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METHODS FOR WASTE WATERS TREATMENT IN TEXTILE INDUSTRY

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Abstract

The processes of production of textiles or wet treatments and finishing processes of textile materials are huge consumers of water with high quality. As a result of these various processes, considerable amounts of polluted water are released. This paper puts emphasis on the problem of environmental protection against waste waters generated by textile industry. The methods of pre-treatment or purification of waste waters in the textile industry can be: Primary (screening, sedimentation, homogenization, neutralization, mechanical flocculation, chemical coagulation), Secondary (aerobic and anaerobic treatment, aerated lagoons, activated sludge process, trickling filtration, oxidation ditch and pond) and Tertiary (membrane technologies, adsorption, oxidation technique, electrolytic precipitation and foam fractionation, electrochemical processes, ion exchange method, photo catalytic degradation, thermal evaporation). The selection of the purification method depends on the composition and type of waste waters.

Keywords: textile industry, waste water, pollution, treatment.

INTRODUCTION

The textile industry is one of the largest and most complicated industrial chains in manufacturing industry. The production of a textile requires several stages of mechanical processing such as spinning, knitting, weaving, and garment production, which seem to be insulated from the wet treatment processes like sizing, desizing, scouring, bleaching, mercerizing, dyeing, printing and finishing operations, but there is a strong interrelation between dry processes and consecutive wet treatments. The textile industry emits a wide variety of pollutants from all stages in the processing of fibers, fabrics and garment production [Table 1].

These include wastewater, solid wastes, emissions to air and noise pollution. The main environmental concern in the textile industry is about the amount of water discharged and the chemical load it carries. The textile industry is very water intensive. Water is used for cleaning the raw material and for many flushing steps during the whole process of production. About 200 L of water are used to produce 1 kg of textile. Water is mainly used for: (a) the application of chemical onto textiles and (b) rinsing the manufactured textiles [2].

Table 1. Types of textile waste produced [1]

Process	Wastewater	Solid Wastes	Emission
Fiber preparation	Little or none	Fiber waste and packaging waste	Little or none
Yarn spinning	Little or none	Packaging wastes, sized yarn, fiber waste, cleaning and processing waste	Little or none
Sizing	BOD, COD, metals, cleaning waste, size	Fiber lint, yarn waste, packaging waste, unused starch-based sizes	VOCs
Weaving	Little or none	Packaging waste, yarn and fabric scarps, used oil	Little or none
Knitting	Little or none	Packaging waste, yarn and fabric scarps	Little or none
Tufting	Little or none	Packaging waste, yarn and fabric scarps, off-spec fabric	Little or none
Desizing	BOD from sizes lubricants, biocides, anti-static compounds	Packaging waste, fabric lint, yarn waste, cleaning and maintenance materials	VOCs from glycol esters
Scouring	Disinfectants, insecticide recisues, NaOH, detergents oils, knitting lubricants, spin finishes, spent solvents	Little or none	VOCs from glycol esters and scouring solvents
Bleaching	H_2O_2, stabilizers, high pH	Little or none	Little or none
Singeing	Little or none	Little or none	Small amounts of exhaust gasses from the burners exhausted with components
Mercerizing	High pH, NaOH	Little or none	Little or none
Heat setting	Little or none	Little or none	Volatilization of spin finish agents-synthetic fiber manufacture

Dyeing	Metals, salt, surfactants, organic processing, assistants, cationic materials, color, BOD, COD, sulphide, acidity/alkalinity, spent solvents	Little or none	VOCs
Printing	Suspended solids, urea, solvents, color, metals, heat, BOD, foam	Little or none	Solvents, acetic acid – drying and curing oven emission combustion gasses
Finishing	COD, suspended solids, toxic materials, spent solvents	Fabric scraps and trimmings, packaging waste	VOCs, contaminants in purchased chemicals, formaldehyde vapours, combustion gasses

The amount of water consumed by various types of fabrics varies from industry to industry depending on the dyeing process and the type of fabrics produced. In fact, it has been found that 38 % of water is used during process of bleaching, 16 % in dyeing, 8% in printing, 14 % in boiler and 24 % for other uses [2]. As a result of various processes, considerable amounts of polluted water are released. The fact is that the water let out after the production of textiles is well beyond the standard and contains a large amount of dyes and other chemicals which are harmful to the environment.

PRECONDITIONS AND MEANS FOR RESOLVING THE PROBLEM

For a long time the toxicity of released wastewater was mainly determined by the detection of biological effects from pollution, high bulks of foam, or intensively colored rivers near textile plants. Today, the identification and classification of waste water are in accordance with existing municipal regulations. General regulations define the most important substances that are critically controlled by consumers and propose a set of activities that should be applied in order to minimize the amount of released hazardous substances.

The characteristics of textile effluents vary and depend on the type of textile manufactured and the chemicals used. The textile wastewater effluent contains high amounts of agents causing damage to the environment and human health including suspended and dissolved solids, biological oxygen demand (BOD), chemical oxygen demand (COD), chemicals, contain trace metals like Cr, As, Cu and Zn and color (Table 2.)

Table 2: Sources of water pollution at various stages of processing [3]

Process	Possible Pollutants	Nature of Effluent
Desizing	Starch, glucose, PVA, resins, fats and waxes do not exert a high BOD.	Very small volume, high BOD (30-50% of total), PVA.
Kiering	Caustic soda, waxes, soda ash, sodium silicate and fragments of cloth.	Very small, strongly alkaline, dark color, high BOD values (30% of total)
Bleaching	Hypochlorite, chlorine, caustic soda, hydrogen peroxide, acids.	Small volume, strongly alkaline, low BOD (5% of total)
Mercerizing	Caustic soda	Small volume, strongly alkaline, low BOD (Less than 1% of total)
Dyeing	Dye stuff, mordant and reducing agents like sulphides, acetic acids and soap	Large volume, strongly colored, fairly high BOD (6% of total)
Printing	Dye, starch, gum oil, china clay, mordants, acids and metallic salts	Very small volume, oily appearances, fairly high BOD.
Finishing	Traces of starch, tallow, salts, special finishes, etc.	Very small volume, less alkaline, low BOD.

The activities to treat hazardous wastes can range from legal prohibition to cost saving recycling of chemicals. Depending on the type of product and treatment, these steps can show extreme variability. Effluents treatment plants are the most widely accepted approaches towards achieving environmental safety. But, unfortunately, no single treatment methodology is suitable or universally adoptable for any kind of effluent treatment. Therefore, the treatment of waste stream is done by various methods, which include physical, chemical and biological treatment depending on pollution load. Our aim is to adopt technologies giving minimum or zero environmental pollution.

During the last 50-75 years, there has been ever-increasing efforts to somehow arrange manufacturing processes in such a way that they cause minimal damage to the environment. At the same time, these efforts are aimed at developing appropriate technologies for wastewater treatment and establish an adequate relationship between regulators and industry. To decrease the quantity of generated waste waters it is necessary applying of a systematic approach to reducing the generation of waste at source. In other words, this approach prevents the creation of waste waters in the first place, rather than treating it once it has been

produced by end-of-pipe treatment methods. Figure 1 shows a general action path recommended to minimize the present problems associated with the wastewater released from textile plant [4, 5]

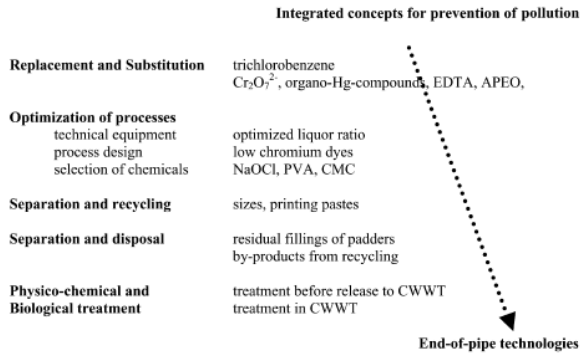

Figure 1. Action plan to minimize the present problems associated with the wastewater released from textile plant

This is a technique that should be applied to all inputs and outputs of a production process. Once waste minimization has been carried out in the factory, effluent will still be produced that will require some form of treatment prior to disposal to sewage, river or sea. Reducing the quantities of generated waste water is important because it contributes to reducing operating costs, the risk of liability and the need to treat the effluents with end-of-pipe methods. It also helps to increase the efficiency of production processes, environmental protection and health, increasing awareness and raising the morale of employees.

END-OF-PIPE TREATMENT METHODS

Numerous techniques and types of equipment have been developed and tested in laboratory tests, on a pilot scale, or in full technical application. The introduction of a technique is always coupled to a general wastewater treatment concept and has to consider the individual situation of a textile producer [6 –8]. As a first step, a separation of different types of wastewater into the following groups is recommended:

- Concentrated liquids: fillings of padders (dyeing, finishing), printing pastes, used dye baths;
- Medium polluted wastes (e.g., washing, rinsing baths);
- Low to zero polluted wastes (e.g., cooling water).

This result in a more effective treatment system as a smaller volume of waste water is treated and it allows for the use of specific treatment methods rather than trying to find one method to treat a mixture of waste with different characteristics. The segregated clean streams can then be reused with little, or no, treatment elsewhere in the factory.

There are two possible locations for treating the effluents, at the textile factory or at the sewage works. The advantage of treating wastewater in the textile factory is that it provides partial or full re-use of water. Produced waste water has to be cleaned from, fat, oil, color and other chemicals, which are used during the several production steps.

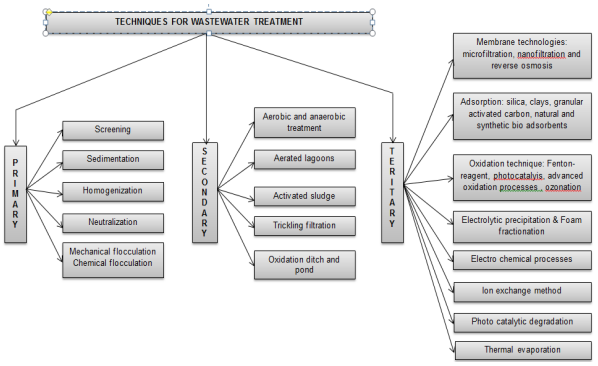

Figure 2. Various methods for the treatment of wastewater from textile plants

The treatment processes may be categorized into primary, secondary and tertiary treatment process (figure 2). The main purpose of secondary treatment is to provide BOD removal beyond what is achievable by simple sedimentation. It also removes appreciable amounts of oil and phenol. In secondary treatment, the dissolved and colloidal organic compounds and color present in waste water is removed or reduced and to stabilize the organic matter. Textile processing effluents are amenable for biological treatments. The textile waste also contains significant quantities of non-biodegradable chemical polymers. Since the conventional treatment methods are inadequate, there is the need for efficient

tertiary treatment process. The commonly used technologies are: coagulation and / or flocculation, membranes (microfiltration, nanofiltration and reverse osmosis), adsorbents (silica, clays, granular activated carbon, natural and synthetic bio adsorbents), oxidation (Fenton-reagent, photocatalyis, advanced oxidation processes, ozonation) and biological treatments (aerobic and anaerobic).

Given the fact that the wastewater from the textile industry is complex and variable, it is unlikely that one treatment technology will be suitable for treatment of all wastewater and water recycling [9]. The application of a certain technology for wastewater treatment is dependent on the type of waste water (not every plant uses the same way of production) and also on the amount of used water. Also not all plants uses the same chemicals, especially companies with a special standard try to keep water cleaned in all steps of production. Water treatment with different kind of pollutants, is large-scale, because of the many cleaning and removing steps involved. So the concepts, to treat the water can differ from each other. Normally a combination of procedures and equipment are applied and a big variety of concepts have been realized.

In Table 3 are given suitable effluent treatment methods for specific textile processing effluents.

Table 3. Suitable effluent treatment methods for specific textile processing effluents [10]

Process	Effluent problems	Coagulation / flocculation	Adsorption	Membranes*	Oxidation	Aerobic	Anaerobic	Other
Sizing								
starch size	COD, BOD, SS					X	X	
synthetic size	BOD, COD, SS			X			X	
Desizing								
cotton blends	COD, BOD, SS, TDS			X		X	X	
Scouring								
cotton / blends	BOD, TDS, colour					X	X	Evap.
synthetic	BOD, TDS					X	X	
wool	pH, BOD, TDS					X	X	
Bleaching								
cotton / blends	SS, peroxide			X				
synthetic	SS, peroxide			X				
wool	SS			X				
Mercerising								
cotton / blends	alkaline, TDS			X				Evap.
Dyeing								
reactive	colour, BOD, TDS, metals			X[2]	X		X[1]	
vat		X	X	X	X	X	X[1]	
disperse		X		X	X	X	X	
direct		X	X	X	X		X	
acid				X	X	X	X	
basic			X	X	X	X	X	
sulphur		X		X	X	X	X	
Printing								
all fabrics	colour, BOD, SS	X				X	X	
Finishing								
cotton / blends	TDS, BOD	X						
synthetics	TDS, BOD	X						

CONCLUSION

The value of water resources is universally recognized and the quality of life depends on the ability to manage available water in the greater interest of the people. The processes of production of textiles especially wet treatments and finishing processes of textile materials (finishing, dyeing, printing, etc.) are huge consumers of water with high quality. As a result of these various processes, considerable amounts of polluted water are released.

Joints efforts are needed by water technologists and textile industry experts to reduce water consumption in the industry. While the user industries should try to optimize water consumption, water technologists should adopt an integrated approach to treat and recycle water in the industry. End-of-pipe technologies are used for wastewater treatment and include sequential application of a set of methods: coagulation / flocculation, flotation, adsorption, evaporation, oxidation, combustion, use of membranes, etc, that has been adapted to the particular situation of a textile plant. As a result of the extreme variety of textile processes and products, it is impossible to develop a realistic concept for an effective treatment of wastewater without a detailed analysis of the actual situation in the textile plant. Characterization of textile process effluent streams is very important to develop strategies for water treatment and reuse. To optimize treatment and reuse possibilities, textile industry waste streams should be in principle considered separately. When the characteristics of the separate streams are known, it can be decided which streams may be combined to improve treatability and increase reuse options.

It is important to explore all aspects of reducing emissions and waste products from the textile industry because it will result not only in improved environmental performance, but also in substantial savings on individual textile companies.

REFERENCE

[1] Moustafa S. (2008) process analysis & environmental impacts of textile manufacturing. Dyes and chemicals.

[2] Ntuli F, Omoregbe I, Kuipa P, Muzenda E, Belaid M (2009) Characterization of effluent from textile wet finishing operations. WCECS 1.
[3] Laxman M (2009) Pollution and its Control in Textile Industry. Dyes and Chemicals.
[4] Anon, Verordnung über die Begrenzung von Abwasseremissionen aus Textilbe-trieben 2/14., BGBL 1992/612, Regulation of the Ministry of Agriculture and Forestry: Austria, 1992.
[5] Schönberger, H., Kaps, U. Reduktion der Abwasserbelastung in der Textilindustrie, Umweltbundesamt; Berlin, 1994;
[6] Ho¨hn, W.; Reinigungmo¨glichkeiten fu¨ r textile Abwa¨sser im U¨ berblick. Melliand Textil. 1998, 79, 647–649.
[7]. Park, J.; Shore, J. Water for the dyehouse: Supply, consumption, recovery and disposal. J. Soc. Dyers Colour. 1984, 100, 383–399.
[8]. Athanasopoulos, N. Abwa¨sser bei der Veredlung von Baumwolle und Baumwollmischungen – von der Versuchsanlage zur Betriebsanlage. Melliand Textil. 1990, 71, 619–628.
[9] Turner MT. Waste Water Treatment and Re-use within the Textile Industry, Water Services Annual Technical Survey, 1978.
[10] Waste minimisation in textile industry, The Indian Textile Journal September 2008, http://www.indiantextilejournal.com/articles/FAdetails.asp?id=1431%20