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Municipal Wastewater Recycling In Cotton Textile Wet Processing - A Review

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Abstract- The global water crisis is emerging as one of the most serious natural resource issues facing the world today. For the water consuming industry, water is no longer regarded as a consumable or utility but as a highly valuable asset. Water is a vital element used in close conjunction with the production processes. Water is a high value resource and it is directly related to economy as well. Due to scarcity of water, the recycling of wastewater is becoming the necessity. Water recycling is important from economical and sustainable point of view, but it must be realized in a proper way while improving product quality and process stability at the same time. The textile industry is the biggest water consuming sector. Therefore use of treated municipal wastewater in textile wet processing and implementing water conservation techniques in production process of fabric are important to overcome the scarcity of water. Many researchers, scientist and scholars dedicated their knowledge in several aspects of wastewater recycling and reuse in different sectors of textiles. Review carried out here covers research work done by distinguished investigators from all over the world.

Keywords- *Wastewater recycling, Cotton textile, Wet Processing*.

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I. INTRODUCTION

Textile industry is one of the major consumers of water and disposing large volume 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.

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. Textile industry is water intensive industry. Mostly textile wet processing industry use more water 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. As the cost of water supplied to industry keeps increasing, recycling becomes more important. Many textile industries in water scarce areas are installing water recycle plants.

With advances in technology municipal wastewater can be treated to meet the most stringent quality requirements and can be used for industries and any purposes desired. The potential uses for reclaimed water are indeed numerous and widely varied. Water recycling and reuse can enable communities to strategically link the distribution and use of locally available water resources with specific water quality and quantity goals, particularly in areas where there are concerns of water. Recycled wastewater is a reliable, valuable, drought proof source of water that must be taken into account in formulating a sustainable water policy. There is a need to encourage planned and appropriate wastewater recycling and reuse in all countries and to establish safe reuse practice for industries.

II. MUNICIPAL WASTEWATER RECYCLING IN COTTON TEXTILE WET PROCESSING

Many researchers, investigators and scientists contributed to the research on wastewater recycling in textile wet processing. Literature review carried out here shows multidimensional research of various contributors in this field.

Researcher Harker carried out experimental work on recycling sewage water for scouring and dyeing in textile wet processing in the city Yorkshire. He developed treatment facilities for sewage water of the Hough side Works of Yorkshire water authority. Using filtration plant and disinfection with chlorine he carried out textile processes of scouring and dyeing. Study performed by Harker showed that there was no difference observed between fabric processed with drinking water quality and fabric prepared with reclaimed water (Harker, 1980).

Investigators Goodman and Porter carried out study on water quality requirements for reuse in textile dyeing processes. They present case study of reverse osmosis to treat the dye waste for reuse. They mention in their study that recycled water containing impurity levels much higher than the average fresh process water used in textile dyeing and finishing can be reused in many dyeing processes. Also they quoted that it may be cheaper to recycle wastewater than to treat it for discharge (Goodman and porter, 1980).

Beckman and Pflug carried out extensive study on reuse of weakly loaded liquors from textile processing operations. Their study involves Dyeing in standing baths in order to conserve valuable constituents, Dyeing in standing baths to conserve water and heating energy, Reuse of rinsing liquors without purification, Reuse of weakly loaded effluents after purification. They conclude that a recycle of process water can be a rewarding measure (Beckman and Pflug, 1983).

Porter and Goodman carried out research on recovery of hot water, dyes and auxiliary chemicals from textile waste streams. They used recovery system and hyper filtration system in experimentation. Pilot studies and preliminary results carried out by Porter and Goodman of the full-scale HF recycle system continue to indicate high potential for recycle operation with reuse of water and chemicals. Further they report that Reuse of the dye pad drops and MF concentrates is possible; the eventual amount will depend on the type of dyes and run length. Plant operator experience and color matching problems will also determine practical limits of concentrate reuse (Porter and Goodman, 1984).

Bergenthal et al. conducted research on full scale demonstration on textile wastewater use. He carried out experimentation with reconstituting dyebath. The full scale demonstration of dyebath reuse showed that up to 10 dyeing could be performed with recycled dye liquor without affecting product quality. This resulted in operating cost savings (Bergenthal et al., 1985).

Wilcock and Hay experimented on recycling of electrochemically treated disperse dye effluent. They used Electrochemical Treatment in experiment. Researchers expected that recycling of electrochemically purified, filtered disperse dyebath effluent can give commercially acceptable results provided that the dyes and carriers are properly selected (Wilcock and Hay, 1991).

Groff discussed about textile-manufacturing wastewater and treatment by physical-chemical and biological systems. According to him necessity for technical innovations, including development of safer cleaning agents, reduction in use of harmful chemicals, improved chemical handling, and the use of recoverable and biodegradable starch sizes in the textile industry are important. He concludes that Process modifications, segregation of drains, recycling, and waste treatment measures for reduction of effluent from cotton mills (Groff, 1991).

Woemer et al. prepared report on use of membrane filtration for water recycling in fiber reactive dyeing. Fabric used in this evaluation was 100% cotton interlock knit from 40/1 ring spun yam. Fabric was scoured and bleached in sufficient quantity from the same yarn lot in order to make available prepared substrate for multiple dyeing. Recycling of water reduces the impact of water and sewer charges and can serve as a mechanism to approach a 'zero wastewater discharge' plant. The problem of salt toxicity can be eliminated without major changes in dyeing procedures (Woemer et al., 1993).

Thakur et al. experimented for zero discharge in textile processing through TDS control. The experimental recipe was used for dyeing scoured yarn with reactive dye HE-8B (red shade) in experiments, and the actual effluent thereafter obtained was used. It is quite obvious that the recovery cost of the salt in crystalline form exceeds the cost of commercial salt, but its reuse in concentrated form up to a certain level is very much techno-economically feasible (Thakur et al., 1994).

Hendrickx concentrates on recycling and reuse techniques while conducting research on pollution prevention studies in the textile wet processing industry. Reusing hot water will significantly reduce the energy consumption at one mill. Improvements in housekeeping will also help to reduce water consumption (Hendrickx, 1995).

DiGiano and Kubiak carried out study on feasibility of wastewater reuse at the National spinning company, inc. in Washington, NC. A pilot plant was constructed at the Wastewater Research Center of the University of North Carolina in Chapel Hill. He carried out various tests on fabric including staining (DiGiano and Kubiak, 1995).

Diaper et al. conducted experimentation on the use of membranes for the recycling of water and chemicals from dyehouse effluents. They installed membrane system in a dying process which was used to treat specific or combined waste streams and recycle particular components of these streams. Diaper et al. analyzed the cases in identifying the most economically favourable scenario for recycling. Further they reported that significant cost savings can be achieved from dye and chemical recovery from the dyebath water, particularly for continuous process operation (Diaper et al., 1996).

Schlaeppi carried out study for optimizing textile wet processes to reduce environmental impact. Escalating costs of effluent treatments incurred by the textile wet processing industry can be controlled by optimizing application processes to reduce, and in some cases to eliminate, effluent and chemical discharge. The important conclusion from him is that need of automation to reduce water, chemical, and dye use and to eliminate waste caused by human error (Schlaeppi, 1998).

Vandevivere et al. in their study took review of emerging technologies for treatment and reuse of wastewater from the textile wet-processing industry. Investigators conclude that in view of the need for a technically- and economically-satisfying treatment technology, a flurry of emerging technologies are being proposed and tested at different stages of commercialization. Promising among these are biologically activated GAC filtration, foam flotation, electrolysis, photo catalysis, (bio) sorption and Fenton oxidation (Vandevivere et al., 1998).

Veerapnneni et al. prepared water treatment technology report for U.S. Bureau of Reclamation Technical Service Center, Water Treatment Engineering & Research Group. In their report they carried out Bench Scale Evaluation on Wastewater Recovery from a Textile Bleach and Dye Operation. A greater demand for process water is anticipated and investigators suggest method of meeting this demand by recycling the industrial wastewater which is currently being discharged after treatment (Veerapnneni et al., 1998).

Deo et al. conducted experimentation on Green technology in textile processing especially on eco-friendly dyeing of polyester/cotton fabric. (Deo et al., 1999).

Paar et al. experimented on Thermo-alkali-stable catalases from newly isolated Bacillus sp. for the treatment and recycling of textile bleaching effluents. Experiment includes studies on three thermoalkaliphilic bacteria, which were grown at p^H 9.3–10 and 60–65 °C were isolated out of a textile wastewater drain. Their conclusions state that protein from the free enzyme might somehow interact with the dyeing process giving a larger color difference to blank using water instead of enzymatically treated bleaching effluent for the preparation of the dyeing bath (Paar et al., 2001).

Ratanatamskul and Kaweenantawong in carried out research on Ultrafiltration as a clean technology for reclamation and recycling of wastewater from textile industry. Their research proposes the optimum operating conditions of decolorization and reclamation of dyehouse wastewater in order to design an ultrafilatration process as a clean technology for water and energy saving in textile industry (Ratanatamskul and Kaweenantawong, 2001).

Marcucci et al. experimented on Treatment and reuse of textile effluents based on new ultrafiltration and other membrane technologies. The experimental results obtained from the pilot-scale tests indicate that the membrane processes are suitable as advanced treatments of textile wastewater for recycling. Further they conclude that dyeing in the recycled water provided a greater consistency of colour than occurred using the free enzyme. The recycling of the washing liquor for dyeing might provide considerable savings in water, energy and time (Costa et al., 2002).

Bes-Piá et al. investigated on reuse of wastewater of the textile industry after its treatment with a combination of physico-chemical treatment and membrane technologies. The combination of the physico-chemical treatment and the nanofiltration leads to a COD removal of almost 100%. Their research state that permeates of NF membranes can be recycled in the industry due to their low COD and conductivity (Bes-Piá et al., 2002).

Wenzel et al. through their research state Experience of industrial application in which experimentation on Process integration design methods for water conservation and wastewater reduction in industry was carried out. It is shown how physical constraints for the system design often set a limit for the sophistication of the water recycle network and thereby also a limit for how sophisticated the method for system design should be (Wenzel et al., 2002).

Schoeberl et al. give treatment and recycling of textile wastewater - case study and development of a recycling concept. In their study they state that For a specific textile finishing company strategies for water recycling and recovery of valuable chemicals have been developed. Based on results obtained from the ultrafiltration experiments, a process integrated recycling concept is proposed. By its implementation water consumption can be cut down by 87.5% within the washing process. Furthermore total COD emissions can be reduced by 80%, and as washing agents are partly recycled, consumption for the washing process can be lowered by 20% (Schoeberl et al., 2004).

Melgoza et al. gives Anaerobic/aerobic treatment of colorants present in textile effluents. The operation of an anaerobic/aerobic process used to degrade the colorants present in textile wastewater is presented. The objective was to produce water that can be reused. It was observed that the biomass pre-acclimatized to the degradation of DB79 was more effective for the color removal than a freshly inoculums used. In the aerobic stage the amines formed and the residual organic matter. The quality of the water of the treated effluent was suitable for recycling purposes in the textile plant (Melgoza et al., 2004).

Mattioli et al. worked on efficient use of water in the textile finishing industry. Their study involves a process data collection for technical/economical evaluation in textile companies was performed and integrated with a characterisation of the process effluents in terms of treatability and reusability. (Mattioli et al., 2005).

Researcher Çapar experimented on development of a membrane based treatment scheme for water recovery from textile effluents. In his experiment a membrane based treatment scheme was developed for the recovery of the print dyeing wastewaters (PDWs) and the acid dye bath wastewaters (ADBWs) of carpet manufacturing industry. (Çapar, 2005).

Lahnsteiner and Klegraf give industrial water reuse case studies. The reclaimed water (60% of total process water) is recycled to the aforementioned textile pretreatment steps. This reuse scheme is highly economic, primarily as a result of a substantial reduction in sewerage charges (Lahnsteiner and Klegraf, 2005).

Tubtimhin carried out research on pollution minimization and energy saving potentials in the cotton dyeing industry. His study was conducted to identify the pollution minimization and energy saving potentials in the cotton dyeing industry. This study recommended the segregation between less polluted and highly polluted wastewater. The result presents 127 m3/day of wastewater can be recycled or directly discharged to public canal as well as the reduction of wastewater quantity that sent to WWTP (Tubtimhin, 2005).

Chen et al. gives advanced treatment of textile wastewater for reuse using electrochemical oxidation and membrane filtration. The treated water can be recycled in many production areas of the factory (Chen et al., 2005).

Ranganathan et al. gives case studies on recycling of wastewaters of textile dyeing industries using advanced treatment technology and cost analysis. Their study shows the recycling of treated wastewater and zero wastewater discharge concept are found technically feasible and economically viable in the textile dying industries located in the area of Tirupur and Karur, (Ranganathan et al., 2006).

Noelte et al. carried out study on maximizing recycled water distribution through technical customer service. According to their study two industrial customers, an electrical power generating station and a textile dyeing company, required special efforts to address their recycled water quality needs. The electrical power generating station faced the problem of controlling the growth of aquatic plants in its cooling water reservoir, while the textile dyeing company faced the problem of maintaining quality control over its dyeing process when utilizing recycled water (Noelte et al., 2006).

Soares et al. conducted investigation on Pilot-scale enzymatic decolorization of industrial dyeing process wastewater. They conclude that overall benefits of the process may include not only a reduction in water costs but also energy savings and reduction in sludge volume, among others, all of which will contribute toward the development of a sustainable textile dyeing process (Soares et al., 2006).

Arafat gives simple physical treatment for the reuse of wastewater from textile industry in the Middle East. In his work, different treatment methods for wastewater from textile washing operations in the Palestinian territories were studied. It was found that carbon was effective in reducing the COD of the wastewater using reasonable quantities; where up to 98% COD reduction was achieved using 6 g carbon/L (Arafat, 2007).

Mohana et al. investigated method of electrochemical oxidation of textile wastewater and its reuse. In their investigation they attempted to treat organic pollutant present in the textile effluent using an electrochemical treatment technique. The results indicate that the electrochemical method is a feasible technique for treatment of textile wastewater and electrochemically treated wastewater can be effectively recycled for dyeing application (Mohana et al., 2007).

Rosi et al. gives best available technique for water reuse in textile SMEs. He gives user-friendly technique to improve the environmental performances of textile finishing enterprises is pursued with the Battle project. To reach the standards for reuse, which will be determined by production requirements, the treatment system performance is expected to comply with the following targets 80–90% removal of total organic matter, 99% for total suspended solids 95–98% for colour and 80% for surfactants (Rosi et al., 2007).

Dresser et al. of craddock consulting engineers carried out project on recycling treated municipal wastewater for industrial water use for Metropolitan council.

All the experimental results in the study have indicated that chemical or electrocoagulation treatment followed by ion-exchange methods were very effective and were capable of elevating quality of the treated wastewater effluent to the reuse standard of the textile industry (Raghu, and Basha, 2007).

Ramesh Babu et al. studied cotton textile processing: waste generation and effluent treatment. They mention that cotton textile processing and methods of treating effluent in the textile industry. Several countries, including India, have introduced strict ecological standards for textile industries. With more stringent controls expected in the future, it is essential that control measures be implemented to minimize effluent problems. Industrial textile processing comprises pretreatment, dyeing, printing, and finishing operations. These production processes not only consume large amounts of energy and water, but they also produce substantial waste products (Ramesh Babu et al., 2007).

Asano et al. gives information of textile industries in U.S. and their water needs. It was demonstrated that the quality of reclaimed water received from the CBMWD was comparable to potable water quality with less variability, and was acceptable to meet all process water needs. In Harlingen, Texas, reclaimed water that is treated with secondary treatment, filtration, and RO is sent to the Fruit of the Loom Corporation for their textile processes. The process wastewater is then returned to the municipal wastewater system (Asano et al., 2007).

Gomes et al. give method of integrated nanofiltration and upflow anaerobic sludge blanket treatment of textile wastewater for in-plant reuse. The UASB reactor performance was good, but the treated effluent would require additional treatment to allow water reuse or to meet the environmental requirements for discharge imposed by national or EU legislation. Other treatment methods that may be considered for improving the quality of the effluent from the bioreactor are aerobic treatment, nanofiltration, reverse osmosis, or microfiltration. Some of these processes should be suitable for removing aromatic amines produced by UASB treatment and additional COD, sulfate, and dye removal (Gomes et al., 2007).

Lokeshappa et al. gives wastewater management strategies with case study. Bleaching and dyeing units are studied in detail for finding treatment options. Researchers find that TDS, chlorides and sulphates are the matter of concern in the treated effluent. Reverse osmosis (RO) system is used for treating the wastewater with high TDS. Permeate from RO can be recycled to the process, which will reduce the cost of purchasing water from other sources (Lokeshappa et al., 2007).

Savin and Butnaru studied wastewater characteristics in textile finishing mills. Aim of their study was to accurately analyze the sources of water pollution and loading concentrations in textile finishing mills. A program of maintenance, inspection, and evaluation of production practices should be established. Significant reductions in water use can be made by implementing the following: minimizing leaks and spills, maintaining production equipment properly, identifying unnecessary washing of both fabric and equipment, training employees on the importance of water conservation (Savin and Butnaru, 2008).

Gozálvez-Zafrilla et al. carried out study on Nanofiltration of secondary effluent for wastewater reuse in the textile industry. In their research ultrafiltration (UF) and nanofiltration (NF) treatment experiences were coupled in order to study the effect of UF as pre-treatment in a NF system. (Gozálvez-Zafrilla et al., 2008).

Wang et al. experimented on Biological aerated filter treated textile washing wastewater for reuse after ozonation pre-treatment. The cost of treatment was less than one yuan/t wastewater, and these processes could enable high quality washing water reuse in textile industry (Wang et al., 2008).

Balachandran and Rudramoorthy studied various aspects of efficient water utilization in textile wet processing. In their study various water conservation techniques is being presented so that industry can benefit to a considerable extent by adopting these measures. They give important remark that it is possible to reduce water consumption by careful auditing and identifying the wastages and reasons thereof. (Balachandran and Rudramoorthy, 2008).

Nangare et al. carried out research on impact of textile industry on ground water quality with special reference to Ichalkaranji city. The main source of groundwater pollution is caused due to the influence of textile industrial waste. So it should be properly treated before disposing it into municipal sewers (Nangare et al., 2008).

Lamasa and Fujisawa studied on reuse of wastewater from polyester fibres dyeing process by thermal fixation with dye acid base: case study in a brazilian auto parts facility. According to results obtained, replacement of traditional chemicals by biodegradable products is technical and economical viable and attends to the waste water reuse policy proposed (Lamasa and Fujisawa, 2009).

Badani et al. conducted experimental research on Membrane separation process for the treatment and reuse of bath dye effluents. Their work is to study the effect of sodium chloride concentration on the removal by nanofiltration of anionic dyes in synthetic colored wastewaters and to characterize some main performances and properties of nanofiltration membranes of different properties. In the experimentation produced permeate is suitable for water recycle (Badani et al., 2009).

Ramesh Kumar et al. conducted research on recycling of Woven Fabric Dyeing Wastewater Practiced in Perundurai Common Effluent Treatment Plant. Wash water and dye bath waste water are the process effluents of dyeing industry which are collected separately and follow the advanced treatment for maximum recycling of recovered waters (Ramesh Kumar et al., 2009).

Krishnaswamy et al. carried on study on Treatment and Re-use of Wash Water Effluent Form Textile Processing by Membrane Techniques. In this study, Reverse Osmosis technique is adopted to treat the wash water effluent and reuse the membrane treated wash water for processing textile products there by aiming for zero discharge to protect green environment. Based on the experimental results an embedded system membrane method with biological treatment is best suited for effective recovery of permeate. They come out with the result as recovery of quality water to be recycled for processing (Krishnaswamy et al., 2009).

Jun-ling Ji et al. performed studies on the possibility of recycling microencapsulated disperse dye-bath effluents. In this study, melamine resin microcapsules containing pure disperse dyes were prepared by in situ polymerization. The treated fabrics exhibited satisfactory levelness and fastness properties. MDDs can be used in dyeing PET, without using surfactants, and the effluents can be recycled and reused (Jun-ling Ji et al., 2009).

Shaikh carried out research on water conservation in textile industry. 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. Reuse of certain process water elsewhere in mill operations and reuse of uncontaminated cooling water in operations requiring hot water result in significant wastewater discharge reductions (Shaikh, 2009).

Charoenlarp and Choyphan gives experimental analysis of reuse of dye wastewater through colour removal with electrocoagulation process. Electrocoagulation is one of the most effective techniques to remove colour and organic pollutants from wastewater. The decolourization of dye solution by this electrochemical process was affected by electrode material, electrical potential and electrolysis time. The results showed that the electrical potential was the most effective parameter. (Charoenlarp and Choyphan, 2009).

Ramesh Kumar and Sarvanan worked on advanced treatment of textile yarn dyeing wastewater towards reuse using reverse osmosis membrane. They concluded that RO was successfully used for the treatment of yarn dyeing. The recycling of treated waste water and zero waste water discharge concept are found technically flexible and economically visible in the textile dyeing industries (Ramesh Kumar and Sarvanan, 2010).

De Souza et al. worked on topic the modified water source diagram method applied to reuse of textile industry continuous washing water. Their work aims at aim, a methodology based on the water source diagram (WSD) method was developed, taking the fabric flow as a reference and applying the concept of pseudo-concentration at the inlet and outlet of the tank units of the continuous washing process. (De Souza et al., 2010).

Rosa et al. carried out investigations on reuse of textile effluent treated with advanced oxidation process by UV/H_2O_2. This work was to study the possibility of reuse of effluent in continuous dyeing of 100% cotton were made five dyeing, four with reactive dyes and one with fluorescent brightener, using the same bath after treatment by advanced oxidation process (AOP) by UV/H_2O_2. (Rosa et al., 2012).

Khandaker et al. in his research work give emphasis on saving underground water by reusing textile wash water in pretreatment process (scouring and bleaching) of cotton goods. The scouring, bleaching and dyeing performances of samples scoured-bleached with BDR wash water was tested against Fresh water samples from the same factory. It was envisaged that, the BDR wash water can be directly used for the scouring bleaching purpose of cotton yarn fabric. For a dyeing mill of 25 ton capacity total saving of water would be 70,000 m^3 per year (Khandaker et al., 2012).

Klemencic et al. studied on recycling of AOP-treated effluents for reduction of fresh water consumption in textile and other high water volume consuming industries. The results indicated that the most efficient colour removal was achieved (Klemencic et al., 2012).

Bertea et al. in his study experimented on reducing pollution in reactive cotton dyeing through wastewater recycling. The study tries to elucidate the feasibility of Fenton-like oxidation treatment as a water recycling process in cotton fabrics preparation. Two commercial dyes, Reactive Blue 19 and Reactive Red 243, have been analysed. It was concluded that the studied Fenton-like process could be effective in recycling wastewater in cotton fabrics preparation (Bertea et al., 2012).

Altun in his research worked on the topic Prediction of Textile Waste Profile and Recycling Opportunities in Turkey. Effective utilization and disposal of textile wastes requires an accurate prediction of solid waste generation. This research predicted the waste quantity generated in households and in industrial facilities in Turkey via surveys, factory research and official databases. Recycling methods, products and the profile of recycling sector were investigated. Approximately 884,890 tonnes of textile waste was generated in 2009. Dialogue problems between manufacturers and recyclers as well as a lack of collection of post-consumer waste were the main reasons for the low recycling ratio (Altum, 2012).

Ramesh Kumar et al. worked on Textile wastewater treatment using reverse osmosis and SDI deals with the effluent standards and different wastages of woven fabric wet processing industries along with reverse osmosis treatment and SDI (Silt Density Index) explained in detail. The recycling of treated wastewater and zero wastewater discharge concept are found technically feasible and economically viable in the textile dyeing industries located in the area of Erode (Ramesh Kumar et al., 2013).

Harane et al. in their paper give Simple Approach for cost effective reuse of water in pretreatements of cotton. In their study an attempt is made to carry out the pre-treatment processes in an ecologically and economically optimal way by simply reusing the baths of each separate pre-treatment process like desizing, scouring and bleaching by standing bath method without further replenishment of water or chemicals but maintaining the Material to liquor ratio (MLR) by adjusting the size of fabric material accordingly. The reuse of the same bath in each process was done until the results obtained were acceptable for further processing (Harane et al., 2013).

Shaid et al. worked on direct reusing of textile wastewater in scouring-bleaching of cotton goods devoid of any treatment. Reusing of textile wastewater is generally based on some sorts of wastewater treatment process before reusing. y (Shaid et al., 2013).

Shah and Shah carried out research on environmental protection in textile wet processing. In their research, the two important steps in pretreatment process, namely mercerization of cotton and scouring of synthetic fibers have been centralized through water consumption to minimize effluent loads. Both these processes have been performed in the present work through the application of solvents (no water used). After the said pretreatment processes more than 90% of solvent can be recovered and recycled for next processes. The new innovative processes were compared with the conventional processes. The results obtained are quite comparable to that of conventional process (Shah S.R. and Shah J.N., 2013).

Khan and Islam carried out study on textile industry management need to play vital roles in order to protect the water-bodies from severe pollutions. They include the separation process (Zero Liquid Discharge Section) in water recycling. The resultant slurry (concentrate) is fed to the thickener and centrifuging section for converting the liquid concentrate to solid waste. The mother liquor from thickener and centrifuge is recycled back to evaporator. The water separated out from evaporator is good enough in quality to recycle in the plant for Dyeing (Khan A.M. and Islam M.M., 2013).

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IV. References

[1] Altum, S., (2012). “Prediction of textile waste profile and recycling opportunities in turkey.” Journal of Fibres & textiles in Eastern Europe, 20, 5(94), 16-20.
[2] Arafat, H.A., (2007). “Simple physical treatment for the reuse of wastewater from textile industry in the Middle East.” Journal of Environmental Engineering Science, 6, 115–122.
[3] Babu, B.R., Parande, A.K., Raghu, S., and Kumar, T.P. (2007). “Textile technology: Cotton Textile Processing: Waste Generation and Effluent Treatment.” Journal of Cotton Science, 11, 141–153.
[4] Badania, Z, Cabassuda, C, and Ait-Amarb H. (2009). “Membrane separation process for the treatment and reuse of bath dye effluents.” Journal of Desalination and Water Treatment, 9, 105-111.
[5] Balachandran, S., and Rudramoorthy, R., (2008). “Efficient Water Utilisation in Textile Wet Processing.” Institution of Engineering (I) Journal–TX, Volume 89, August, 25-29.
[6] Beckmann, W. and Pflug, J. (1983). “Re-use of weakly loaded liquors from textile processing operations” Journal of American Dyestuff Reporter, 1-6.
[7] Bergenthal, J.F., Eapen, J., Hendriks, R.V., Tawa, A.J., and Tincher, W.C. (1985). “ Full-scale demonstration of Textile Dye wastewater reuse.” Conf. 40th waste conf., 165-171.
[8] Bertea, A.F., Butnaru, R. and Berariu, R., (2012). “Reducing pollution in reactive cotton dyeing through wastewater recycling.” Journal of Cellulose chemistry and technology, 47 (1-2), 133-139.
[9] Bes-Pia, A, Mendoza-Roca, J.A., Alcaina-Miranda, M.A., Iborra-Clar, A., and Iborra-Clar, M.I., (2002). “Reuse of wastewater of the textile industry after its treatment with a combination of physico-chemical treatment and membrane technologies.” Journal of Desalination, Elsevier, 149, 169–174.
[10] Borrows, J.D., and Simpson, T., (1997). “Water reuse: considerations for commissions.” Report by The National Regulatory Research Institute (NRRI), National Association of Regulatory Utility Commissioners (NARUC)., www.nrri.ohio-state.edu, 1-5.
[11] Capar, G., (2005). “Development of a membrane based treatment scheme for water recovery from textile effluents.” Ph.D., Thesis, in environmental engineering,

The graduate school of natural and applied sciences of Middle East technical university, 1-266.

[12] Charoenlarp, K., and Choyphan, W. (2009). "Reuse of dye wastewater through colour removal with electrocoagulation process." Asian Journal on Energy and Environment, 10(04), 250-260.

[13] Chen., X., Shen., Z., Zhu, .X., Fan.,Y., and Wang, W., (2005). "Advanced treatment of textile wastewater for reuse using electrochemical oxidation and membrane filtration." Journal of Water SA, Vol. 31, No. 1, January, 127-132.

[14] Costa1, S.A., Tzanov1, T., Carneiro1, F., Gübitz, G.M., and Cavaco-Paulo1, A. (2002). "Recycling of textile bleaching effluents for dyeing using immobilized catalase." Journal of Biotechnology Letters, 24: 173–176.

[15] De Souzaa, A.A., Meloa, A.R., Pessoab, F.L.P., and De Souzaa, S.M., (2010). "The modified water source diagram method applied to reuse of textile industry continuous washing water." Journal of Elsevier Resources, Conservation and Recycling, 54, 1405–1411.

[16] Deo, H. T., Wasif, A. I., Desai B. K. and Chakraborty A. (1999). "Green technology in textile processing: Part IV-Eco-friendly dyeing of polyester/cotton fabric." Journal of Indian Journal of Fibre & Textile Research, Division of Technology of Fibres and Textile Processing, Vol. 24., 64-69.

[17] Design Manual, (1986). U.S. Environmental Protection Agency, Cincinnati, OH, Effluent Disinfection Processes, Onsite Wastewater Treatment Systems Technology Fact Sheet 4, 17-22

[18] DiGiano, F.A., and Kubiak E.A. (1995). "Feasibility of wastewater reuse at the national spinning company, Washington, NC." Report Water Resources Research Institute of the University of North Carolina., 1-44.

[19] Dresser, C., & McKee, Crook, J., and Molzahn, R. (2007). "Recycling Treated Municipal Wastewater for Industrial Water Use", Report Prepared for Legislative Commission on Minnesota Resources, 1-10.

[20] Environmental Protection Agency Publication,(2002). "Guidelines for environmental management disinfection of treated wastewater.", 1-24.

[21] Ghosh, P.K. and Philip, L., (2005). "Performance evaluation of waste activated carbon on atrazine removal from contaminated water." Journal of Environmental Science and Health, Part B, 40:425–441.

[22] Gomes, A.C., Goncalves, I.C., Pinho, M.N., and Porter, J.J. (2007). "Integrated Nanofiltration and Upflow Anaerobic Sludge Blanket Treatment of Textile Wastewater for In-Plant Reuse" Journal of Water Environment Research, Volume 79, Water Environment Federation, 1-9.

[23] Goodman, G.A., and Porter, J.J. (1980). "Water quality requirements for reuse in textile dyeing processes" Journal of American Dyestuff Reporter, 33-38.

[24] Gozálvez-Zafrilla, J.M., Sanz-Escribano, D., Lora-García, J. and León Hidalgo M.C. (2008). "Nanofiltration of secondary effluent for wastewater reuse in the textile industry" Journal of Desalination Elsevier, 222, 272-279.

[25] Groff, K.A., (1991). "Textile wastes." Research Journal WPCF, Volume 63, Number 4, June, 459-461.

[26] Harane, R.S., and Adivarekar, R.V., (2013). "Simple approach for cost effective reuse of water in pretreatments of cotton." International Journal of Chemical Technology Research, Vol.5, No.2, 671-675.

[27] Harker, R.P. (1980). "Recycling Sewage Water for Scouring and Dyeing" Journal of American Dyestuff Reporter, 28-37.

[28] Heap, S.A., Stevens, J.C., Bailey, D. and Grow, J., (1996). "Dimensional properties of cotton fleece fabrics." Cotton Textile Processing Conference, January 11th 1996, Nashville, TN, USA, 1-5.

[29] Hendrickx, I., and Boardman, G.D. (1995). "Pollution prevention studies in the textile wet processing industry." Report Department of Environmental Quality, Virginia, 1-10.

[30] Hunterlab, (2008). "Kubelka monk theory and k/s application note", vol.18, no. 7, Technical services Department, Virginia, 1-4.

[31] Iowa Storm water Management Manual, (2009). "Gravity Separator Systems." Version 3; October 28, Grease and OilWastes – Problems andbSolutions, 1-11.

[32] Jiang, H., Dong, M. and Yang, F. (2007). "Forecasting of the reactive dyes k/s value based on BP nerve network" Third international conference on natural computation (ICNC) , 1-2.

[33] Jun-ling, Ji, Xu-Jie, Yang, Lu-De, Lu,Wang, X., (2009). "Studies on the Possibility of recycling microencapsulated disperse dye-bath effluents." Journal of Applied Polymer Science, Vol. 113, 3774–3781.

[34] Khan, A.M., and Islam, M.M., (2013). "Textile Industry Management Need to Play Vital Roles in Order to Protect the Water-bodies from Severe Pollutions." Research Journal of Management Sciences, Vol. 2(6), 22-26.

[35] Khandaker, S., Hassan, J., and Osman S. (2012). "Saving underground water by reusing textile wash water in pretreatment process (scouring and bleaching) of cotton goods." IJASETR, Vol.1, Issue 3, 2-13.

[36] Klemencic, A.K., Balabanic, D. (2012). "Recycling of AOP-Treated Effluents for Reduction of Fresh Water Consumption in Textile and other High Water Volume Consuming Industries" Conf. BALWOIS 2012 – Ohrid, Republic of Macedonia – 27 May, 2 June, 1-11.

[37] Kon, H., and Watanabe, M. (2007). "Construction of a treated wastewater reuse system for renewal of water cycle mechanism in urban areas- modeling analysis of reclamation treatment processes corresponding to target water quality by use." Proceedings of 4th IWA Specialist Conference, Efficient Use and Management of urban Water Supply, 171-180.

[38] Krishnaswamy, R., Kaliannan,S., Kannadasan, T., and Duraisamy, P.K., (2009). "Study on treatment and re-use of wash water effluent form textile processing by membrane techniques." Journal of Modern Applied Science, Vol. 3, No. 10., 3-8.

[39] Lahnsteiner, J., and Klegraf, F., (2005). "Industrial Water Reuse Case Studies." Report WABAG, IWA, Newsletter of the Specialist group on Water Reuse, 1-5.

[40] Lamasa, W.Q., and Fujisawa, R. S., (2009). "Reuse of wastewater from polyester fibres dyeing process by thermal fixation with dye acid base: case study in a brazilian auto parts facility." Journal of Thermal Engineering, Vol. 8, No 02, 42-49.

[41] Laosheng Wu, L. (2009). "Safe Application of Reclaimed Water Reuse in the Southwestern United States." Report by WEDC Loughborough University, Leicestershire, http://anrcatalog.ucdavis.edu, 1-21.

[42] Lokeshappa, B., Harapanahalli, R., and Siddesha H. (2007). "Wastewater management strategies for textile industries- a case study." Journal of IPHE, Vol.No.3, 37-41.

[43] M. Azwri, (2010). "The effectiveness of activated carbon from coconut shell as wastewater pollutant removal." Thesis submitted at Engineering Faculty of Civil Engineering & Earth Resources Universiti Malaysia, Pahang, 1-2.

[44] Manivaskam, N. (1995). "Water used in textile processing-quality, treatment and analysis." Sakthi Publications, Coimbatore, India, 61-64.

[45] Manual, (2006). Texanlab Laboratories Pvt. Ltd.Colourfastness Testing Series,1-6.

[46] Marcuccl, M., Nosenzo, G., Capannelli, G., CiabattP, I., Corrieri, D., and Ciardelli, G. (2001). "Treatment and reuse of textile effluents based on new ultrafiltration and other membrane technologies." Journal of Desalination, Elsevier, 138, 75-82.

[47] Mattioli, D., Florio, L.D., and Giordano, A.et al. (2005). "Efficient use of water in the textile finishing industry." Report Official Publication of the European Water Association (EWA), 1-18.

[48] Melgoza, R.M., Cruz, A. and Buitrón, G. (2004). "Anaerobic/aerobic treatment of colorants present in textile effluents." Journal of Water Science and Technology, IWA Publishing, Vol. 50, No. 2, 149–155.

[49] MODULE - 1 Fibre and Fabric (2010). Home Science in Daily Life, 169-170.

[50] Mohan, N., Balasubramanian, N., and Basha, C.A. (2007). "Electrochemical oxidation of textile wastewater and its reuse." Journal of Hazardous Materials, 147, 644–651.

[51] Nangare, P.B., Wadkar, D.V., and Karale, R.S., (2008). "Impact of textile industry on ground water quality with special reference to Ichalkaranji city, M.S., (India)." Journal of Environmental Research And Development, Vol. 2 No. 4, April-June, 717-725.

[52] Noelte, J., Berch, C., Pak, B., Love, T., and Sheilds, P. (2006). "maximize your recycled water distribution through technical customer service." Journal of Water Environment Foundation, WEFTEC, 932-937.

[53] Paar, A., Costa, S, Tzanov, T., Gudelj, M., and Robra, K.H. (2001). "Thermo-alkali-stable catalases from newly isolated Bacillus sp. for the treatment and recycling of textile bleaching effluents." Journal of Biotechnology, 89, 147–153.

[54] Patel, T.M., Roy, T., Mishra, A. and Nath, K., (2012). "Reclamation of dye wastewater using a flat sheet nanofiltration membrane: Study of permeate flux and quality." Journal of scientific and industrial research, Vol. 71, 437-442.

[55] Petra Forte Tavčer, P.F., (2011). "Dyeing of Environmentally Friendly Pretreated Cotton Fabric." Textile Dyeing, Edited by Prof. Peter Hauser, www.intechopen.com, Slovenia, 78-88.

[56] Phipps, R.J., (2008). "Understanding Fabrics" Manual Learning Seed Suite 301, www,learningseed.com, 1-3.

[57] Porter, J.J., and Goodman, G.A. (1984). "Recovery of hot water, dyes and auxiliary chemicals from textile waste streams." Journal of Desalination, Elsevier Science Publishers, 49,185-192.

[58] Project Report, (2013). "Study of the groundwater potential and quality in Ichalkaranji Municipal council area. District: Kolhapur, Maharashtra.", Volume I, Hydrological investigations, Senior geologist, Groundwater surveys and development Agency, Kolhapur, Water supply and sanitation Department, Government on Maharashtra, 1-10.

[59] Raghu, S., and Basha, C.A., (2007). "Chemical or electrochemical techniques, followed by

[60] Rajamohan, N. (2009). "Equilibrium studies on sorption of an anionic dye onto acid activated water hyacinth roots." African Journal of Environmental Science and Technology, Vol. 3 (11), 399-404.

[61] Ramesh Kumar, M., Koushik, C.V. and Saravanan, K. (2013). "Textile wastewater treatment using reverse osmosis and SDI." Journal of Elixir Chemical Engineering,. 54A, 12713-12717.

[62] Ramesh Kumar, M., Saravanan K. and Shanmugam, R., (2009). "Recycling of Woven Fabric Dyeing Wastewater Practiced in Perundurai Common Effluent Treatment Plant." Journal of Modern Applied Science, Vol.3 No.4, 146-160.

[63] Ramesh Kumar, M., Saravanan, K.,(2010). "Advanced treatment of textile yarn dyeing waste water towards reuse using reverse osmosis membrane." International journal on Applied Bioengineering, Vol. 4, No.1, 25-33.

[64] Ranganathan, K., Karunagaran,K., and Sharma D.C. (2006). "Recycling of wastewaters of textile dyeing industries using advanced treatment technology and cost analysis—Case studies." Journal of Elsevier B.V., 306-318.

[65] Ratanatamskul, C., and Kaweenantawong, N., (2001). "Ultrafiltration as a clean technology for reclamation and reuse of wastewater from textile industry." Conf. Ninth International Conference of Greening of Industry Network, Bangkok, Sustainability at the Millenium: Globalization, Competitiveness and the Public Trust January, 21-25.

[66] Reuse Projects Worldwide (2011). "Review of Wastewater" Collation of Selected International Case Studies and Experiences Report Code: 012_GBP_IIT_EQP_ SOA_01_Ver 1_Dec 2011, 1-60

[67] Rosa, J.M., Tambourgia, E.B., and Santanac, J.C., (2012). "Reuse of Textile Effluent Treated with Advanced Oxidation Process by UV/H2O2" Journal of chemical engineering transactions, Vol. 26, 207-212.

[68] Rosi, O.L., Casarcia, M., Mattiolib, D., and Floriob, L.D. (2007). "Best available technique for water reuse in textile SMEs (BATTLE LIFE Project)." Journal of Desalination, Elsevier, 206, 614-619.

[69] Salvato, J., Nemerow, n. and Agardy, F.J., (2003). “Environmental engineering.” john Wiley & sons, fifth edition, 391-92.
[70] Savin, I.I., and Butnaru, R. (2008). “Wastewater characteristics in textile finishing mills” Journal of Environmental Engineering and Management Journal, November/December, Vol.7, No.6, 859-864.
[71] Sawyer, D., and Chung, L., (2007). “Cost-Benefit Analysis for Cleaner Source Water.” Marbek Resource Consultants Ltd., 1-67.
[72] Schlaeppi, F., (1998). “Optimizing Textile Wet Processes to Reduce Environmental Impact.” Journal of Textile Chemist and Colorist , Vol. 30, No. 4, 19-26.
[73] Schoeberl, P., Brik, M., Braun, R., and Fuchs, W., (2004). “Treatment and recycling of textile wastewater case study and development of a recycling concept.” Journal of Desalination Elsevier, 171, 173-183.
[74] Shah S.R. and Shah J.N. (2013). “A Step towards Environmental Protection in Textile Wet Processing.” Research Journal of Recent Sciences, Vol. 2 (ISC-2012), 35-37.
[75] Shaid, A., Osman M.S., Hannan M.A., and Bhuiyan, M. A. R., (2013). “Direct reusing of textile wastewater in scouring-bleaching of cotton goods devoid of any treatment.” International Journal of Engineering Research and Development, Volume 5, Issue 8, 45-54.
[76] Shaik, M.A. (2009). “Water conservation in textile industry.” Journal of PTJ , November, 48-51.
[77] Smith, B., and Rucker, J., (1987). “Water and Textile Wet Processing-Part I.” Journal of American Dyestuff Reporter, 15-23.
[78] Soares, G., Amorim, T.P., Lageiro, M., and Costa-Ferreira, M. (2006). “Pilot-scale Enzymatic Decolorization of Industrial Dyeing Process Wastewater.” J. Textile Research Journal , Vol. 76(1), 4-11.
[79] Syed, U., Jhatial, R.A., and Peerzada, M.H. (2013). “Influence of Warp Yarn Tension on Cotton Woven Fabric Structures.” Research Journal of Engineering & Technology, Volume 32, No. 1, January, 125-132.
[80] Thakur, B.D., Joshi, M., Chakraborty, M., and Pathak, S. (1994). “Zero Discharge In Textile Processing Through TDS Control.” Journal of American Dyestuff Reporter, August, 32-37.
[81] Tubtimhin, S., (2005). “Pollution minimization and energy saving potentials in the cotton dyeing industry.” Thesis M.S. Asian Institute of Technology, School of Environment, Resources and Development, Thailand, 1-174.
[82] Vandevivere, P. C., Bianchi, R., and Verstraete, W. (1998). “Treatment and Reuse of Wastewater from the Textile Wet-Processing Industry: Review of Emerging Technologies.” Journal of Chem. Technol. Biotechnol., 72, 289-302.
[83] Veerapnneni, S., Wiesner, M.R., Hirschl, D., and Grout, H. (1998). “Wastewater recovery from a textile bleach and dye operation, bench scale evaluation.” Report Water Treatment Technology, Houston, Texas, Report No. 39, 1-34.
[84] Wang, X. J., Chen, S. L., Gu, X. Y., Wang, K. Y., and Qian, Y. Z. (2008). “Biological aerated filter treated textile washing wastewater for reuse after ozonation pre-treatment.” Journal of Water Science & Technology, IWA Publishing, 919-923.
[85] Water Resources Sustainability Project, (2010). “Cost benefit analysis of the chromium recuperation unit for the tanneries.” Environmental Alternatives Unlimited (E.A.U.), 1-3.
[86] Wenzel, H., Dunn, R.F., Gottrup, L., and Kringelum, J., (2002). “Process integration design methods for water conservation and wastewater reduction in industry Part 3: Experience of industrial application.” Journal of Clean Techn. Environ. Policy, 4, 16–25.
[87] Wilcock, A.E., and Hay, S.P., (1991). “Recycling of electrochemically treated disperse dye effluent.” Journal of Canadian Textile, May, 37-44.
[88] Woemer, D.L., Farias, L.T., and Hunter, W.D. (1993). “Use of Membrane Filtration for Water Recycling in Fiber Reactive Dyeing.” Research report, Textile Research and Implementation, Cotton Incorporated, 1-31.

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