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NOVEL TECHNIQUES OF WATER RECYCLING IN TEXTILE WET PROCESSING THROUGH BEST MANAGEMENT PRACTICES (BMP'S)

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Abstract: Water has been a cheaper commodity for a very long period and never accounted for in processing cost. Now it becomes scarce and a priced commodity and the costs for water and its treatment to make it suitable for processing have escalated to the newer heights necessitating its inclusion in production costs Water conservation techniques must be instigated in the textile industries. The industries must take initiatives to implement water management practices. Also it is necessary to encourage industries for investment in various water recycling methods.

Fresh water is an increasingly scarce resource as the demands of an ever-growing world population and agricultural activity needed to support it consume a steadily rising proportion of global fresh water resources. Consequently, industry generally needs to find ways to reduce its water consumption. As a major user and potential polluter of water, the textile wet processing industry is under particular pressure to reduce water consumption on both environmental and economic grounds. Securing a reliable and economic supply of water is now a strategic imperative for textile operations.

The proposed paper comprises study on Best Management Practices for water recycling in textile wet processing.

Keywords: Wastewater recycling, textile wet processing, textile effluent treatment, BMP's

1. SOURCES OF WATER FOR TEXTILE WET PROCESSING

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. 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).

2. TEXTILE WET PROCESSING AND WATER USAGE

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).

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The water usage for different purposes in a typical cotton mill and synthetic textile processing mill is given in table 1.

Table 1
Water Usage in Textile Mills

Sr. No.	*Purpose*	*Percentage water use*	
		Cotton Textiles	*Synthetic Textiles*
1	Steam generation	5.3	8.2
2	Cooling water	6.4	-
3	Demineralized water for specific purpose	7.8	30.6
4	Process water (Raw water)	12.3	28.3
5	Sanitary use	7.6	4.9
6	Miscellaneous and Fire fighting	0.6	28.0

Every textile processor should have knowledge of quantity of water used for processing. Certain simple operations such as sizing requires less water, while others with sequential operations such as dyeing many washings and rinsing, requires large quantities. The quantity of water will vary depending on the material processed and requirements of finish.

Resource recovery contributes to environmental as well as to financial sustainability. It can include agricultural irrigation, aqua- and pisci culture, industrial cooling and process water re-use, or low-quality applications such as toilet flushing (Veenstra. et.al. 1997).

The textile Industry is in no way different than other chemical industries, which causes pollution of one or the other type. The textile industry consumes large amount of water in its varied processing operations. In the mechanical processes of spinning and weaving, water consumed is very small as compared to textile wet processing operations, where water is used extensively. Almost all dyes, specialty chemicals, and finishing chemicals are applied to textile substrates from water baths. In addition, most fabric preparation steps, including desizing, scouring, bleaching, and mercerizing use aqueous systems. According to USEPA a unit producing 20,000 Ib / day of fabric consume 36000 liters of water (Shaikh, M.A. 2009).

Water pollution is of grave consequence because both terrestrial and aquatic life may be poisoned; it may cause disease due to the presence of some hazardous substance, may distort the water quality, add odours and significantly, hinders economic activities. If textile waste water, not properly treated is released into the environment, it can introduce metals (*Cr* and *Cd*) and organochlorine compounds which can bio-accumulate in fishes in receiving streams. These fishes can have harmful effect on human when consumed. Dye residue and degraded starch render the water unfit for drinking because they reduce its quality by imposing colour and odour on water. Hot effluent also affects dissolved oxygen (DO), which in turn affects the aquatic environment of living organisms in such streams (Ogunlaja1 O. and Ogunlaja A. 2009).

Water is most essential but scarce resource in our country. Presently the quality & the availability of the fresh water resources is the most pressing of the many environmental challenges on the national horizon. The stress on water resources is from multiple sources and the impacts can take diverse forms. Geometric increase in population coupled with rapid urbanization, industrialization and agricultural development has resulted in high impact on quality and quantity of water in our country. The situation warrants immediate redressal through radically improved water resource and water quality management strategies (CPWB, 2008).

Study has confirmed that the wastewaters discharged from wet processing textile mills are harmful to the environment. On an average about one million litres of effluent is discharged per day by an average sized textile mill having a daily production of 8000 kg. The industrial owners should implement cleaner technology in the processing stage, so that the waste will be minimized in the initial stage itself (Lokeshappa B. et. Al. 2008).

Textile industry is a very diverse sector in terms of raw materials, processes, products and equipment and has very complicated industrial chain. Although there is a large variety of processes and technologies within the textile industry, this sector can be categorized into dry and wet processes. Dry processing includes yarn manufacturing, fabric weaving and knitting while wet processing includes preparation, dyeing and finishing. The textile industry has always been regarded as water intensive sector. The main environmental concern is, therefore, about the amount of water discharged and the chemical load it carries (Alanya, S. et. al. 2005).

Due to the various processing steps, such as de-sizing, bleaching, dyeing or finishing in aqueous solutions, the water consumption and chemicals used will differ. The variations also dictate the amount of wastewater that needs to be treated and the different treatment processes that are necessary and feasible. Generally speaking, a textile factory manager's objective should be to recycle internally and to cut down the amount, as well as the chemical load, before releasing wastewater into the environment. Before its release, the water is typically treated again by different means (www. bsr.org, 2008)

Main pollution in textile wastewater came from dyeing and finishing processes. These processes require the input of a wide range of chemicals and dyestuffs, which generally are organic compounds of complex structure. Because all of them are not contained in the final product, became waste and caused disposal problems. Major pollutants in textile wastewaters are high suspended solids, chemical oxygen demand, heat, colour, acidity, and other soluble substances. (Al-kdasi A.et. al. 2004).

A substantial reduction in water flow can produce corresponding savings in treatment water costs. However, small or token reductions will yield very few, if any, savings. (Pollution prevention program, NC, 1993)

As yet, in the textile areas of Great Britain, there is no shortage of water generally, nor will there be for a long time to come, although there may be local limitations arising from undue abstraction of water. There have been large increases in water charges, however, and these will rise still more in the future, so that it may be economical to limit water consumption and to consider how water may be saved by recycling or reuse after purification. (Little A., 1975).

3. RECOVERY AND REUSE OF WASTE WATER THROUGH BMP'S

Textile industry is listed one among the industries that consume large quantities of water. As the fresh water becomes scarce, and its treatment costs are escalating, the two possible means to solve the crisis are (i) to cut down the consumption of fresh water at possible stages of processing, and (ii) reuse of waste water in place of fresh water in certain operations. The latter way is gaining importance due to the twin advantages incurred-reduction in water consumption and lower quantities of effluents generated. With top management backing, reuse of waste water could result in large reductions of water consumption (NIIR Board Delhi, 2010).

As there was plenty of fresh water, the reuse of waste water never assumed significance in the past. Now, the trend is changed and most of the mills recycle at least a part of their waste waters into their processes with or without treatment. The proportion and properties of the waste water to be recycled are dependent on the process for which it is used. Some of the possible reuses of waste water cited in literature and practiced in many mills are indicated below.

The effluents let out from many washing processes are clear and pure. Their relatively small chemical content picked up from the earlier process will not affect the other process for which they are reused. For example, the rinses after bleaching can be collected and used for rinsing after scouring without detriment to the latter process. Savings up to 40 percent is reported by such recycling and careful selection of the rinse waters.

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 methods (low cost) available to recover the FVA from these effluents and the size stripped effluent can be reused for desizing. Reuse of caustic bearing effluents is practiced in some mills for mercerizing /kiering. The dilute caustic waste is subjected to dialysis and evaporation to concentrate it and the concentrated solution is reused for mercerizing or kiering. The rinse waters from mercerizing are stored and used for kier make up in certain units.

Reuse of exhausted dye bath is also possible with certain class of dyes. For example vat dyes are recovered from spent dye liquors, and are reused. In a similar way, the bright colored lakes and lacquers may also be recovered and reused. The other class of dyes reported to be recoverable are, basic azo dyes and reactive dyes. Dyes are recovered either by precipitation or by hyper filtration. Topping up of the dye bath with required amount of dyes and auxiliary chemicals is also a method of reuse.

In a cotton finishing mill, if the operations are changed to the sequence-caustic saturator $\rightarrow$ J box washer $\rightarrow$ peroxide saturator $\rightarrow$ J box washer and the rinse water from the peroxide washer-is reused in the caustic washer a reduction in water requirements of about 35 percent is possible. Effluents arising from printing are also reused after clarification to wash the blankets and screens of the printing machines.

Reuse of cooling water assumes significance and they are reused with or without treatment depending on the process. (Cooling waters are the waters that would not normally come into contact with the fabric). Some of the areas of reuse of cooling water indicated by S.G. Cooper are (*i*) Cooling in hydrosulfite operation reused as indigo wash water. (*ii*) In printing, cooling water reused to wash blankets. (*iii*) Cooling water as final rinse in dyeing.

Some of the used waters need treatment. The best treatment that yields a water of good quality is ultra nitration (ultra filtration is different from hyper filtration (reverse osmosis). The treated waters could be used even for processing, especially when a single dye shade is applied. (At single dye shade dye houses not only water is recovered but dyes and heats are also recovered, at reasonable cost).

In some mills, a portion of the raw water used for processing is replaced with used water so that the total requirements are reduced considerably. As stated previously, this is especially suitable for single dye-shade dye houses. It should however be kept in mind that there is an upper limit on dissolved solids that can be tolerated. The technique of counter-current washing is coming in to prominence. It can significantly reduce water consumption. In counter-current washing, washing is carried out in stages so that the cleanest water meets the final fabric and moves back until the dirty water meets the unwashed material. This method is now in common use in many washing ranges. This counter-current method is highly useful in concentrating mercerizing effluents. In mercerizing, the second and third rinse waters do not contain appreciable amounts of alkali for recovery and they are simply let down into effluent streams. If the rinsings during mercerization are carried by counter-current systems the rinse waters would be concentrated and justify the recovery of caustic alkali.

In wool processing, it is reported that counter, current washing enables a reduction in water quantity by up to 60000 litres/1000 kg' of wool. Counter flow can also be used as a neutralizing wash from one process to another if conditions are carefully controlled.

Research indicates that biologically or chemically treated waters may be suitable for reuse in processing or as cooling water make up. For example, waste water after filtration and treatment with activated carbon is found to be suitable for hosiery dyeing. Pilot scale studies reveal that cotton bleaching waste could be reused for rinsing after bleaching, (after the removal or 85 per cent BOD by activated sludge process).

Research works carried out hitherto on waste water reuse are inadequate. They have to be intensified further in order to evolve new techniques for complete utilization of waste water at reasonable cost. The waste water after tertiary treatment may be used for irrigation. Textile wastes normally have high sodium content usually in the range of 90-98% which is detrimental to crops. To counter act the effects of high content of sodium, addition of gypsum (calcium sulfate) is recommended. The water used in the rinsing of ion-exchange columns and sand filters can be reused elsewhere in the factory (Barclay, S., and Buckley, C. 2000).

Normally the excessive water usage considering the wastage alone in most of the units works out to be 10% - 20% on the average. Since the water is bought from outside, it is necessary to reduce the wastage to the lowest minimum, which will decrease the overall production cost (Balachandran, S., and Rudramoorthy R. 2009).

4. CONCLUSIONS

4.1 Need of Water Conservation

1. Water is expensive to buy, treat, and dispose. If industry does not have water conservation program, industry is pouring money down the drain.
2. The amount of water used in many fabric pretreatment operations is often preset to treat the most difficult cloth processed. As a result, large amounts of water are wasted when cleaner/easier fabric is treated.
3. There is a tendency in the textile industry to use more water than necessary when removing chemicals during rinsing.
4. Similarly there are many operations in the wet processing industry which doesn't require water of drinking quality but all water used in the industry is of drinking water standard which requires expensive treatments.

4.2 Best Management Practices

1. Carry out a water audit to target plant-wide water use. Identify where and how water is currently being used. Track water use over several weeks.
2. Determine the cost of the water going to each process line. These costs can be used to determine the level of conservation that is feasible and to justify modifications with reimbursement.
3. Appoint a water conservation team to evaluate conservation thoughts, methods and equipment.
4. Acquire conservation information from vendors, trade associations, consultants and state agencies.
5. Educate human resources on the significance of water conservation and implore employee suggestions on ways to use water more efficiently.

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