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Ethiopian Institute of Textile & Fashion Technology

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REUSING OF PRETREATMENT BATH IN BAHIR DAR TEXTILE SHARE COMPANY

By

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Abstract

Textile industries are doing on to minimize their production costs by using sustainable technologies and by inventing new methods. Pretreatment is the heart of textile production. Bahir Dar Textile Share Company is using combined pretreatment process with exhaust and semi-continuous method. After the treatment is over, the residual chemicals are drained out into effluent treatment plant. The purpose of this project is to reuse the residual chemicals by replenishing the measured amounts of chemicals again for combined pretreatment process. The concentration of main chemicals, after pretreatment, before draining was analyzed. In case of jigger pretreatment process, the liquor is drain out after six ends with chemicals, then the main chemical concentrations (H_2O_2 and NaOH) was checked at this stage. In case of pad roll bleaching, the fabric rotates in the steaming chamber six up to twelve hours and washed with counter current washing machine. The chemicals are analyzed after washing is over. Based on the chemical analysis results, by replenishing with measured amounts of chemicals, pretreatment is done in both laboratory scales up to four times without changing water and on the bulk production; it has been done by mixing used water and fresh water. The effectiveness of pretreatment was evaluated in terms of absorbency; whiteness and the effect in subsequent dyeing parameters are checked. The dyeing and printing performance is also evaluated by doing dyeing and printing after each pretreatment is over. Acceptable results are found which can fulfill the products of the factory. Finally the amount of cost saved by fabric pretreatment, raw water and waste water treatment chemicals is calculated and also the amount of water which can be saved is shown.

Declaration

I hereby declare that the thesis is submitted in fulfillment of the Master's degree is my own work and that all contributions from any other persons or sources are properly and duly cited. I further declare that the material has not been submitted either in whole or in part, for a degree at this or any other university. In making this declaration, I understand and acknowledge any breaches in this declaration constitute academic misconduct, which may result in my expulsion from the program and/or exclusion from the award of the degree.

Name: ______________________

Signature: ___________________

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ADVISORS' APPROVAL SHEET

ETHIOPIAN INSTITUTE OF TEXTILE AND FASHION TECHNOLOGY (EiTEX)

POST GRADUATE STUDIES AND PROJECT DEVELOPMENT OFFICE

This is to certify that the thesis entitled "**Reusing of Pretreatment Bath in Bahir Dar Textile Share Company**" submitted in partial fulfillment of the requirement for the degree of Master's with specification in **Textile Chemistry**, the postgraduate studies program of the Ethiopian Institute of Textile and Fashion Technology, and has been carried out by **Yenesew Mullu,** ID. No. **MTC/R/005/09**, under my/our supervision. Therefore I/we recommend that the student has fulfilled the requirements and hence hereby can submit the thesis to the institute.

___________________________	__________________	________________
Name of major advisor	Signature	Date
___________________________	__________________	________________
Name of co - advisor	Signature	Date

Acknowledgement

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Table of contents

List of tables

List of figures

Acronyms

AATCC	American association of Textile Chemists and Colorists
ASTM	American Society for Testing and Materials
BDTSC	Bahir Dar Textile Share Company
CIE	International Commission on Illumination
COD	Chemical Oxygen Demand
D-65	Daylight
EiTEX	Ethiopian Institute of Textile and Fashion Technology
ETP	Effluent Treatment Plant
ISO	International Organization for Standardization

CHAPTER ONE

1. INTRODUCTION

1.1. Background

The textile industry is looking forward to minimize their production cost and make more profit by using sustainable technology. Pretreatment is the heart of textile dyeing, printing and finishing process because fibers, yarns, fabrics have many impurities like sized polymers (Starch, PVA, polyacrylate, CMC, CMS), cotton wax, lubricant, silk, sericin etc. To remove this impurities a massive amount of water is required in this process per day. It is estimated that on an average, almost 100 liters of water is used to process only 1 kg of textile goods and thus the water consumption of an average sized textile mill having capacity only 8 tons/day is about 1.6 million liters per day (Allègre 2006). Among the textile fibers, about 48% are cotton fibers that we consumed as clothing materials all over the globe (Broadbent 2001). All the cotton goods as woven or knit all goes through the pretreatment process like desizing, scouring, bleaching etc. before dyeing process. These pretreatment processes create huge pretreatment liquor and wash liquor which the industries discharge as textile effluent.

All the chemicals used in desizing, scouring and bleaching of cotton woven fabric do not fully react with it. As a result pretreatment liquor contains some residual chemicals like caustic soda, peroxide and other auxiliary chemicals (Choudhari 2011).

This project is going to find the possibilities of reusing the textile pretreatment liquor or wash liquor in disizing, scouring and bleaching of cotton fabric. It is an appropriate, cost effective recycling method for chemical consumption rate, fresh water consumption rate and reducing the pollution level. The pretreatment liquor or wash liquor from single bath must be collected in periodic basis and analyzed. Then they will be used for the purpose of combined desizing, scouring and bleaching. Combined treated and dyeing performances of the samples must be then compared against the samples prepared by conventional method.

The focus of this project is on recycling and reusing water and chemicals in the textile pre-treatment process of Bahir Dar Textile Share Company without prior waste water treatment.

The conventional three step pre-treatment process for cotton fabric consists of desizing, scouring and bleaching. Desizing of a grey fabric removes previously added size or starchy material which can be done by using water (rot steeping), acid, enzyme, oxidation chemicals and alkali. Scouring uses alkali to remove oils, fats and waxes to improve the absorbency whereas bleaching uses oxidizing agents to improve the whiteness of the fabric. In a conventional process, scouring and bleaching is done once which results in underutilization of alkali and hydrogen peroxide. But in BDTSC all these three processes are combined into one that is single stage pretreatment process by using jiggers and pad roll bleaching machines. In case of jiggers' pretreatment process, all the chemical liquors after six ends chemical rotation are drain out and in case of pad roll bleaching, after 6-12 hours of rotation in the reaction chamber the residual chemicals are washed out in washing machine.

1.2. Problem statement

Textile industry is water intensive industry. As textile chemical processing operations are carried out in aqueous medium, water is the input which is used in larger quantities for their production. Water is expensive to buy, treat & dispose and as it is becoming a scarce commodity, sustainable developments of the textile industry needs recycling of waste water generated and conservation of water to reduce the water requirements and also dependency on other water sources.

Bahir Dar Textile Share Company is one of integrated textile industries in Ethiopia. The major operations performed in BDSTC wet processing section are desizing, scouring, bleaching, neutralizing, dyeing, printing and finishing.

Most of the time this industry is using combined pretreatment process by pad roll bleaching machine and jiggers. The main chemicals used are NaOH, H_2O_2, stabilizer, wetting agent and OBA. In case of jigger pretreatment, the liquor is drain out after six ends chemical rotation and in pad roll bleaching, the fabric is washed with counter current washing machine after rotation in reaction chamber. The drain out liquors and wash water can be replenished by adding measured amounts of chemicals and reused again and again based on the concentration of chemicals for pretreatment process. This project can reduce the chemical costs, water usage, and energy consumption as well as can reduce the effluent load of ETP.

1.3. Objective

1.3.1. General objective

- Reusing pretreatment liquor of Bahir Dar Textile Share Company.

1.3.2. Specific objectives

- Reduce chemical consumption
- Reduce water consumption and waste water discharge,
- Prevent the effluent load on the environment.

1.4. Benefits and beneficiaries

1.4.1. Benefits

- Economical, this project has economical benefit because there is a great saving of chemicals from raw water treatment, textile pretreatment and waste water treatment. There is also economical benefit from the saving of water.
- Environmental, sine this work can enable reusing of waters again and again, there is a reduction of effluent treatment and environmental pollution load.

1.4.2. Beneficiaries

- Bahir Dar Textile Share company;
- All other textile industries;

CHAPTER TWO

2. LITERATURE REVIEW

2.1. Pretreatment of textiles

In Textile Chemical Processing the chemical treatments are given to the fabric after being manufactured. Actually the fabric coming from the loom is not having properties like absorbency, softness etc. and the most important is that the appearance of the fabric is dirty or pale yellow; we cannot use it directly for making apparels or clothing. So, it is necessary to go for chemical processing of the material to make it wearable (N.P. Sonaje 2013).

There are number of impurities present in the fabric such as dust, dirt, oil stains, oil and waxes, starches or other sizing materials, seed particles, and natural coloring materials (Mauskar 2007). Wet processing enhances the appearance, durability and serviceability of fabrics by converting undyed and unfinished goods, known as grey or greige goods, into finished consumers' goods. There are various stages of wet processing, such as singing, desizing, scouring, bleaching, mercerizing, dyeing, printing, mechanical and chemical finishing. Some of these stages may be optional, depending on the style of fabric being manufactured or whether the material being wet-processed (N.P.Sonaje 2015).

2.2. Water in textile industries

The textile industry utilizes abundant water in pretreatment, dyeing and finishing processes. There is a need to adopt economical practices for the use of water in textile industries. The quantity of water required for textile processing is large and varies from mill to mill depending on the fabrics produced and processed, the quantity and quality of the fabric, processes carried out and the sources of water. The longer the processing sequences, the higher will be the quantity of water required. Bulk of the water is utilized in washing at the end of each process (N.P.Chougule 2015).

The water usage of different purposes in a typical cotton textile mill and synthetic textile processing mill and the total water consumed during wet process is given in table 2.1 and table 2.2 respectively.

Table:2.1 Water usage in textile mills

Purpose	**Percent water use**	
	Cotton textile	**Synthetic textile**
Steam generation	5.3	8.2
Cooling water	6.4	---
Demineralization or water for specific purpose	7.8	30.6
Process water	72.3	28.3
Sanitary use	7.6	4.9
Miscellaneous and fire fighting	0.6	28.0

As it seen from table 2.1 more than 72 percent of which is fed to textile industries are used for pretreatment process. Water conservation and sustainable technology is recommended in this area.

Table:2.2 Water requirements for cotton textile wet processing operations

Process	**Requirement in liters/1000kg of product**
Sizing	500-8200
Desizing	2500-21000
Scouring	20000-45000
Bleaching	2500-25000
Mercerization	17000-32000
Dyeing	10000-300000
Printing	8000-16000

Very huge quantities of is utilized by three main wet processing sections, desizing, scouring and bleaching as it is shown in table 2.2.

2.3. Water quality requirements for pretreatments

As long as impurities in the water do not interfere with the process and the fabric performance, the water is acceptable for process use. Recommendations for water quality in specific textile processes have been published. The recommended water quality criteria are rather limiting and are intended to meet requirements for the most critical process or dyeing formulation. They do not necessarily apply to most production needs. Recent experiences with water reuse in the textile industry indicate that recycled water, having impurity levels above historically accepted limits, can be used to produce first-quality goods. The minimum water quality for process reuse, therefore, is defined as the treated wastewater containing the highest level or concentration of impurities that will consistently produce an end-product of first quality (Lanza 2007). The tables 2.3 and 2.4 below show the recommendation of water quality parameters for textile pretreatment process.

Table:2.3 The recommended water quality parameters for pretreatment,

Parameters	Value
Turbidity (silica scale, ppm)	5
pH	6-7.5
Total hardness (ppm)	50
Iron (Fe, pm)	0.25
Manganese (Mn, ppm)	0.1

Table: 2.4 American recommendation of water parameters for pretreatment,

Parameters	Value
Turbidity (silica scale, ppm)	0.5-3
Total hardness (ppm)	0-25
TDS (ppm)	65-150
Iron (Fe, pm)	0.02-0.1

Manganese (Mn, ppm)	0.02
Alkalinity (as Ca_2Co_3) to methyl orange	35-64

2.4. The needs of water recycling & reuse in wet processing

Recycling and reusing has become a necessary element, not because of the shortage of any item, but because of the need to control pollution. There are three ways to reduce pollution:

1. Use of new, less polluting technologies;
2. Effective treatment of effluent so that it conforms to specified discharge requirements; and
3. Recycling waste several times over before discharge.

The textile industry consumes a lot of water, energy and chemicals for the production of textile products, and discharges a significant wastewater, high in volume and in most pollution parameters. Due to increasing water scarcity and costs, there is a need for water savings, reclamation and reuse, and closed water loops in the textile industry. A system analysis in textile processing can help to identify relevant textile processes and water streams with a potential for both direct reuse of waste water and efficient water recycling with membrane technology.

Efficiency and cost economics for recycling and reuse of water would, however, depend upon the process parameters, chemicals and machinery used (Saxena and Arputharaj 2017).

2.5. Reusing of textile pretreatment baths

Current research paper discusses the possibilities of without treatment reusing of textile wastewater in the same factory. Industries do not need water as pure as for drinking purpose. Hence, they can reuse their wastewater. This research project has illustrated the possibilities of reusing the textile wastewater without any wastewater treatment process. It is an appropriate, cost effective water recycling method for reducing the pollution level and fresh water consumption rate (Abu Shaid 2013).

Analysis has been carried out for repeating the bath in Cotton pre-treatment operations. Here these pre-treatment operations considered are desizing, scouring and bleaching. It is possible to reduce the water consumption in cotton pretreatments by reusing the same bath. Same scouring and bleaching bath can be used up to 6 times and 4 times respectively. It helps to reduce the effluent load so that the effluent treatment cost is also reduced substantially with saving of water and chemical costs. Conservation of water and chemicals are achieved by reusing the same bath for several times in cotton pretreatments as desizing, scouring and bleaching (Chougule 2014).

Water reuse measures reduce hydraulic loadings to treatment systems by using the same water in more than one process. Water reuse resulting from advanced wastewater treatment (recycle) is not considered an in-plant control, because it does not reduce hydraulic or pollutant loadings on the treatment plant (Shaikh 2009).

The survey, which was recently expanded and updated, showed that little work had been done on the recovery and reuse of textile processing chemicals. The caustic soda used in mercerization appears to be the outstanding exception (Raleigh 1972).

2.6. Process water reuse options in textile industry

Significant savings can be made in textile processing industries by recovering and re-using of water at processes itself. Few areas where these options can be examined by the units are out lined and as follows.

- Recycling of final wash water after H_2O_2 bleaching as wash water for second scouring step or for earlier bleaching steps.
- Reusing bleaching wash water to start another bleaching batch,
- Re-use of hot bleach water for starting optical brightening batch.

- Re-use of optical brightening wash water to start another batch of optical brightening batch.
- Final wash water of cone scouring and bleaching can be used as wash water for scouring and bleaching.
- Cold rinse water used after scouring step for sulphur black dyeing can be used for the reduction step.
- Re-use of hydrosulphite wash water for another batch of hydrosulphite bath.
- Re-use of clarified print washes water in washing blankets and screens of the print machine (Chavan, et al. 2016).

2.7. Recovery and reuse of process chemicals

As textile processing baths usually contain a number of chemicals and auxiliaries in dilute solutions or dispersions, their individual recovery is difficult and may not be cost-effective. Also they may undergo changes during the process. Therefore, only a few instances of recovery and reuse of process chemicals are found in textile wet processing. It is common knowledge that alkali containing mercerizing wash liquor can be used for scouring and bleaching (Sujata Saxena 2017).

All the chemicals used in scouring and bleaching of cotton knit fabric do not fully react with it. As a result pretreatment liquor contains some residual chemicals like caustic soda and hydrogen peroxide (Md. Abdul Hannan 2016).

2.7.1. Reusing of desizing liquor

Reuse of desizing effluent after the recovery of size is also practiced in some mills. When polyvinyl alcohol is used as size, the resultant effluent is nothing but an aqueous solution of PVA. There are low cost methods available to recover and reuse the size stripped effluent again for desizing.

This research is used to decrease the waste load from the desizing of fabrics, therefore, may be concerned with developing more effective and less expensive treatment methods or with developing processes for recovering and reusing the desizing products (M. C. Sonaje 2012).

Recovery Methods

The contemplated methods of recovering desizing products were precipitation, evaporation, and combinations of the two. Emphasis was placed on precipitation methods which do not require evaporation or other concentrating procedures because, for economic reasons, the process should be as simple as possible (Raleigh 1972).

The rinse water from the scouring operation is adequate for reuse in other processes such as desizing that do not require water of an extremely high quality. This reuse is particularly true with scouring wastes from synthetic or cotton/synthetic blend fabrics (Chougule 2014).

2.7.2. Reusing of desizing liquor for scouring

Ravindra V. Adivarekar *et al* uses desizing liquor for scoring. In his work, the liquor was reduced by reusing the same bath of the pre-treatment process by using standing bath technique repeatedly without further addition of chemicals or water but maintaining the MLR by adjusting the size of fabric material till a stage comes where the fabric properties were unacceptable for further processing in another method, the fabric from the last reused bath of acid desizing was cut into four parts and was taken for scouring process where the bath was reused four times with the four parts of fabric used at each stage. Then the fabric from the fourth scouring bath was cut into four parts and was used for the bleaching bath where this bath was also reused four times (Rachana S. Harane 2013).

2.7.3. Reusing of desizing liquor for bleaching process

An enzymatic process is proposed to utilize desizing baths for bleaching in which glucose oxidase (GOx) enzymes generate hydrogen peroxide and gluconic acid using glucose as a substrate (Tzanov T. 2001). Advantages of the process are reducing the COD of the effluents by degrading glucose units, and reducing the use of peroxide stabilizing agents with the help of gluconic acid, which is capable of completing catalysts as well as saving water and energy by using desizing liquor for bleach. However, starch has to be degraded with glucose units in order to achieve process efficiency because of the high substrate selectivity of GOx enzyme. Conventional commercial desizing enzymes do not seem appropriate for this purpose since most include α-amylase in formulations, whereas amyloglucosidases are suitable amylase enzymes to degrade starch until it becomes glucose (Aniş P. 2008).

2.7.4. Reusing of scouring liquor

Sonaje *et al* have done different tests after the scouring process for waste liquor. From the results of the tests it is observed that same liquor can be reused for several times. After carrying out of process 1, it is observed that the amount of liquor was decreased because of evaporation and water absorbed by fabric. So while reusing same scouring liquor bath in process 2 hot wash liquor was added to replenish the amount of liquor to be used. Same liquor bath was used for eight times (N. P. Sonaje 2015).

2.7.5. Reusing scouring and bleaching liquor for desizing

In textile processing, scouring is done by alkali followed by bleaching using oxidizing agent whereas desizing is possible by both alkali and oxidizing agent. In any wet processing, there is never complete utilization of the process chemicals onto the fabric, some amount gets back into the wastewater. Thus in the current work, scouring and bleaching wastewaters containing the unexhausted chemicals were segregated and reused as a desizing bath with and without prior treatment and also excluding addition of any extra chemicals.

Rachana Haranehas done the theoretical comparison of proposed reused method with the conventional method and it shows about 50% reduction in intake of fresh water, 19% reduction in usage of chemicals and an overall saving of 40% on the processing cost of the fabric.

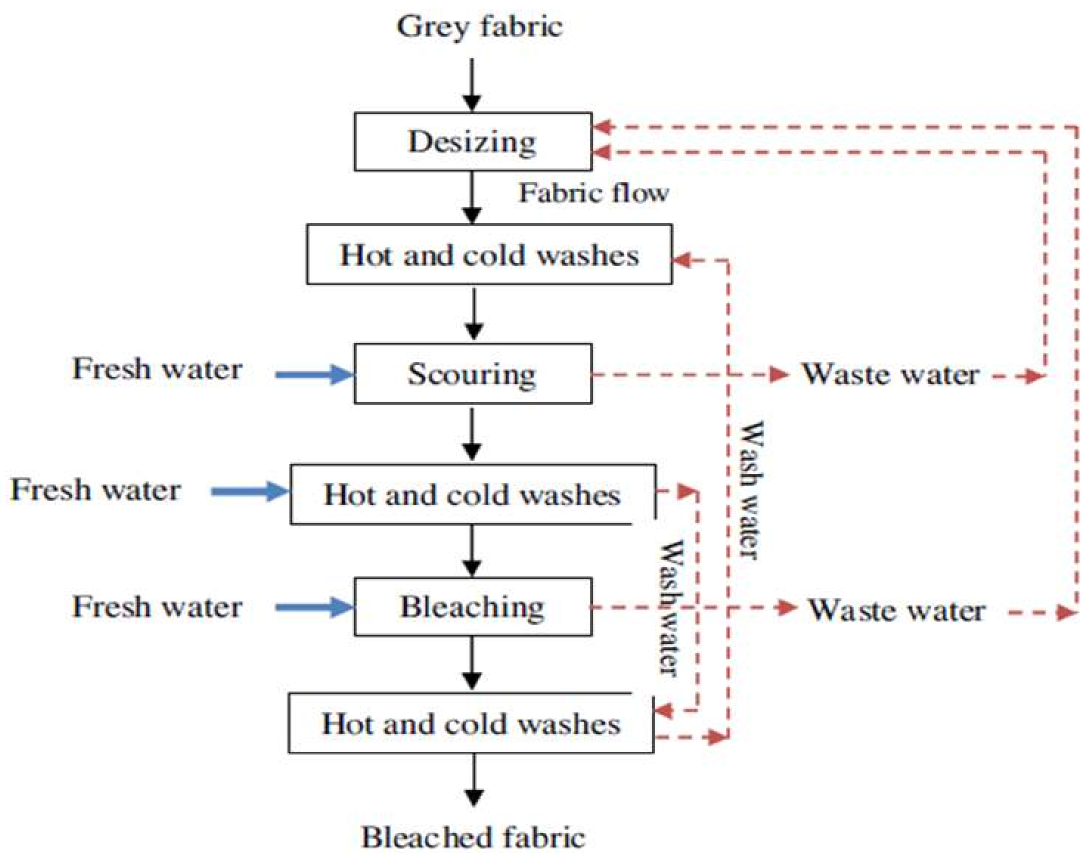

Figure: 2.1 Reusing of scouring and bleaching liquor for desizing a grey fabric

In the reuse method (Figure. 2.1), scouring and bleaching was carried out by using fresh water as per the conventional method. The unexhausted alkali and oxidizing agent in the scouring and bleaching wastewater respectively were reused to desize a new grey fabric (Rachana Harane 2017).

2.7.6. Reusing bleaching liquor

After the beaching process different tests are carried out for waste liquor. From the results of the tests it is observed that same liquor can be reused for several times. After carrying out of process 1, it is observed that the amount of liquor was decreased because of evaporation and water absorbed by fabric. So while reusing same bleaching liquor bath in process 2, hot wash liquor was added to replenish the amount of liquor to be used. Same liquor bath was used for eight times (N. P. Sonaje 2015).

2.7.7. Reusing of bleaching liquor for scouring

Mercerizing or bleaching rinse water can be used in scouring and desizing operations as long as size recovery is practiced. Generally, the caustic or bleach stream will degrade many size compounds to an extent that they cannot be recovered. The major factor providing the driving force for the recycle of bleaching rinse water to scouring is the economics of the process (Chougule 2014).

2.7.8. Reusing of washing water

A typical preparation department may also reuse wash water as follows:

- Reuse scour rinses for desizing,
- Reuse mercerize wash water for scouring,
- Reuse bleach wash water for desizing,
- Reuse water-jet loom wash water for desizing,
- Recycle kier drains to saturator (S. Balachandran 2008).

The most popular and successful strategy applied for reusing wash water is counter-current washing. The counter-current washing method is relatively straightforward and inexpensive. For both water and energy savings, counter-current washing is employed frequently on continuous preparation and dye ranges. Clean water enters at the final wash box and flows counter to the movement of the fabric through the wash boxes. With this method the least contaminated water from the final wash is reused for the next-to-last wash and so on until the water reaches the first wash stage, where it is finally discharged. Direct counter-current washing is now generally built into the process flow sheet of new textile mills. It is also easy to implement in existing mills where there is a synchronous processing operation. (Shaikh 2009).

2.7.9. Reuse of wash water for desizing, scouring and bleaching

Cotton and cotton blend preparation are performed using continuous or batch processes and usually are the largest water consumers in a mill. Continuous processes are much easier to adapt to wastewater recycling/reuse because the waste stream is continuous, shows fairly constant characteristics, and usually is easy to segregate from other waste streams.

Waste stream reuse in a typical bleach unit for polyester/cotton blend and 100% cotton fabrics would include recycling j-box and kier drain waste water to saturators, recycling continuous scour wash water to batch scouring, recycling washer water to equipment and facility cleaning, reusing scour rinses for desizing, reusing mercerizes wash water or bleach wash water for scouring.

Preparation chemicals, however, must be selected in such a way that reuse does not create quality problems such as spotting.

Batch scouring and bleaching are less easy to adapt to recycling of waste streams because streams occur intermittently and are not easily segregated. With appropriate holding tanks, however, bleach bath reuse can be practiced in a similar manner to dye bath reuse and several pieces of equipment are now available that has necessary holding tanks (k.Brita 2010).

2.7.10. Reusing of washing liquor for desizing

The effluent from the desize J-box can be used to make-up the desize mix. Wash water from the caustic washer can be reused in the desize washer. The caustic present in this water will enhance the removal of sizing chemicals. Batch operation processes do not easily allow for water recycling. When trying to reuse wastewater in batch operations, storage facilities for the reusable wastewater must be provided. Other problems associated with the reuse of wastewater from batch bleaching and scouring are the non-continuous character of the waste stream and the higher liquor ratios (Smith 1986).

2.8. Research gaps

Previous research works have showed opportunity of reusing textile waste liquor. However, the existing reusing methods of industrial pretreatment liquor are not as cheap as comparatively easily available fresh water (Ciardelli 2001). Few other methods to treat textile waste liquor are ion exchange, coagulation method, filtration, biological and Fenton process, enzymatic technique, electrochemical process, supercritical water oxidation, adsorption process (Brunner 2009)etc. However most of the reusing and recycling treatment techniques are not acceptable to most factories due to additional operational and maintenance cost. Hence the process mentioned in this project will be a comfortable choice to the industrialist. The present research work is a novel method showing the possibility of reusing textile pretreatment liquor or wash liquor for the desizing, scouring and bleaching of cotton goods. It is free from additional treatment cost but can reduce huge amount of chemical and freshwater to be consumed for the same purpose (Abu Shaid 2013).

CHAPTER THREE

3. MATERIALS AND METHODS

3.1. Materials

1. 100% cotton fabric.
2. Machines –jiggers
3. Laboratory equipment's – beakers, oven, thermometer, stirrer, spoons, electronics weighing balance, rotta beaker dyeing machine, launder-o-meter, rubbing fastness tester, burette, scissors, ruler, spectrophotometer, light cabinet (color matching booth), and digital pH meter.
4. Chemicals – hydrogen per oxide, caustic soda, stabilizer, wetting agent, optical brightening agents, acetic acid, sequestering agent, iodine solution, phenolphthalein indicator, Sulphuric acid, hydrochloric acid, common salt, soda ash, potassium per manganet, binder, thickener, emulsifier,

3.2. Methods

3.2.1. Method -1

1. Collecting the drain out pretreatment bath from jiggers after six ends.
2. Analyzing chemicals concentration of hydrogen per oxide (H_2O_2) and caustic soda (NaOH) by titration method.

Analyzing of Hydrogen peroxide (H_2O_2)

Standard concentration of H_2O_2which we are using in our factory is 50%, and its molecular weight is 34.0147.

Procedure:

10 ml of sample solution is diluted to 1000 ml with distilled water. From this, 10 ml of solution is pipetted out into a conical flask and 10 ml of 10% sulfuric acid is

added to it. This solution is then titrated against 0.1N potassium permanganate ($KMnO_4$) till pink colour of permanganate solution persists.

Reaction

$5H_2O_2 + KMnO_4 + 3H_2SO_4$------> $K_2SO_4 + 2MnSO_4 + 8H_2O + 5O_2$

1 ml of 0.1 N $KMnO_4$ = 0.0017 g H_2O_2

$$\text{Strength of } H_2O_2 = \text{Burette Reading x Normality of } KMnO_4 \text{ x } \frac{\text{Eq. Wt. of } H_2O_2}{1000} \text{x} \frac{1000}{10} \text{x} \frac{100}{10}$$

Strength of H_2O_2 = Burette reading x 1.7

Analyzing of Sodium hydroxide (NaOH)

We are using flake caustic soda which has standard strength about 98% and molecular weight is 40. It rapidly absorbs water and carbon dioxide from air and is very corrosive to animal and vegetable tissues.

Purity of flakes

2 gm. of the sample is accurately weighed in a weighing bottle and dissolved in distilled water and made up to 500 ml in a volumetric flask. 10 ml of this solution is pipetted with the help of a volumetric pipette and transferred in to a conical flask. 2-3 drops of phenolphthalein indicator is added in to it and titrated against (N/10) HCl using phenolphthalein as indicator, till the pink colour is discharged.

1 ml (N/10) HCl = 0.0040 gm. NaOH

$$\% \text{ Purity} = \frac{\text{Burette reading} \times \text{Equivalent weight}}{4} = \frac{X \times 40}{4} = 10\text{ X}$$

Chemical Reaction

$$NaOH + HCl \longrightarrow NaCl + H_2O$$

3. Replenishing the drain bath by adding measured amounts of H_2O_2, caustic soda, stabilizer and wetting agent based on the titration results of caustic soda and H_2O_2 concentration.

4. Doing combined pretreatment of cotton fabric with the replenished water.
5. Checking and comparing the treated fabric parameters with the conventional treated fabric.
6. Collecting the drain out bath for the second time and repeating procedure 2, 3 and 4.
7. The above procedure will be repeated up to three or four times depending on the concentration of chemicals in the drain bath.

3.2.2. Method - 2

To avoid and minimize contamination of the fabric by the degraded starch and other impurities in the used liquor, it is better to mix used liquor and fresh water in different proportions. These mixing with fresh water can be used for full bleached fabric rather than printed. So the following three blends of used and fresh water are used.

1. Mixing 70% used water and 30% fresh water,
2. Mixing 50 % used water and 50 % fresh water,
3. Mixing 30 % used water and 70 % fresh water.

The chemical concentrations are already analyzed in the above method one. In method two it is directly tried in the bulk production including 100 % used water. Finally as in the case of method 1, all necessary fabric parameters are checked and compared with the conventional treated fabrics.

The following fabric parameters should be tested after pretreatment.

a) Absorbency test

The fabric absorbency should be checked by the following three methods such as, water drop test, wicking height and sinking time test.

i) Drop test

For drop test, AATCC/ASTM Test Method TS-018 is used. This test method is designed to measure the water absorbency of textiles by measuring the time it takes a drop of water placed on the fabric surface to be completely absorbed into the fabric.

- Sample is placed over the top of a beaker so that the center is unsupported
- A measured drop of water is placed on the fabric 1 cm from the surface
- Time is recorded until the water drop absorbs completely.

ii) Wicking height test

For the wicking height test, AATCC Test Method 197, vertical wicking of textiles is used. This test method is used to evaluate the ability of vertically aligned fabric specimens to transport liquid along and/or through them, and is applicable to woven, knitted, or nonwoven fabrics. This test method measures distance at a given time. The sample should be conditioned in atmospheric conditions.

iii) Sinking time test

Sinking time test can be tested by AATCC Test Method 17-1994. In this test, specimens of 1 cm X 1 cm were cut at random and place on the surface of water. Slowly the fabric samples were wetted and entrapped air was removed. The time taken by the fabric samples to go inside water from floating state and sank in completely was noted down. The shorter the time taken by the specimen to sink in water completely, the greater is its absorbency.

b) Assessment of desizing efficiency

Desizing efficiency can be checked by weight loss or by residual starch by TEGEWA rating test. The weight loss is of the order of 7-10%. The more scientific method, which is used industrially also, is TEGEWA rating test.

i) Residual starch by TEGEWA rating test

It is a scale, which consists of colors ranging from violet to white as given below.

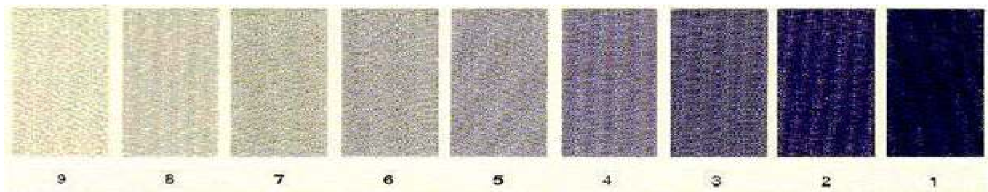

Figure: 3.1 TEGEWA scale rating

Reagent preparation

1. Ten gram (10 g) potassium iodide (KI,100%) is dissolved in 100 ml of water
2. To the solution, 0.6358 g of iodine (100%) is added
3. The mixture is stirred well until iodine is completely dissolved in the KI solution.
4. To the solution, 800 ml of ethanol is added
5. The volume is to 1000 ml by adding water

Method of testing

One or two drops of the above solution are put on the desized fabric and rubbed gently. The fabric should be cold and free from any residual alkalinity. In a short time the color of the spotted area changes. The change in color is assessed with TEGEWA scale visually.

Assessment

- ✓ No Color Change = No starch is present
- ✓ Pale blue to bluish violet = Presence of starch size or a blend of starch + synthetic size
- ✓ Brown = Presence of modified starch or a blend of starch/PVA size

c) **Whiteness and yellowness index**

Whiteness index

The whiteness index can be checked as per CIE standard method. The CIE Whiteness Index value (CIE WI) will be determined for the bleached fabric using AATCC test method. The whiteness must be measured using a spectrophotometer, illuminants D-65, day light and TL84.

$$W_{\mathrm{CIE}} = Y + 800(xn - x) + 1700(yn - y)$$

Where Y is the Y-tristimulus value of the sample, x and y are the x, y chromaticity coordinates of the sample. And x_n, y_n the chromaticity coordinates of the perfect diffuser for the CIE 1994 standard colorimetric at 2^{o}observer.

Yellowness index

Yellowness index as per ASTM method E313 is calculated as follows:

$$YIE313 = \frac{100(CxX - CzZ)}{Y}$$

Where X, Y and Z are the CIE tristimulus values and the coefficients depend on the illuminants and observer as indicated in the table below. Yellowness index may only be calculated for illuminants D65 and C.

Coefficient	C/2^o	D65/2^o	C/10^o	D65/10^o
C_x	1.2769	1.2985	1.2871	1.3013
C_z	1.0592	1.1335	1.0781	1.1498

3.2.3. Dyeing

To see the effect of the above results on the dyeing behavior, reactive dyeing has been done by using bezactive blue HP – R. Dyeing was done by 1% (owf) shade for all treated fabrics. As the dye supplier recommends, the dyeing is done by exhaust dyeing method at 60 ^{o}c for 60 minutes. After dyeing is over the following dyeing parameters has been tested: color strength (K/S) value, color difference (ΔE), percent reflectance, Wash fastness, rubbing fastness, Light fastness.

1) Measurement of Color Strength

The color yield of dyed samples can be evaluated by light reflectance measurements using spectrophotometer machine. The color strength (K/S value) are assessed using the Kubelka-Munk equation $K/S= (1-R)^2/2R$. Where K is the sorption coefficient, R is the reflectance of the dyed fabric and S is the scattering coefficient. K/S is a color value dependent on the light absorption of the dyed fabric at maximum absorption wavelength and is associated with the reflectance of the dyed fabric. K/S value is of primary importance in the discussion of the strength of a dyeing and higher values represent darker and more saturated colors.

2) Color difference measurement (ΔE)

The assessment of the color difference (ΔE) is made by comparison between two colors. One is chosen as the standard which is conventional treated fabric in this case (or target) and the other one is chosen as the sample.

3) Washing fastness testing

In the test, change in color of the textile and also staining of color on the adjacent fabric has been assessed. A 10 x 4 cm swatch of the coloured fabric should be taken and is sandwiched between two adjacent fabrics and stitched, the sample and the adjacent fabric are washed together. Five different types of washing are specified as different washing methods. But test method 3, IS: 764:79 is used. The solution for washing should be prepared to the required temperature of washing. The liquor to material ratio is 50:1. After soaping treatment, remove the specimen, rinse twice in cold water and then in running cold water under a tap. Squeeze it and air dry at a temperature not exceeding 60°C. The change in color and staining is evaluated with the help of grey scales.

4) Rubbing fastness testing

For rubbing fastness testing, AATCC Test Method 8 is used. The scope of the test determines the amount of color transferred from the surface of colored textile material to other surfaces by rubbing.

- Sample is placed on crock-meter
- A 100% cotton white fabric cloth is rubbed across the sample 10 times in the wet and dry state
- The cotton cloth is evaluated for staining

5) Light fastness testing

For light fastness testing was used AATCC Test Method 16 - Option 3. This method is the general principles and procedures which are currently in use for determining the colorfastness to light of textile materials.

- Sample is placed in a testing mask with part of the sample exposed and part covered as a control
- The testing mask is loaded in a weather-o-meter holder and placed in a rack in the weather-o-meter for exposure
- Sample is exposed to a customer requested amount of AATCC fading units (hours)
- Color change of the sample is evaluated

CHAPTER FOUR

4. RESULT AND DISCUSSION

4.1. Results

4.1.1. Chemical analysis

In Bahir Dar Textile Share Company wet processing section, combined pretreatment is done by different jiggers and pad roll bleaching machine. The chemical recipes which are used in jiggers are as follows:

- 50 % concentrated H2O2 – 5gpl
- Flake caustic soda (NaOH) – 4gpl
- Stabilizer – 1g/l
- Wetting agent – 1gpl
- Optical brightener – 0.6gpl

This project work is done based on the above recipe and the replenished fabric parameters are compared by considering the fabric which is treated with those recipes as conventional fabric. With these chemicals, the fabric was run for 6 ends at 90 ^{o}c on jiggers.

The residual liquor after 6 ends were collected and analyzed for two main chemicals, hydrogen per oxide (H_2O_2) and caustic soda (NaOH) concentration by titration method. The following results in table 4.1 are found.

Table: 4.1$H_2O_2$and NaOH analysis results;

Parameters	1^{st} analysis	2^{nd} analysis	3^{rd} analysis	4^{th} analysis	Average
pH	10.20	11.60	12.05	11.30	11.29
Amount of H_2O_2 in (g/L).	1.64	1.40	1.62	1.66	1.58
Replenished H_2O_2 amount out of 5 (g/L)	3.36	3.60	3.38	3.34	3.42
Amount of NaOH in (g/L)	0.80	1.48	2.04	2.12	1.61

Replenished NaOH amount out of 4gpl (g/L)	3.20	2.52	1.96	1.88	2.39

As we see in table 4.1, out of 5 g/l H_2O_2 and 4 g/l NaOH 1.58 g/l and 1.61 g/l respectively can be recovered and reused in a single jigger treatment. The pH is in the acceptable range for of oxidative bleaching that is around 11.30. The replenishing treatment is done based on the analysis results. The recovered amount will be increased when the conventional chemical recipe increases. When these are converted into percentage31.6 % H_2O_2 and 40.3 % NaOH can be recover.

The first analysis is done with the liquor after the conventional pretreatment is over and second analysis is also done with the liquor after first analysis is over, third and fourth analysis are also done from second and third liquor respectively. Above fourth analysis it is impossible because more than 90 % of the water is consumed in replenishing one up to four.

4.1.2. Pretreatment parameters

Without replacing water by adding the above measured chemicals, combined pretreatment is done up to four times in the laboratory scale. The following pretreated fabric parameters are tested.

- Absorbency
  - Drop test
  - Sinking time test
  - Capillary rise test
- Residual starch by tegawa rating test method
- Whiteness index
- Yellowness index

Table: 4.2 Pretreatment test results;

Parameters	**Conv.**	**1st repl.**	**2nd repl.**	**3rd repl.**	**4th repl.**	**Average**
Drop test	< 5	< 5	< 5	< 5	< 5	<5

(second)						
Sinking time test (second)	6.5	6.4	6.2	7.5	6	6.5
Wicking height test (cm)	7.9	6.5	6.3	9.5	8	7.6
Residual starch (tegawa rating)	8	5	5	6	6	5.5

The results show that there is no significant difference between the conventional one and the replenished results and pretreatment is acceptable. The drop test results of all samples are less than five seconds. The sinking time test for the conventional and the average values of the replenished is similar. The tegawa rating results shows 8 for the conventional and 5.5 for the replenished, the difference is because of residual starch present in used liquor. So, it can be used for full bleaching, dyeing and printing purpose.

Whiteness and yellowness index are also tested at 2^{o} observer under D65, daylight and TL84 light sources using color eye spectrophotometer.

Table: 4.3Whiteness and yellowness index value;

Samples	**Light sources**	**Conv.**	**1st repl.**	**2nd repl.**	**3rd repl.**	**4th repl.**	**Average**
Whiteness index	D65	140.09	129.19	136.34	143.91	133.16	135.65
	TL84	136.30	126.65	132.76	140.16	129.48	132.26
	Daylight	141.89	130.38	138.12	145.67	134.85	137.25
Yellowness index	D65	-26.45	-25.29	-26.15	-29.37	-25.20	-26.50
	TL84	-33.55	-32.82	-33.55	-37.52	-31.96	-33.96
	Daylight	-26.66	-25.22	-26.35	-29.52	-25.37	-26.62

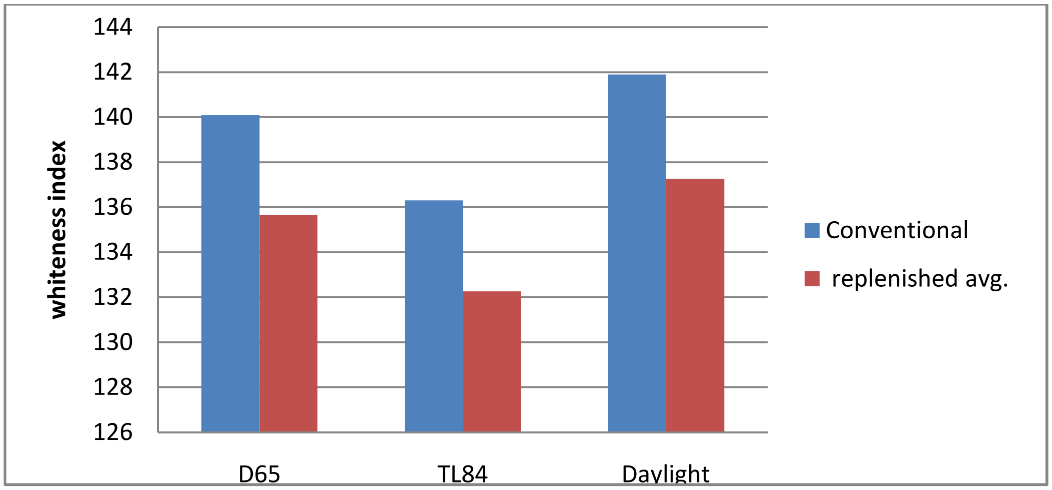

Figure: 4.1.Whiteness index of laboratory treated fabrics

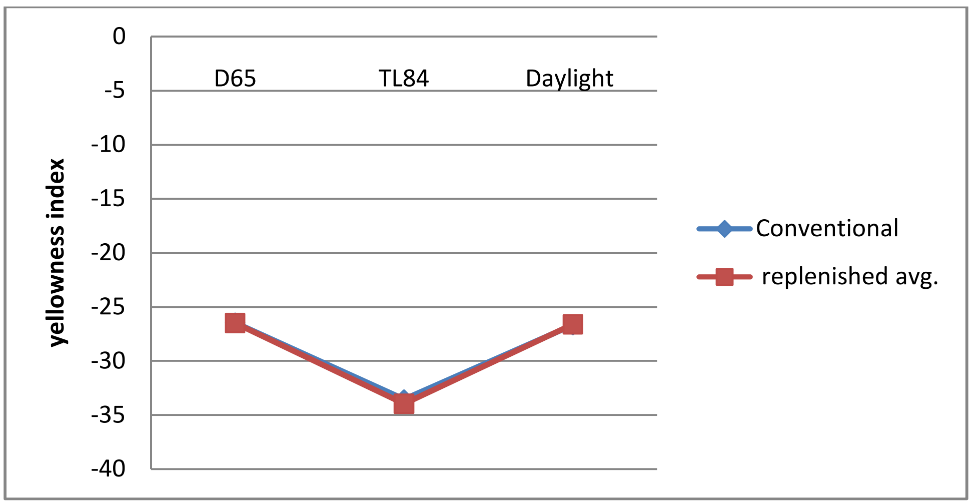

Figure: 4.2.Yellowness index of laboratory treated fabrics

As it is shown from the table 4.3 and graphs the conventional and the replenished average values are within the acceptable range. When we take daylight light source, the whiteness index is 141.89 and 137.25 for both conventional and replenished respectively. The yellowness index value is negative which shows the whiteness index is higher and as whiteness index increases yellowness index decreases. The differences of yellowness index between conventional and replenished average graphs of two samples are almost over lapped, which means, the difference is insignificant.

4.1.3. Evaluating of dyeing performance

The dyeing performance of treated samples is evaluated with similar shade and dyestuff. Dyeing have also been done all the above pretreated fabrics by using, Bezactive blue HP-R 1% owf. After dyeing is over, then the following dyeing parameters tested:

- Washing fastness,
- Rubbing fastness
- Color strength
- Color difference

Table: 4.4 Dyeing parameter test results;

Parameters	**Conv.**	**1st repl.**	**2nd repl.**	**3rd repl.**	**4th repl.**
Washing fastness	4/4	4/4	4/4	4/4	4/4
Dry rubbing fastness	5	5	5	5	5
Wet rubbing fastness	4	4	4	4	4

The fastness properties of both the conventional and replenished samples have good results as it is shown the grey scale in table 4.4. The washing fastness results of both staining and fading rating shows 4 and dry and wet rubbing values are 5 and 4 respectively for both conventional and replenished average. There is no difference between them, so it is fully acceptable.

Bezactive blue HP-R dyed samples K/S value (color strength), % reflectance and color difference values are tested at 2^o observer and under D65, TL84 and daylight light source by using spectrophotometer. Maximum results are found at 620nm wave length and all readings except K/S value and percent reflectance and comparison is done under this wave length.

Table: 4.5 K/S value, % reflectance and color difference of the dyed samples;

Samples	**Light sources**	**Conv.**	**1st repl.**	**2nd repl.**	**3rd repl.**	**4th repl.**	**Ave.**
K/S value		3.6921	3.4304	3.3052	3.4342	3.6149	3.4462
% reflectance value		10.78	11.44	11.78	11.43	10.97	11.41
Color difference	D65		1.82	2.31	2.05	1.63	1.95
	TL84		1.61	2.02	1.81	1.48	1.73
	Daylight		1.88	2.325	2.06	1.655	1.98

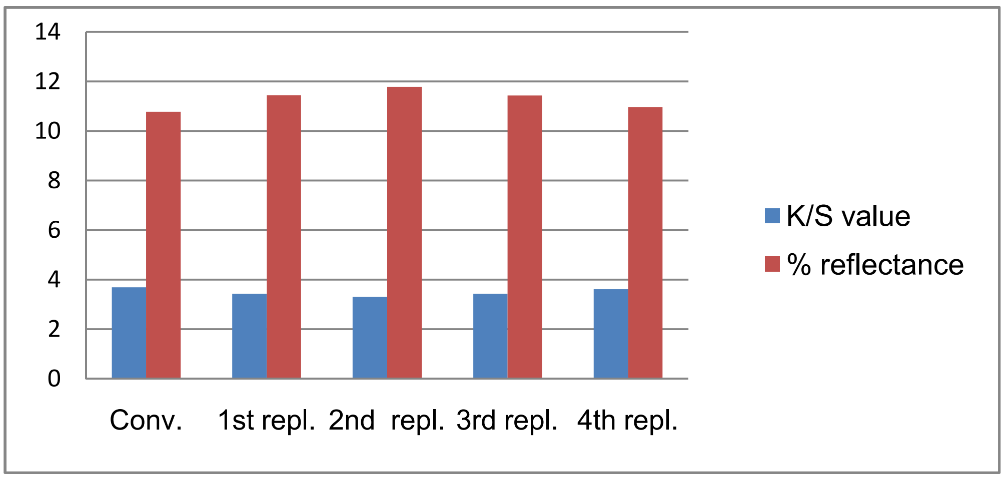

Figure: 4.3. K/S value and % reflectance of the dyed samples

The results in table 4.5 and in figure 4.3 shows the measured results and comparison of the parameters. The graph in red color shows the percentage reflectance value. The conventional has 10.78 % and replenished average is about 11.41 % it shows a little bit difference, the reason is that, as the K/S value increases percent reflectance decreases. The K/S value is shown in blue color in figure 4.3. The maximum value is 3.6921 for the conventional and the replenished is about 3.4462. Color difference between conventional and replenished is also shown, which is less 2 under all light sources.

The laboratory results are not getting reproduced in bulk stage. The main reasons are:

1. Material to liquor ratio difference between laboratory tests and bulk. 1:20 MLR is used in laboratory, but at the bulk or in jiggers it is about 1:1.5.
2. Temperature and time have also an effect in reproducibility of bulk production.
3. For ready for dyeing fabric there must be desizing in a separate process before scouring, but in this factory, desizing is not done. The above all results can be reproduced by the soft flow machine. But in our factory, Bahir Dar Textile Share Company, only open width jiggers and pad roll bleaching machines are available.

Due to insufficient steam, pad roll bleaching machine is not working. Entire pretreatment is done by jumbo jiggers and old jiggers.

There is no dyeing order is carried out in the factory at present, only pigment printing is done on full bleached and ground fabric.

4.1.4. Bulk results

Keeping the laboratory results in mind and considering contamination of water because of decomposed starch present in liquor, the following experiments have been done on the mass production machines by using small jiggers. The drain water is collected on jumbo jiggers after chemicals ends over and pretreatment with the following combination has been done on the factory small jiggers. These old jiggers have the capacity of 300 liters of solution and can load about 135 kg of fabric. The replenished amount of chemicals in each blend is summarized in table 4.6.

- 100% used water by replenishing chemicals only,
- Mixing 50% fresh water and 50% used water,
- Mixing 30% fresh water and 70% used water,
- Mixing 70% fresh water and 30% used water,

Collecting liquor on jumbo jigger | Liquors ready for small jiggers | Processed on small jiggers

Figure: 4.4 Reusing jumbo jiggers' liquor for small jiggers after replenishment

In figure 4.4, it is shown that when collecting of the liquor from jumbo jigger and poured into the can which can carry about 100 liters of solution. The collected liquor has 1.6 g/l of H_2O_2 out of 5 g/l and 1.4 g/l of NaOH out of 4 g/l. the remaining amounts of chemicals and other auxiliary chemicals are added to make up the conventional recipe before using on small jiggers. Then as it is shown in the figure it has been processed and the parameters are evaluated and compared.

Table: 4.6 Replenished amounts of chemicals in the bulk trial;

Chemicals	**Conv.**	**100% used**	**70% used + 30% fresh**	**50% used + 50% fresh**	**30% used + 70% fresh**
H_2O_2 (gram)	1500	1020	1165	1260	1355
NaOH (gr)	1200	780	905	990	1075
Stabilizer (gr)	300	205	230	250	270
Wetting agent (gr)	300	300	300	300	300
OBA (gr)	180	180	180	180	180

The chemical amounts in table 4.6 are based on the recipe, H_2O_2 – 5g/l, NaOH – 4g/l, stabilizer – 20% of H_2O_2, wetting agent – 1g/l and OBA – 0.6g/l.

With these, after doing pretreatment on small jigger whiteness and yellowness index are checked and compared with the conventional with same chemical recipes. In addition to this, on the treated fabrics, pigment printing has been done with Bezaprint Blue BT pigment which is available and currently used in factories product and checking all round fastness, color strength, color difference and percent reflectance. This experimentation has fulfilled the requirements of the existing printing orders of the factory.

Table: 4.7 Whiteness and yellowness index value of the bulk product;

Samples	Light sources	Conv.	70 % fresh & 30 % used	50% fresh & 50% used	30% fresh & 70% used	100% used	Ave.
Whiteness index	D65	101.26	88.64	86.74	82.62	65.15	80.79
	Daylight	102.62	89.80	87.83	83.74	65.67	81.76
	S	99.13	87.50	85.86	81.76	65.85	80.24
Yellowness index	D65	-9.41	-4.63	-3.44	-2.88	4.22	-1.68
	Daylight	-9.71	-4.94	-3.74	-3.22	3.96	-1.99
	S	-9.90	-4.83	-3.56	-2.97	4.56	-1.70

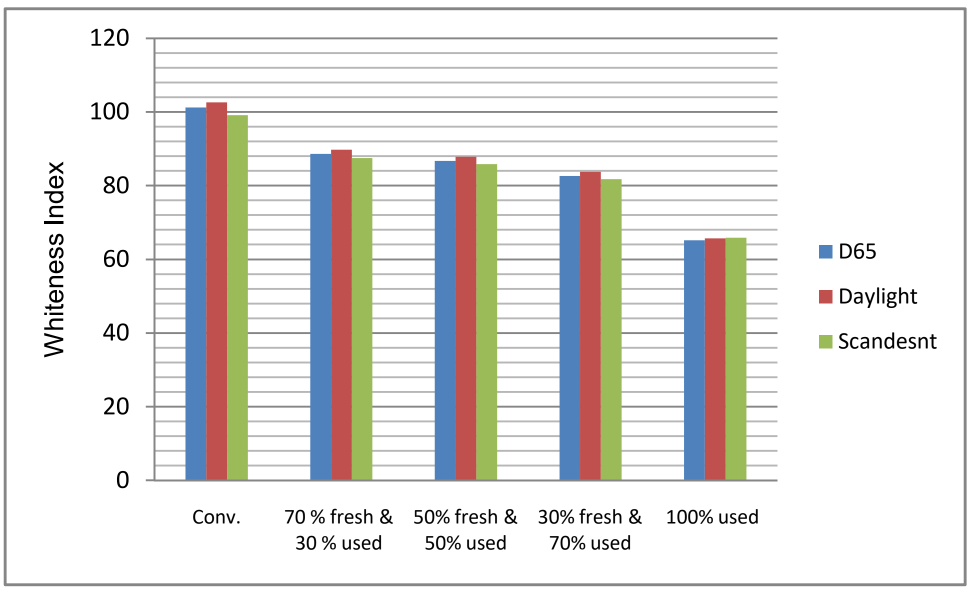

Figure: 4.5 Whiteness index of bulk samples

The whiteness and yellowness index values of the bulk samples are summarized in table 4.7 and in figure 4.5. As it is shown both in the graph and in the table, the whiteness index is decreasing and yellowness index is increasing from the conventional to fourth replenished. The reason for this decrement is that decomposed starches in the used liquor are reacting with per oxide. Even if the results decreased, the variation is not too much and it can be used for printing, grounding and off-white fabric. To make more white fabric per oxide amount must be increased to compensate the reaction.

Bezaprint Blue BT pigment printed samples K/S value (color strength); % reflectance and color difference values are tested at 10° observer and under D65, day light and scan descent light sources. Maximum results are found at 600nm wave length. And all reading is taken in this wave length.

Table: 4.8 K/S value, % reflectance and color difference of the printed samples

Samples	**Light sources**	**Conv.**	**1st repl.**	**2nd repl.**	**3rd repl.**	**4th repl.**	**Ave.**
K/S value		4.8104	4.5701	4.5701	4.7003	4.5221	4.5907
% reflectance value		8.67	9.05	9.05	8.84	9.13	9.02
Color difference	D65		0.77	1.01	1.29	1.62	1.17
	Daylight		0.78	1.00	1.33	1.54	1.16
	Scand sent		0.80	1.06	1.28	1.65	1.20

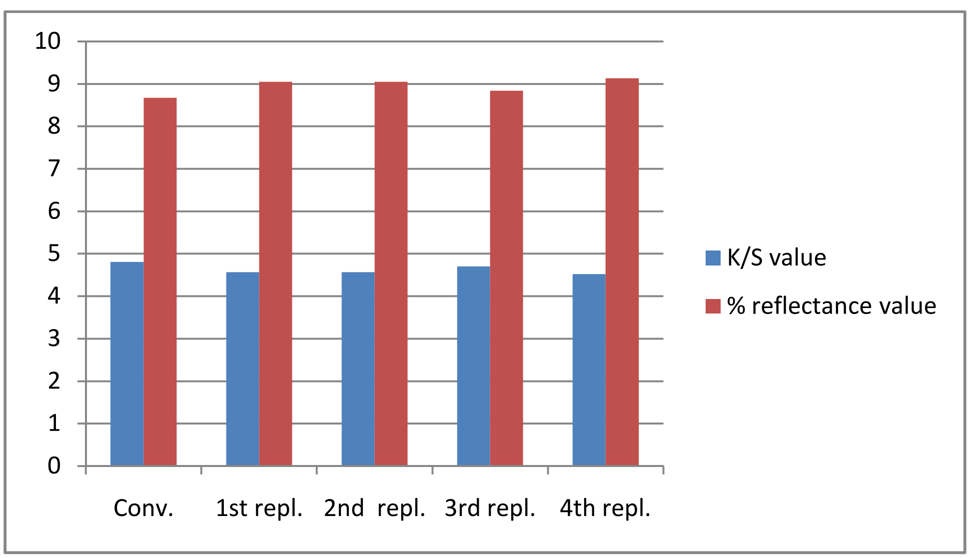

Figure 4.6 K/S and % reflectance value of printed products

The K/S values of the printed samples show that very minor variation between conventional and replenished. It is 4.801 for the reference and 4.5907 for the replenished average. The reflectance shows a little increment, but the difference is less than unity. The color difference is almost around 1.1 under three light sources.

Table: 4.9 Pigment printing parameter test results of the bulk product;

Parameters	**Conv.**	**100% used water**	**50% used & 50% fresh**	**70% used & 30% fresh**	**30% used &70% fresh**
Washing fastness	4/4	4/4	4/4	4/4	4/4
Dry rubbing fastness	4	4	4	4	4
Wet rubbing fastness	3	3	3	3	3

The fastness properties of the printed samples are within acceptable range based on gray scale value. Both staining and fading of washing fastness it 4; dry rubbing and wet rubbing staining values have 4 and 3 respectively. The fading value for rubbing fastness is difficult to give rating because the area to be analyzed is very small.

4.1.5. Cost benefit analysis

The cost analysis is focusing on H_2O_2 and NaOH chemicals, raw water and waste water treatment chemicals and water saving by itself. The factory has two big jiggers which have 1000 liters capacity. Raw water and waste water treatments are using different chemicals, so analyzing those chemicals should be very essential. Two doffs can be done in each jigger in a shift or in 8 hrs. In each doff 300 – 400 liters of chemical carrying liquor is drain out. By collecting three doff chemicals, we can use or replenish again for a single doff. The cost benefit analysis can be done in the following way.

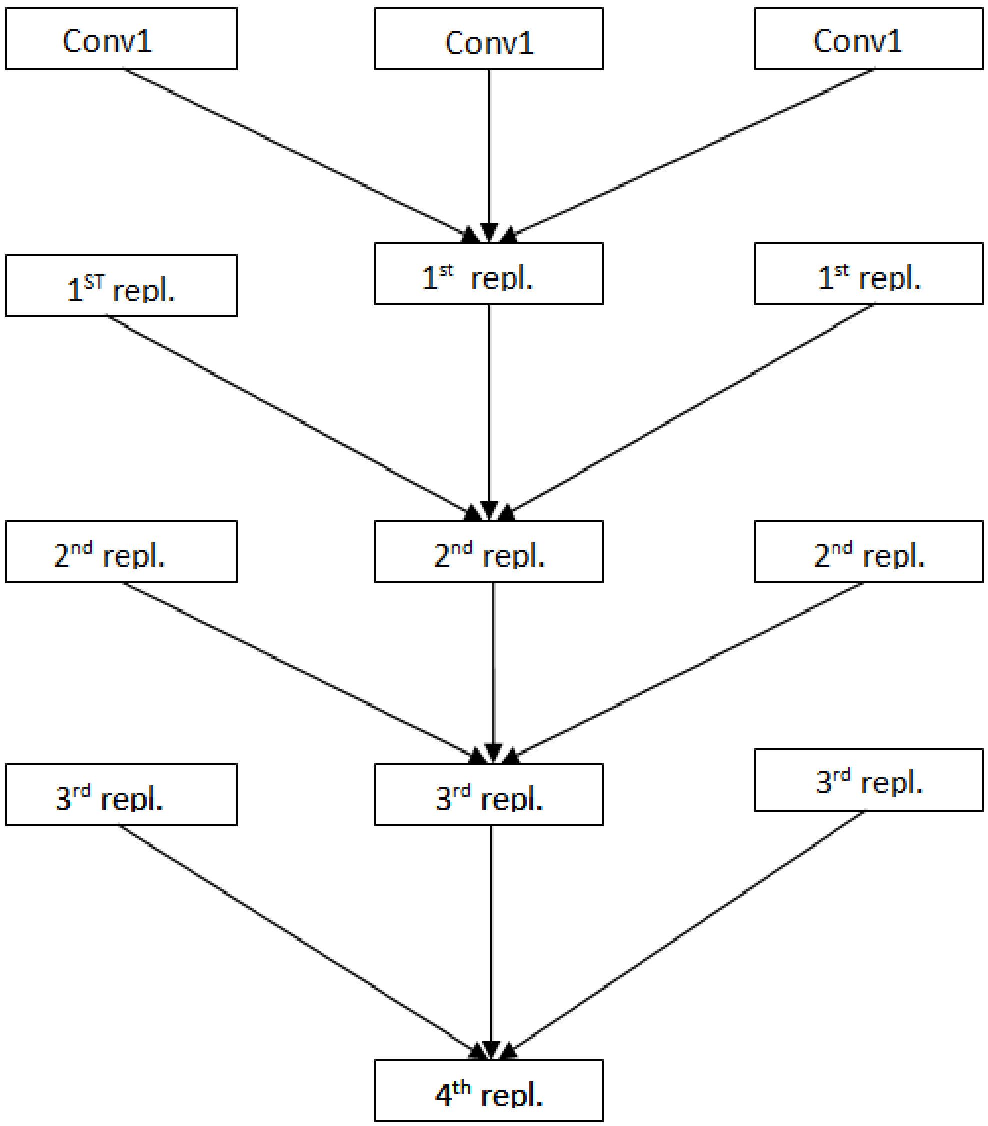

Figure: 4.7 Number of replenishment in each step;

Table: 4.10 Repetition of replenishment in a month;

Days in a month	Conv.	1st repl.	2nd repl.	3rd repl.	4th repl.(for small jigger)
1	8				

2	8				
3	8				
4		8			
5	5		3		
6	7			1	
7	8				1
8	1	7			
9	6		2		
10	8				
11	3	5			
12	5		2	1	
13	8				1
14	3	5			
15	6		2		
16	8				
17	2	6			
18	6		2		
19	7			1	
20	3	5			1
21	6		2		
22	8				
23	2	6			
24	6		2		
25	7			1	
26	3	5			1
27	6		2		
28	8				
29	2	6			
30	6		2		
31	7			1	1

Total doffs/month	171	53	19	5	

Table 4.10 shows that eight doffs can be done per day by two jiggers. Within 8 doffs, 2400 – 3200 liters of liquor can be collected and replenished for the first time. The collected liquor cannot be stored more than three days, because the residual per oxide will be decomposed. Second, third and fourth replenishment can be done with the same manner.

Cost saved by pretreatment chemicals

Table: 4.11 amount of money saved from chemicals per month and per year;

Saved amount per month	**R1**	**R2**	**R3**	**R4 (for small jigger)**	**Total**
Left liquor (liters)	51300	15900	5700	1500	
Amount of H_2O_2 reused (kg)	82.1	25.4	9.1	2.4	119
Amount of NaOH reused (kg)	71.8	22.3	8	2.1	104.2

Cost saved from raw water treatment chemicals

The factory is using its raw water for different purposes, machines and in different amounts. Among these, the water which is used for jiggers and washing machine can be reused. Those three machines water are used for recycling purpose. In jiggers there are three steps which are using plenty of water, i.e. chemical washing, hot washing and cold rinsing. In case of washing machine, the water flow rate is 40 liters per minute in counter current washing system. How much water can be saved by each machine in each step is shown in the table 4.12 below.

Table: 4.12 Water saved by machines/Day

Process	**Jumbo jigger recovered water(l)**	**Old jigger recovered water(l)**	**Washin g m/c**	**Sum**
Chemical treatment	4800	1800		6600

Hot washing	8400	3600	38400	50400
Cold washing	8400	3600		12000
Total	21600	9000		69000

As we see in table 4.12, 21.6m^3 of water from jumbo jiggers, 9m^3 of water from old jiggers and 38.4m^3 of water from washing machine, total 69 m^3 of water can be saved and reused per day.

Bahir Dar Textile Share Company is using Abay River for raw water for pretreatment purpose. Aluminum sulfate and calcium hydroxide chemicals are used for this water treatment. Around 36 m^3 of water per hour can be feed to the factory. 21 and 42 kilo gram of aluminum sulfate and calcium hydroxide are used per day respectively to treat the water. The cost analysis of the two chemicals is shown in table 4.13.

Table: 4.13 Cost saved from raw water treatment chemicals.

Chemicals	**Amount /day**	**Water feed to finishing/day(m^3)**	**Water saved by jiggers and washing/day(m^3)**	**Saved chem./ day**	**Saved chem./ year**
Aluminum sulfate(kg)	21	864	69	1.68	591.4
Calcium hydroxide (kg)	42			3.35	1179.2

Waste water from all directions of the factory is drain into the central ETP. This water has been passed different waste treatment steps with different chemicals. About 9m^3/hr of treated water is drained into Abay River. As mentioned above there is a possibility of saving and reusing 69m^3 of water per day and this much amount can be reduced getting into ETP. The ETP is using poly aluminum chloride, aluminum sulfate, anionic organic polymer and sulfuric acid for waste water treatment as shown in table 4.14.

Table: 4.14 Cost saved from waste water treatment chemicals.

Chemicals	**Amount /day (kg)**	**Water drained to ETP/day(m^3)**	**Water saved by recycling/day (m^3)**	**Chem. Saved/ day (kg)**	**Chem. Saved/ year (kg)**

Poly aluminum chloride	16	216	69	5.1	1795.2
Aluminum sulfate	1.4			0.45	158.4
Anionic organic polymer	1			0.32	112.6
Sulfuric acid	0.67			0.21	75.3

CHAPTER FIVE

5. CONCLUSION

Based on the results and discussion in the early section, it can be summarized that pretreatment liquor and wash liquor can be reused in the pretreatment process of textiles instead of fresh water. The pretreatment liquor and wash liquor can safely be reused after replenishing with measured amounts of H_2O_2, NaOH and other auxiliary chemicals based on the analysis results for the scouring-bleaching purpose of next batch with satisfactory bleaching, printing and dyeing performance.

The effectiveness of this reusing have been checked in laboratory scale and on mass production for full bleached, printed and dyed products of the factory. The full bleached fabric whiteness shows little inferior than the fresh water. The reason is that H_2O_2 in the replenishing treatment acts on the residual starch instead of bleaching. Considering this the whiteness can be improved by adding more peroxide than the conventional. But for printing and dyeing products it is fully accepted. If extra white fabric is required, by blending used and fresh water with different proportion is also done both in lab and bulk stage and an acceptable product have been produced.

As a result, the reuse of pretreatment liquor ensures saving of a lot of chemicals consumption, water consumption as well as reduce waste water discharge and effluent load and the reuse of wash liquor ensures the consumption of huge amount of fresh water.

Therefore, it is recommended that Bahir Dar Textile Share Company should investigate of their own pretreatment liquor and wash liquor, collect and reuse it in combine pretreatment process and after that the current orders of the factory, such as full bleached, half bleached, printed and dyed with different shades can be done.

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