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RESEARCH ARTICLE

An experimental study on water reuse in textile pretreatments especially in scouring and bleaching

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Abstract

Water is expensive to buy, treat, and dispose. Water conservation and reuse are rapidly becoming a necessity for textile industry. Water conservation and reuse can have tremendous benefits through decreased costs of purchased water and reduces costs for treatment of wastewaters. Prevention of discharge violations as a result of overload systems can be a significant inducement for water conservation and reuse. By implementing water conservation and reuse programs, the decision to expand the treatment facilities can be placed on hold, and the available funds can then be used for expansion or improvements to process equipment.Textile industries are consuming large quantity of water. Major portion of water is used for wet processing of textile (60 to 70 %). Keeping this in mind there is acute need of water conservation programmed to implement in textile wet processing. Water conservation in textile wet processing achieved through countercurrent washing, machine modification, process modification, good housekeeping and reusing and recycling. Reuse of same scouring and bleaching bath in textile wet processing helps for water conservation. Here analysis has been carried out for repeating the bath in Cotton pre-treatment operations. Pre-treatment operations considered are scouring and bleaching processes.

INTRODUCTION

There are many sources of water, the most common being:"Surface sources, such as rivers, Deep wells and shallow wells, Municipal or public water systems, Reclaimed waste streams. (Smith and Rucker, 1987)

Water is essential natural resource for sustaining life and environment, which is always thought to be available in abundance and free gift of nature (Chae and Hamidi, 1997).

Textile industries are one of the major consumers of water and disposing large volumes of effluent to the environment. The textile industry utilizes abundant water in dyeing and finishing processes. There is need to adopt economical practices for the use of water in textile industries. It has been estimated that 3.5 % of the total cost of running the industry is required for water utilization in textile industry. In India textile units are developed all over the country in the form of small industrial estates (Cheremisinoff, 1995).

Textiles are manufactured to perform a multitude of functions. They are produced to a range of specifications using a variety of fibers, resulting in a complex waste or effluent. Textile waste occurs in a variety of forms throughout production process (Sonaje and Chougule, 2012).

The surface water sources are limited and availability of water from them vary from year to year depending upon monsoon conditions. The underground water resources are also getting depleted with the increasing amount of water drawn from them every year without adequate replenishments. Therefore, the cost of water is rising steeply and the textile mills, which need a large quantity of water, have started taking measures to conserve (Wasif, 1998).

Municipal treated wastewater can be best and sure source of water for textile wet processing.
Experience has shown that the amount of water required in textile processing varies widely, even between similar wet processing at different sites. The quantities water used for various types of processes is of site-specific nature and various processing situations. Many mills have very high water costs, especially when the water is being purchased from a municipal system. These operations usually are much more conservative with water than others with less costly sources (Smith and Rucker 1987).
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. The processing of yarns also requires large volumes of water (Manivaskam, 1995).

Scouring Process

On cotton fibres, this treatment removes fatty and pectic substances, softening motes and preparing the material to absorb the subsequent treatment agents. Scouring is usually carried out in soft water additivated with textile auxiliaries such as absorbing agents, detergents, emulsifying agents, caustic soda and/or Solvay lye and sequestering agents. Alkali make the fibre swell and enhance the action of surfactants. This treatment can be carried out on filaments, yarns and fabrics. Instead of the traditional scouring process, it is also possible to carry out an enzymatic scouring process (bioscouring) to remove non-cellulosic material from cotton fibres, to make them more easily wettable and enhance the subsequent absorption of finishing liquors. The scouring of pure silk is a degumming process used to remove sericin (silk gum) from fibroin floss. Sericin is the gummy element which keeps together the fibroin floss and gives the silk a hard hand and dull appearance. It is carried out on yarn, on dyed yarn, piece-dyed fabric or on products ready for printing. The treatment, which causes a loss of weight ranging between 24 and 28%, gives the degummed silk a lustrous appearance and a soft hand; the treatment is carried out with soapy solutions or with buffer dissolving agents. It is also possible to use enzymes (protease), which hydrolyses sericin. Recently, a treatment with H2O at 120°C has also been successfully applied especially on yarns. On wool, the scouring process removes oils and contaminants accumulated during upstream processing steps and can be carried out on slivers, yarns and fabrics with solutions containing sodium carbonate with soap or ammonia, or anionic and non-ionic surfactants, which carry out a softer washing to avoid any damage to the fibres. The scouring process applied to synthetic fibres removes oils, lubricants and anti-static substances, dust, contaminants and can be carried out on yarns and fabrics (when warp yarns have been bonded, the treatment is called debonding). It is carried out by means of surfactants, detergents and emulsifying agents. Scouring is usually carried out by means of continuous or discontinuous systems, with the same machines used for downstream treatments; temperature, processing time, pH, concentration of reagents, depend on the fibre and on the machine used. Incomplete scouring processes usually originate dyeing and printing defects due to different degrees of wettability and to inconsistent affinity for dyes of the material.

Bleaching Process

Bleaching treatments are applied to eliminate any impurity and obtain a pure white tone, to prepare substrates for low-density dyes or prints and to level off undesired tone variations. Bleaching agents mainly used for cellulosic fibres are sodium hypochlorite and hydrogen peroxide. They both require the addition of sodium hydroxide in the bleaching liquor to make it alkaline it by favouring the formation of the bleaching ion, which in the first case is the hypochlorite ion and in the second one is the perhydroxyl ion. When using hypochlorite the pH must range between 9 and 11 and the temperature must not exceed 30° C. In fact, as far as the pH is concerned, pH values below 4 give rise to the formation of chlorine while pH values ranging between 4 and 9 give rise to the formation of hypochlorous acid: these chemical substances affect the fibre negatively and do not perform a bleaching action. After the bleaching with hypochlorite it is necessary to carry out an antichlor treatment. Fibres must be treated with hydrogen peroxide, which completely removes the chlorine and avoids the formation of chloramines, which, in drying machines, could generate HCl dangerous for cellulose. With hydrogen peroxide, in the presence of alkali, little motes can be eliminated and the autoclave scouring can therefore be avoided (Bellini et al., 2002).

Processing of Fabric

Desizing

After the weaving process, the sizes have to be removed from the fabric because they interfere with subsequent

processing steps. Sizes have, in general, a high biological oxygen demand (BOD) and will contribute significantly to the waste load of the industry effluent. Three methods frequently used in textile processing are acid desizing, enzyme desizing, and oxidative desizing. The goal of these different methods is to hydrolyze the starch.
After getting the grey fabric, the fabric was firstly desized which removes out the starch from the fabric by using following recipe.
Chemical - hydrochloric acid MLR - 1:15
In desizing it is found that the amounts of size add - on was 12 % and desizing liquor was so polluted that it is not possible to reuse it.

Scouring

Here the fabric is proceeding further for the scouring process. In the scouring process the removal of fatty acids, oils, wax takes place. So the fabric is scoured with the following recipe which is given in Table 1

Table 1 Recipe details for Scouring

S.N.	Parameter	Values
1.	NaOH	2 % owf
2.	Na_2CO_3	1 %
3.	Scourex	0.5 %
4.	Wetting Agent	0.5 gpl
5.	Sequestering Agent	0.1 %
6.	Time	90 Minutes
7.	Temperature	95^0 c
8.	MLR	1:20

After the scouring 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 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. After each scouring process following tests were carried out for the liquor and fabric. The results obtained after each scouring and bleaching process are given in Table 2

Table 2 Characteristics of Scouring Liquor & Scoured fabric samples

Parameters	Process 1	Process 2	Process 3	Process 4	Process 5	Process 6	Process 7	Process 8
P^H	10.8	10.8	10.7	10.6	10.5	9.9	9.8	9.8
Alkalinity	32.4	32.3	31.6	30.4	29.4	28.9	28.7	28.6
TDS (ppm)	5100	5900	6500	7150	7980	8500	8750	8980
TSS (ppm)	498	576	675	799	825	866	902	937
TS (ppm)	5598	6476	7175	7949	8805	9366	10156	10789
COD(ppm)	901	912	952	1009	1059	1088	1180	1217
BOD(ppm)	355	435	532	657	751	837	922	940
CAC Carboxylic Acid Content	0.9	0.9	0.8	0.9	0.8	0.9	0.9	0.9
Absorbency	<3sec	<3sec	<3sec	<3sec	<3sec	<3sec	<3sec	<3sec
Tensile Strength (Warp) kgf	40	40	41	41	42	42	42	42
Tensile Strength (Weft) kgf	67	67	68	68	68	70	70	70

From above result it is observed that the scouring efficiency was very good as in all processes absorbency is less than 3 sec. The fabric damage is also negligible as Carboxylic Acid Content values are in between the desired limit. But the solid content and BOD, COD in the liquor goes on increasing continuously. After sixth process the total solid content increased to a greater extent so the carrying out seventh scouring process was impossible.

Bleaching

After souring the fabric is proceed for the bleaching process. In the bleaching process the natural colouring impurities are decolourised and whiteness is improved. Table 3 shows receipe followed for bleaching process.

Table 3 Recipe used for bleaching

S. N.	Parameter	Values
1.	H_20_2	2 % owf
2.	Soda ash	2 gpl
3.	Stabilizer	1/3rd of H_2O_2
4.	Time	90 Minutes
5.	Temperature	95^0 c
6.	MLR	1:20

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. The results obtained after each bleaching process are given in Table 4 as follows:

Table 4 Characteristics of Bleaching Liquor & Bleached fabric samples

Parameters	Process 1	Process 2	Process 3	Process 4	Process 5	Process 6	Process 7	Process 8
P^H	9.6	9.6	9.7	9.6	9.7	9.7	9.8	9.8
TDS	2698	2742	2819	2879	2911	2956	2994	3012
TSS	189	207	212	217	235	239	275	295
TS	2887	2949	3031	3096	3146	3195	3227	3445
COD	442	529	637	725	843	949	987	1018
BOD	159	193	247	299	347	397	448	497
Whiteness Index	66.25	65.07	64.11	61.13	59.23	55.2	54.5	53.2

From above result it is observed that the bleaching efficiency was very good as whiteness index is good i.e greater than 60. But the solid content and BOD, COD in the liquor goes on increasing continuously. After fourth process the whiteness index found to be less than 60 i.e. 59.23 and 55.2 and total solid content increased to a greater extent so the carrying out fifth bleaching process was difficult.

Effect on various parameters with repeated bath in Scouring and bleaching

P^H

P^H of textile waste water vary widely from time to time. P^H is a measure of hydrogen ion concentration or more precisely the hydrogen ion activity. P^H is the most important as it indicate the acidic or alkaline condition of an effluent or water. For scouring and bleaching, alkaline condition is required.

Cotton fabric is having property to absorb NaOH due to which hydrolysis takes place Same thing happened in all process and due to absorption of NaOH by fabric, alkalinity and p^H goes on decreasing but for scouring it is necessary to have P^H between 9.5 - 10.5 for that after each process the percentage of NaOH remain in bath is calculated and replenishment of bath with required NaOH takes place such that P^H will be maintained in between 9.5 to 10.5.

Alkalinity

Alkalinity in waste water is due to presence of bicarbonate, carbonates and hydroxides of metal ion such as calcium, magnesium, sodium and potassium. Of these, bicarbonates are most common. Salt of weak acid ammonia present in wastewater contribute to the total alkalinity. Bicarbonates are present in the original sample along with hydroxide & carbonates. Here alkalinity is decreasing as amount of NaOH gets reduced after each process.

Total Solids (TS)

Total solid in waste water refers to the matter that remains as a residue after evaporation and drying at 103^0C to 105^0C. It is sum of total dissolved solids and total suspended solids present in effluent.

Total Dissolved Solids (T.D.S.)

Both inorganic and organic matter causes T.D.S. Inorganic matters like mineral, metal and gases are mainly responsible for T.D.S. It may produce aesthetically displeasing odour. It mainly used for deciding the mineral matter content. In all processes T.D.S. is increasing continuously.

Total Suspended Solids (T.S.S.)

The undissolved matter present in water or waste effluent is referred as suspended solids. It is one of the valuable parameter for judging the pollution load of an effluent. Suspended solid is mainly organic therefore responsible for significant portion of oxygen demand.

Biological Oxygen Demand (B.O.D.)

It is an essential parameter and is highly useful in assessing the nature and quantity of dissolved organic matter. This test gives a measure of the amount of biologically oxidisable organic matter. Because of biological oxidisable impurities present in the liquor, BOD is continuously increasing.

Chemical Oxygen Demand (C.O.D.)

COD value continuously increases due to increase in the biologically oxidisable and biologically inert organic matter. In bleaching the impurities present in liquor are less, hence the COD of the bleaching liquor is less than that of scouring liquor.

Whiteness Index

It is a measure of whiteness obtained after bleaching process. For this CCM (Minolta Treepoint system) is used. Here up to 4th process whiteness index is obtained more than 60 but 5th and 6th process showed less than desirable whiteness index value.

Conclusion

From Table 2 Characteristics of Scouring Liquor & Scoured fabric samples it is revealed that scouring bath can be repeated for 6 times. This is resulting in water economy. Similarly Table 4 shows characteristics of Bleaching Liquor & Bleached fabric samples. This Table shows that bleaching bath can be used for 4 times. This results in water economy in textile pretretments.

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