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Recycle and Reuse of Textile Waste Liquor fromScouring and Bleaching of Cotton Shakti Prasad Jena ^{1*}, Bharat Behera ²

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Abstract- The global problem of environmental pollution has a negative impact on all living things. One of the main areas of concern for the entire planet is it. Desizing, scouring, and bleaching are the key steps involved in preparing cotton woven fabric for dyeing. Each operation releases a variety of compounds into the effluent stream along with water. The environmental damage caused by the chemicals emitted by the worldwide textile industry is unthinkable. The goal of this study is to find ways to reuse and recycle chemicals and water without adding any further treatment to prevent pollution.

Keywords: scouring, recycled, pretreatment.

I. Introduction

ndustrialization has brought ease, comfort, luxury,and prosperity to our modern life. Wet processing industry uses vast amounts of water, energy, and chemicals. At the same time, it has also createdproblems for us. Two issues of concern today areenvironmental pollution by industrial wastegenerated the during manufacturing activities, and the otheris the endangerment of the health and safety of the userof the industrial products. There are two approaches, tocombat the menace of environmental pollution by liquidwaste from the dye house/print works. One is theoperation of Effluent Treatment Plant to control thepollution and the other is to prevent the pollution. The

U.S. Environmental Protection Agency defines pollution prevention (also referred to as source reduction) as the use of materials, processes, or practices that reduce or eliminates the generation of pollutants or wastes at the source. Pollution prevention minimizes water pollution, land, and air. It is a source reduction and other practices that reduce or eliminate the creation of pollutants through increased efficiency in the use of raw material, energy, water or other natural sources or protecting resources through conservation. Reducing the volume of effluent released through the prevention of pollution can be accomplished by conservation and more efficient use of resources. Pollution prevention is accomplished through many ways such as:

- Good housekeeping and maintenance.
- Substitution of chemicals.
- Process modification and technology through the selection of clean/green technology.

- Recycle, Reuse and Recovery.
- Modification of machinery, equipment optimization of processes, dyes, chemicals, and water [8].

Moreover, Pollution prevention is more than just another way of reducing pollution. Pollution prevention is a philosophy. Such a philosophy does not accept "that is how we always did it" as a rationale for maintaining a policy or practice [3].

Pollution prevention may result in several benefits for the textile processor, these includes:

- Loss Reduction.
- Decreased Waste Collection.
- Decreased Handling and Disposal Cost.
- Reduction of Chemical, Water and Energy Consumption, thereby resulting in savings, sometimes even increased production.
- Improve Compliance with Regulations.
- Improve Employee morale and Participation.

Textile pre-treatment involves desizing, scouring and bleaching process. Desizing is a process of removal of starch from the woven fabric. Scouring removes the natural (oil, wax, gum, fat etc) impurities. Bleaching destructs the natural color from the textile material. Each process drains a plethora of chemicals along with water, in the effluent stream. Pollutants released by the global textile industry are continuously doing unimaginable harm to the environment. It pollutes land and makes them useless and barren in the long run [2, 3]. Table 1.1 - Water usage and pollution loads in cotton pretreatment processes [7]

| Pre- treatment Process | Water Usage (l/kg) | Water Usage (%) | Approx BOD (mg/l) | BOD (%) | Pollution Load (%) |
|------------------------------|--------------------------|-----------------------|-------------------------|------------|-----------------------|
| Desizing | 20 | 5 | 4500 | 22 | >50 |
| Scouring | 4 | 1 | 11000 | 54 | 10-25 |
| Bleaching | 180 | 46 | 1000 | 5 | 3 |

The main work of this research is to recycle and reuse the water and chemicals of the textile pre- treatment process. Recycle means utilization of previously used process liquor one or more times/purpose whereas reuse can be defined as the utilization of used process liquor for another purpose.

II. Literature Review

a) Cotton

Cotton is nature's most abundant polymer. It is an organic cellulosic compound which is a kind of polysaccharide. Cotton is the backbone of the world's textile trade. In the world cotton fiber has many qualities and countless end uses. Cotton mill consumption estimated around 24.3 million tones which are 45% of total world fiber production in 2015 [1]. It is a soft fiber of genus Gossypium. The cotton plant belongs to the natural order of the MALVACEAE. The cellulose polymers in cotton fiber have high degree of polymerization. The DP (Degree of polymerization) of cellulose molecule is high. It ranges as 10000 [1, 2].

b) Fibre Morphology

Cotton is the important fiber in today's textile industry. The major use of cottonis to make the garments for over 5000 years before, so knowledge of the structural features of these cellulose substrates is essential for analyzing the effects of physical and chemical properties. Cotton fibers have a fibrillar structure. Their morphology, illustrated schematically in below figure, exhibits four main features: cuticle, primary wall, secondary wall, and lumen.

Cotton consists of cellulosic and non-cellulosic material; the primary wall has a network of cellulose fibrils covered with the outer most layer cuticle, covered

waxes, and proteins. It serves as a smooth, water- resistant coating, which protects the fiber. The outer cell wall is relatively hydrophobic.

The wax renders the fiber impermeable to water and aqueous solutions unless a wetting agent is present. Cuticle layer surrounded by a primary wall, built of cellulose, pectin, waxes and protein material. The inner part of the cotton fiber comprises of the secondary part, subdivided into several layers of parallel cellulose fibrils and the lumen. The secondary wall consists of several layers and the spiral angle of the fibrils varies from one layer to the next, from about 20° to 35° . The lumen, the cavity that may remain after the protoplasm in the cell interior has proteins, coloring matter and minerals deposited on its walls. The smallest unit of the fibrils consists of densely packed bundles of cellulose chains [6, 9].

The hydroxyl groups OH protruding from the sides of the molecule chain link neighboring chains together by the hydrogen bond and form ribbon-like micro-fibrils which arranges into larger building blocks of the fiber [2].

It is very laborious to give a precise value for the degree of polymerization (n) of cotton. The DP of cellulose varies with itsorigin and is expressed as an average value, since a distribution found in most samples. The degree of polymerization of cellulose molecule may be as high as 10000 [4].

III. Methodology

a) Process Flow Chart



Fig. 3.1: Schematic Flow Diagram of the Recycle and Reuse Process

b) Process Curve for Desizing





c) Process Curve for Scouring



Fig. 3.3: Process Curve of Scouring

d) Process Curve for Bleaching



Fig. 3.4: Process Curve of Bleaching

IV. TestinG & AnaLysis

a) Tegewa Test

Iodine drop test (Tegewa test) employed to check the desizing efficiency. The principle of this testis the violet coloration of starch with iodine. Hence, the presence of starch remaining on fabric deciphered. The desized fabric immersed in a beaker consists of a solution of potassium iodide and iodine for 1 min. After one minute the sample rinsed thoroughly under water, dabbed with filter paper and compared with the Tegewascale or violet scale, having rating 1 to 9. The scale denotes 1 is no removal of size material and rating of 9 indicate complete removal of size material from the fabric. The acceptable rating is 6-7.

b) Drop Test

The absorbency test followed by using AATCC Test Method 79-2000, where a drop of water is acquiesced to fall from a settled height onto the firm surface of a sample specimen. The time required for the reflection of the water drop to disappear, measured and recorded as wetting time. It took five seconds or less to represent the adequate absorbency.

c) Column Height

For column height, $18X5 \text{ cm}^2$ sample was prepared. This sample hung from support by immersing the 1 cm portion of the fabric.

The sample was dried and observed the wicking height performance. The wicking length is 30-50 mm and the above range indicates excellent scouring. 30 mm denotes acceptable and 40-45 mm is good to very good scouring.

d) Presence of Alkali in the Scouring Bath

In this test, the accurately measured volume of the sample titrated against a standard sulphuric acid solution with a phenolphthalein indicator. The alkalinity measured is regarding of $CaCO_3$ (mg/l)

Where,

Alkalinity, mg CaCO₃/1 = (A)(N)(50,000)/ml sample:A:

Milliliter of the standard acid used,

- N: Normality of the standard acid.
- *e) Presence of alkali in the bleach bath containing peroxide*

This test carried as per AATCC Test Method 98-2007. A weighed specimen of the bleach bath is titrated with a standardized solution of sulphuric acid using Phenol Red indicator or to the pH range 6.8–8.4 on a pH meter. The total alkali expressed as % NaOH, is calculated based on the weight of the bath.

% Total alkali, as NaOH.

% = (ml)(N)(0.040)(100)/W Where,

ml: The number of milliliters of the sulphuric acidsolution required,

N: The normality of the sulphuric acid solution,

0.040: The milliliters equivalent weight of sodiumhydroxide, W: Mass of the specimen.







From fig 5.2 it was seen that the 1st and 2nd recycle scoured sample gave better result compared to 3rd sample which was in acceptable range (above 30mm). Column height gradually falls due to decrease of alkali content in the recycled bath.



Fig. 5.2: Column Height of Different Scoured Samples



Fig. 5.3: Weight Loss Percentage of Different Processed Sample

From fig 5.3 it was found that weight loss% were lower in every step of scouring processing with recycled liquors. The reduction in weight loss indicates the reduction of alkali in recycling bath. As the more recycled, less scouring action occurs so the 3rd recycling bath shows minimum weight loss.

In case of bleaching also similar trend was observed in respect of weight loss. The loss in peroxide strength resulted in the decrease in weight loss.

VI. Conclusion

Water, energy, and process chemicals were all efficiently conserved by the suggested sustainable pre-treatment method. Alkali and hydrogen peroxide are used excessively in both the scouring and bleaching bath recycling processes. After recycling, the fabric's qualities were determined to be up to two times good. The sample to bath ratio of S:B 30:70 produced a better result, however samples treated in the mixed bath still demonstrated strong scouring and bleaching effects. Understanding the waste stream's potential can lead to new ideas for reducing the amount of chemicals and water that are discharged into the environment. This work will lessen the amount of sewage produced and ease the strain on the effluent treatment facility.

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