25. Cycle time, magnate, rope length etc.

Finally, some tasks those were followed behind process parameters are discussed below in a nut shell. As a part of RFT below tasks were done.

### 2.1. Batch Indication

Some Fabric must have to be undergone through heat set before pretreatment and dyeing e.g. PC FLEECE, PC S/J, LYCRA S/J, LYCRA SINGLE PK, LYCRA VISCOSE, LYCRA (4*2) RIB, ALL FILAMENT FABRIC, 85% POLY 15% LILEN whereas 100% polyester, drop needle, mesh etc. do not require heat set.

### 2.2. Before Lab Dip

Dyes lot, chemicals & dyes strength, desired color in desired packets, measurements of dyes, calculation of dyes according to substrate (fabric) weight were ensured. Shade matching result, whiteness index, yarn lot, yarn construction ensuring physical or chemical test, desired dyeing goods pick up for lab dib developments were checked for accuracy.

### 2.3. During Lab Dip

Lab dip written information was double checked with order sheets. Dyes, yarn were also double checked to ensure expire date, strength, desired color which is updated or required for dyeing, during lab dip development: pretreatment procedure, dyeing procedure, after-treatment procedure & parameters were checked perfectly such as calculation, auto-dispensing, color strength & date of dispensing etc.

### 2.4. After Lab Dip

The lab dip was sent to the dyeing sections manager for checking lab dip info & shade for production of bulk quantity. Both visual and CMC, one set of lab dip was preserved separately as a data for future reference and reproducibility which had been submitted to dyeing section.

### 2.5. Before Pretreatment

Dyes lot, chemicals & dyes strength, desired color in desired packets, measurements of dyes, calculation of dyes according to goods were checked. Shade matching result, whiteness index was ensured in presence of production officer when workers taking those materials from go-down. Lab dip info, dyes & chemicals calculation was checked for pretreatment/dyeing/after treatment according to demand. Water characteristics checkup, machines inside were also checked for next steps.

### 2.6. During Pretreatment

All parameters were followed up strictly which was given as process sheet by GM and production officer. Those parameters were ensured by continuous follow-up such as dyes pot should not be taken during pretreatment chemical carry, during mixture of chemical, dosing time checkup etc.

### 2.7. After Pretreatment

Machine wash was done for the removal of dust/waste and started next steps.

### 2.8. During Dyeing

It is very crucial point that CVC/PC fabric with color fabric have to be dyed separately & AOP fabric with neck fabric also have to be dyed separately. Moreover, according to nozzle, batch has to be ready for dyeing. It was confirmed that the process parameters were followed up strictly, e.g. special care was taken during dyes mixture whether it was done according to process sheet where time, temperature etc. parameters were mentioned. Moreover, production officer was knocked after an every while so that workers cannot skip or shorten any process or parameters.

### 2.9. After Dyeing

Machine wash followed up & made ready for next steps. All parameters were followed by us with help of workers, production officer.

### 2.10. During After Treatment

Extra impurities removal & dyes fix up continued until became cleaned. Workers were instructed to unload the batch timely and carefully so that materials do not get in contact with other color materials in same trolley or don't touch with each other otherwise color bleeding will create adverse color effect between materials and dyed materials. In this regard the trolley containing the dyed fabric was covered by polyethylene or available pack so that dust cannot come on the dyed fabric surfaces.

## 3. Experimental

### 3.1. Raw Materials

100% cotton single jersey knitted fabric, reactive dyes and dyeing chemicals and auxiliaries used were collected from the dyes and chemical store of Dird Composite Textile Ltd, Gazipur, Bangladesh. For bulk dyeing the sample weight for the both RFT followed sample and non RFT sample were 1000kg.

### 3.2. Instruments

Scouring, bleaching, bio-polishing and dyeing were performed in a dyeing machine (Fong's, Hong Kong, capacity: 1500kg). Whiteness Index (%) and spectrophotometric value of thefabric were collected from spectrophotometer (Data color 650 TM). Color fastness of the dyed sample was measured by using Gyro Wash (James Heal, UK). The Rubbing fastness measure by using crock master (James Heal, UK). Bursting strength measured by using PnuBurst™ (SDL Atlas, USA).

### 3.3. Development of the Lab Dip

A color standard (Table 1) was supplied by the buyer for the development of lab dip. The provided reflectance values were input in the spectrophotometer (Datacolor 650™). The conditions were keyboard % R-31 and F11 10 Degree & D65 10 Degree was the light sources.

***Table 1.*** *Reflectance value for the buyer standard shade.*

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 300nm | | | | | | | | | | |
| 400nm | 50.32 | 51.30 | 51.51 | 51.80 | 52.78 | 55.11 | 58.45 | 62.85 | 68.06 | 70.03 |
| 500nm | 69.01 | 65.94 | 62.28 | 58.29 | 54.16 | 50.06 | 45.98 | 42.33 | 39.09 | 36.06 |
| 600nm | 33.22 | 30.58 | 28.25 | 26.52 | 25.37 | 24.56 | 23.82 | 23.09 | 22.69 | 22.86 |
| 700nm | 24.06 | | | | | | | | | |

According the reflectance value, the spectrophotometer gave the desired shade (Figure 1) of the lab dip.

***Figure 1.** Shade of the lab dip.*

A recipe was created by using data color and different small pieces of fabric were dyed with the relevant recipe. The dyed samples (4 samples i.e. A, B, C, D) were submitted to buyer for lab dip approval. The buyer approved the closest sample (A) for the bulk dyeing production. The lab recipe of the approved lab dip along with the sample was submitted to dyeing department for reference.

### 3.4. Scouring and Bleaching of Single Jersey Knitted Fabric

Scouring breaks down pectin's and waxes and helps remove other impurities present in cotton fibers to improve water absorptivity; and bleaching commonly done with hydrogen peroxide under near boiling temperature, removes colored impurities from fabrics that may produce an undesirable appearance and hinder dyeing performance [10-11]. The scouring and bleaching (as shown in Figure 2) of Single jersey knitted fabrics were performed by using following recipe.

Wetting agent: 0.5 g/l
Sequestering agent: 0.2 g/l
Anti-creasing agent: 0.5 g/l
Anti-foaming agent: 0.5 g/l
Caustic soda (NaOH): 0.5 g/l
Stabilizer: 0.3 g/l
Hydrogen peroxide (50%) ($H_2O_2$):0.5 g/l
pH: 10.50-11.00
M: L = 1:10
Temperature: 98°C
Time: 60 min

To check the efficiency of scouring water, absorb efficiency of soured fabric was measured. Single jersey knitted scoured fabric sample of 1cm x 1cm size was cut and left on water surface. With the help of stop watch, the time of the fabric for immersing was recorded. The time of fabric sample immersing observed was 3sec (Standard time of immersing is 5 sec). Whiteness of the bleached fabric was determined with the reflectance value using spectrophotometer (Datacolor 650™) and 10-degree observer. The whiteness index of bleached fabric was 72.

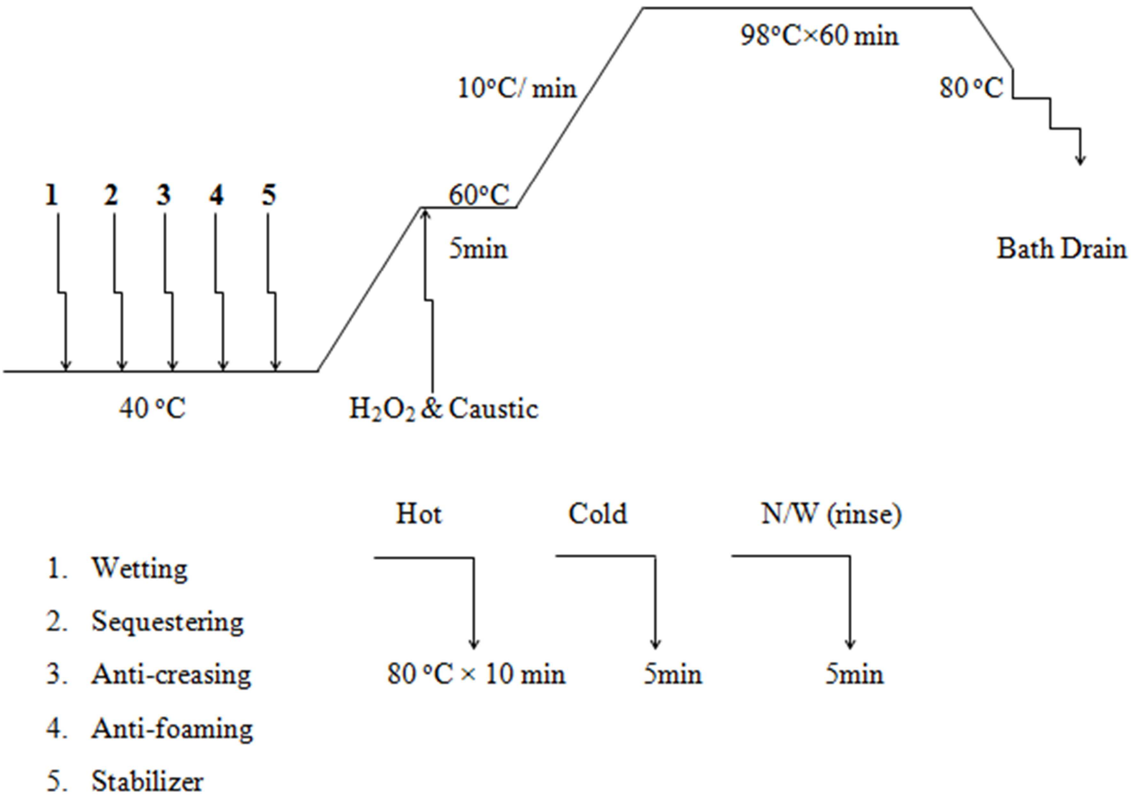


***Figure 2.** Scouring & bleaching of cotton knitted single jersey fabric.*

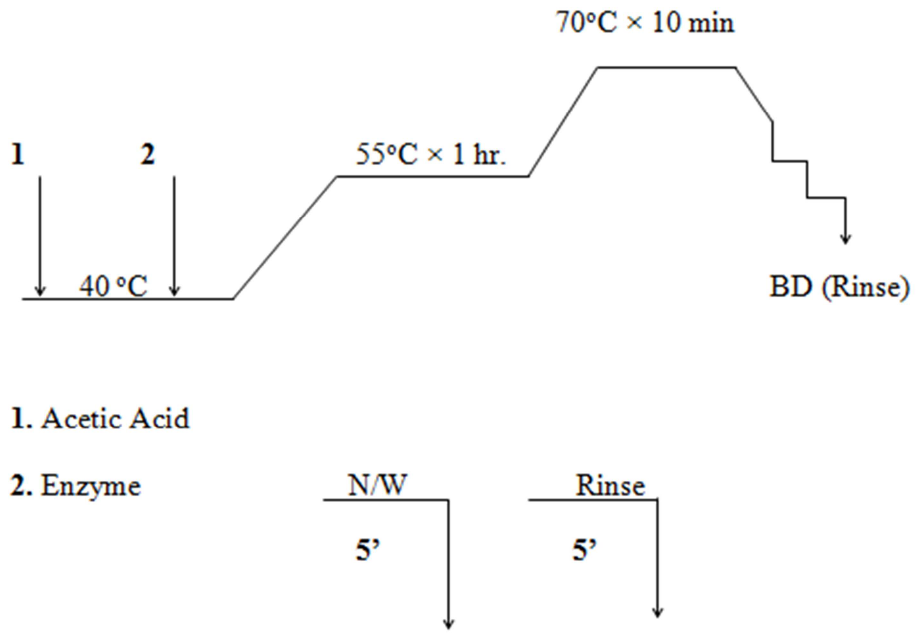


***Figure 3.*** *Bio-polishing of Cotton knitted single jersey fabric.*

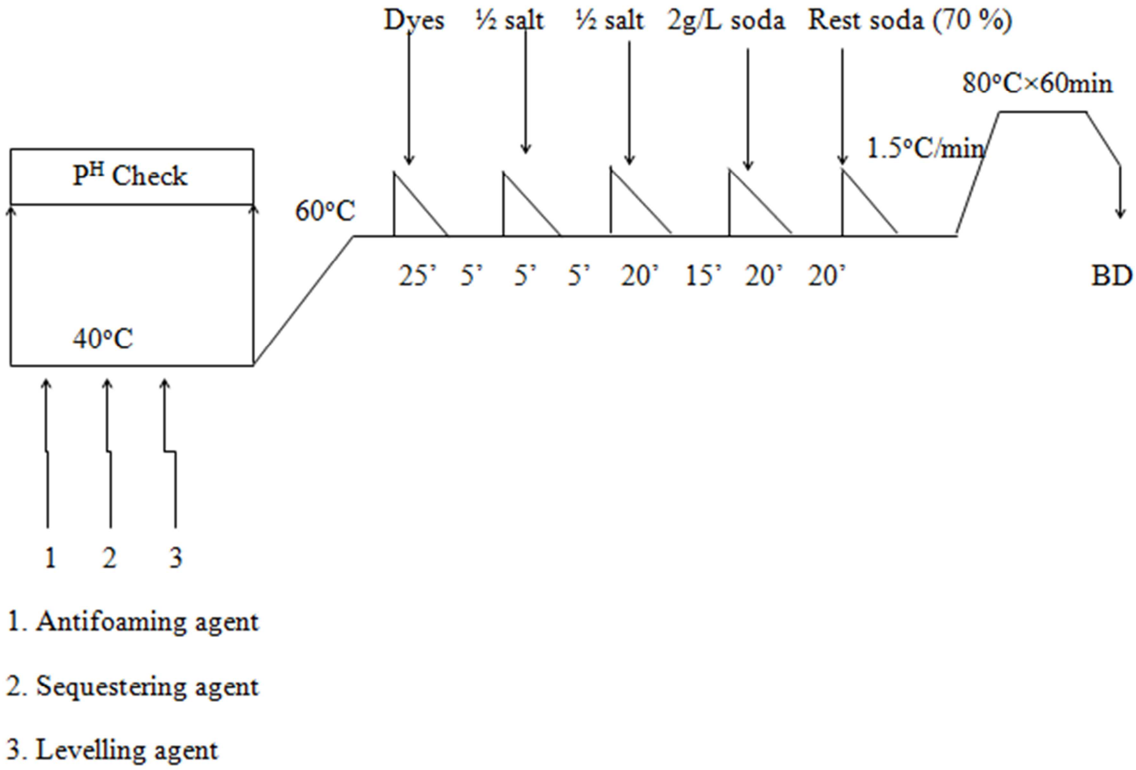


***Figure 4.*** *Dyeing of Cotton knitted single jersey fabric.*

### 3.5. Bio-polishing of Single Jersey Knitted Fabric

The Figure 3 describes the bio-polishing process of single jersey knitted fabric. After bio-polishing, the hairiness on the surface of the treated fabrics was observed manually. The process of eliminating the surface fibers by treatment with cellulose enzyme is well established. The treatment with cellulose enzyme is carried out under mild conditions so as to minimize the degradation of the fabric. This process of eliminating surface fibers is also known as bio-polishing [12]. The bio-polishing of single jersey knitted fabrics were performed by using following recipe.

Enzyme – 0.2%
Acetic acid – 0.8 g/l
PH: 4.5-5.00
M: L = 1:10
Temperature: 55°C
Time: 60 min

### 3.6. Dyeing of Single Jersey knitted Fabric

The following recipe was followed for the dyeing of single jersey knitted fabric. The total dyeing process described in Figure 4.

Shade: Turquoise
Fabric type: S/J-160 GSM
COLVAJOL YELLOW- 4GL: 0.020%
DRIMARINE T BLUE CLB: 0.270%
DRIMARINE T BLUE CLBR: 0.0420%
Glauber salt-30 g/l
Soda ash-10 g/l
Levelling Agent-0.6 g/l
Sequestering Agent-0.5 g/l
Anti-creasing Agent-0.5 g/l
PH 10-11
M: L = 1:6

## 4. Methodology

Better dye house water quality was ensured for the dyeing of goods by testing water hardness, pH etc. in the lab before starting the whole process. The strength and purity of the reagents were checked before using for bulk production. The fabrics, dyes and chemicals used for lab dip must be same for the bulk dyeing process. For the bulk dyeing same substrate (fabric) and the same reagents were ensured that was used for lab dip development. Because materials difference is not acceptable for getting desired result to the bulk production. Scouring, bleaching and bio-polishing of these fabrics were carried out in a bulk dyeing machine. Whiteness Index (%) and Spectrophotometric values were measured by using spectrophotometer. Color fastness of the dyed fabric was also measured (method followed; ISO 105:CO3). Rubbing fastness of the dyed fabric was also measured (method followed; ISO 105: X12). Bursting strength was measured and method followed was ASTM D3786. Each and every operation involved from lab dip development to bulk dyeing followed with great care for achieving RFT.

## 5. Results and Discussion

### 5.1. Spectrophotometric Evaluation

Spectrophotometric values of the RFT followed sample and non RFT sample were measured by using (Datacolor 650™) under the light source of F11 10 Degree & D65 10 Degree. Non RFT sample (Table 2) showed higher color difference (2.46 & 2.19) than the approved shade. As a result, the data color gave the decision 'fail' that means the non RFT sample failed to achieve the target shade. RFT followed sample (Table 3) shows very close value as similar to the standard. Color difference of the RFT sample was 0.62 for F11 10 deg. and 0.43 for D65 10 deg. Which were very closer to the standard that's why data color showed the decision 'pass'. The metamerism index of RFT sample (0.31) was much less than non RFT sample (0.49).

***Table 2.*** *Spectrophotometric values of non RFT sample.*

| Ill/Obs | CMC DE | DL* | Da* | Db* | Dc* | DH* | Metamerism Index | CMCDecision |
|---|---|---|---|---|---|---|---|---|
| F11 10 Deg | 2.46 | 0.74 | 0.62 | 3.45 | -2.01 | -2.87 | 0.49 | Fail |
| D65 10 Deg | 2.19 | 0.53 | 0.80 | 3.11 | -1.66 | -2.75 | | Fail |

***Table 3.*** *Spectrophotometric values of R.*

| Ill/Obs | CMC DE | DL* | Da* | Db* | Dc* | DH* | Metamerism Index | CMC Decision |
|---|---|---|---|---|---|---|---|---|
| F11 10 Deg | 0.62 | -0.94 | -0.82 | -0.36 | 0.90 | -0.07 | 0.31 | Pass |
| D65 10 Deg | 0.43 | -0.94 | -0.39 | -0.19 | 0.43 | 0.05 | | Pass |

### 5.2. Hand Feel

Fabric's hand feel is a vital point to be checked. In this study both the fabric samples processed with and without following RFT were tested manually for hand feel investigation. The surface of fabric sample undergone through RFT process was felt better than sample processed without RFT procedures.

### 5.3. Color Fastness to Wash

The fastness property to wash is one of the most important properties that need to be checked in case of dyed fabric for quality assurance. As clothing and garments undergo lot of laundry wash based on use it is vital to check whether the color bleeds or not during washing. Accordingly, color fastness property of processed fabric was checked following ISO 105:CO3 method and compared with the fabric sample processed without following RFT where the fabric treated following RFT process showed better rating than fabric sample did not undergo through RFT as depicted in table 4.

### 5.4. Color Fastness to Rubbing

Garments undergo through various kind of abrasion and rubbing. So it is important to check the abrasion resistance of the fabric. Color fastness to rubbing in regard was measured by ISO 105 *12 method utilizing a crock meter. The sample fabric was characterized by both dry and wet rubbing. Alike color fastness to wash the fastness property to rubbing of processed sample was better than fabric processed without RFT application. The results are illustrated in table 5.

### 5.5. Bursting Strength

The fabric was tested for checking bursting strength also. This test was done as per ASTM D3786 method by Pneumatic Bursting strength tester (PnuBurst™- sdl atlas).

The results revealed the same rating of fabric processed with and without following RFT as shown in Table 6.

***Table 4.*** *Color fastness to wash rating.*

| Fastness to | Staining to | Rating (Following RFT) | | Rating (Following RFT) | |
|---|---|---|---|---|---|
| | | Color change | Color Staining | Color change | Color Staining |
| Washing | Acetate | 5 | 5 | 4-5 | 4-5 |
| | Cotton | 5 | 5 | 4 | 4 |
| | Nylon | 5 | 5 | 4 | 4 |
| | Polyester | 5 | 5 | 4-5 | 4-5 |
| | Acrylic | 5 | 5 | 4-5 | 4-5 |
| | Wool | 5 | 5 | 4-5 | 4-5 |

***Table 5.*** *Color fastness rating to rubbing rating.*

| Fastness to | Staining to | Rating (Following RFT) | Rating (without following RFT) |
|---|---|---|---|
| Dry rubbing | Rubbing cloth | 4-5 | 3-4 |
| Wet rubbing | Rubbing cloth | 3-4 | 3 |

***Table 6.*** *Bursting strength.*

| Fabric sample type | Rating (Following RFT) | Rating (without following RFT) |
|---|---|---|
| Processed | 66 | 66 |
| Grey | 69 | 69 |

## 6. Conclusion

As per analysis from this study it is evident that RFT comprises great importance for quality production within prescribed time limitation. It's not RFT but a challenge for smooth production with quality products without waste of money & time. So many points needed to be checked and ensured for the right production with right quality. Accordingly, dye house water quality needs to be ensured for dyeing goods by testing water hardness, pH etc. Another key point that must be kept in mind for getting RFT result that right process has to be followed for right production choosing right material in right time. Because materials difference than lab dip development is not acceptable for getting desired result in the bulk production. A small deviation than the actual process can make a big difference in quality. In this study it is observed that RFT could be a part of production unit having immense importance as just following the aforementioned procedures of RFT one can increase its efficiency in terms of utility consumption, power consumption, process time and production cost. RFT can play a vital role to get right product at right time saving cost and time just by being conscious while entire production process. Following RFT properly, textile dyeing industry can easily avoid the repetition incurred by previously done faulty process. Any kind of reprocess causes huge financial damages to the company. So each and every task needs to be followed accordingly to get desired result that can be achieved by exploitation of RFT precisely. Notably, efforts would be taken to figure out the beneficial economic concerns of RFT against traditional process in our next paper.

## References

[1] Islam, M. M., Khan, A. M., Islam, M. M. (2013): Textile Industries in Bangladesh and Challenges of Growth, *Research Journal of Engineering Sciences*, 2 (2), 31-37.

[2] Islam, A., Rehman R., Jiang H. (2015): Prospect and Scope of Laboratory and Bulk Production Floor in Achieving and Improving RFT in Exhaust Dyeing, The 8th cross strait conference on textile technology, 397.

[3] Park J., Shore J. (2009): Evolution of right-first-time dyeing production, *Color Technol*, 125, 133-140.

[4] Kader S. and Maeen, M. K. A. (2014): Analysis of the Factors Affecting the Lead Time for Export of Ready Made apparels from Bangladesh; Proposals for Strategic Reduction of Lead Time, *European Scientific Journal*, 10 (33), 268-283.

[5] Farrington, D. W. (1988): Right-first-time - an approach to meeting the demands of today's customer, presented at the Societys international conference 'Coloration: the demands of the 90s 'held at the University of Leeds. 14-16.

[6] Gregory P. (1993): Dyes and dye intermediates. Kirk-Othmer encyclopedia of chemical technology.

[7] Hunger K et al. (2004): Important chemical chromophores of dye classes. *Industrial Dyes: Chemistry, Properties, Applications*, 13-112.

[8] Hunger K et al. (2004): Dye classes for principal applications. *Industrial Dyes: Chemistry, Properties, Applications*, 113-338.

[9] Gregory P. (2004): Functional Dyes. *Industrial Dyes: Chemistry, Properties, Applications*, 543-584.

[10] Karmakar S. R. (1999): Chemical Technology in the Pre-treatment Processes of Textile, Elsevier, Amsterdam, volume 12.

[11] Tomasino C. (1992): Chemistry & Technology of Fabric Preparation & Finishing, Raleigh, North Carolina.

[12] Rasel M., Sadi M. S., Hasan M., Mridul M. H., Ahmed M. T. and Hazari A. B. (2018): The Impact of Enzyme Concentration (%) onDifferent Properties of Knitted Fabric During Biopolishingand Their Technical Relationship, *International Journal of Scientific & Engineering Research,* 9 (2), 1142-1146.