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Wastewater Reuse and Recycling in the Textile Industry

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Abstract- The textile industry is one of the most significant and rapidly growing sectors of the economy. Textile effluent has a variety of properties due to the usage of a variety of chemicals. Chemicals used in textile manufacturing Textile effluent have a high pH due to the usage of various alkaline chemicals. Chemicals used in textile manufacturing pH, TDS, TSS, and colour may all be removed using a variety of ways ion exchange, coagulation and flocculation, biological decolorization, and adsorption from textile effluent etc. (Khatmode, 2015) In this review paper various methods are explained also reuse of the recycled effluents are also explained.

Keywords- Textile effluent, sawdust, pH, TDS, TSS, BOD, COD, Wet Process.

I. INTRODUCTION

Textile industries have a positive influence on global economic development. China is the largest exporter of all types of fabrics, followed by the European Union, India and then the United. However, one of the problems associated with textile mills is unacceptable effluent, especially dyes, which are difficult to degrade.

The classification of textile industries depends on the type of the fabrics they produce, including cellulosic wastewater. This process includes sizing, desizing, sourcing, bleaching, mercerizing, dyeing, printing and finishing techniques. The dyeing process is an important step in textile production. During this step, color is added to the fibre sand various chemicals can be used to improve the adsorption process between the color and the fibres. When the final product is ready later in the finishing process, some of the dyes and chemicals are part of the textile industry effluent.

These dyes and chemicals, in addition to their unacceptable appearance and toxic effects after breaking, can contaminate the materials obtained from plants (e.g. cotton, rayon and flax), protein fabrics, which are derived from animals (e.g. wool, silk and mohair), and man-made synthetic fabrics (e.g. nylon, polyester and acrylic). The production of fibres in textile factories involves both dry and wet processes. The wet processes significant amount of potable water and releases highly contaminated surrounding soil, sediment and surface water, becoming one of the major global challenges for environmental pollution. (Yaseen, 2019).

This wastewater release causes anomalous colouring of surface water. Some researchers have found that textile wastewater is considered the most polluted water (COD). This includes dyes, pH changes, biochemical oxygen demand (BOD), chemical oxygen demand, contaminated water (COD), large amounts of suspended solids (TDS), and salts and organics. Therefore, laws regulating the use of these substances have been passed in many countries. (Assila, 2020).

Advances in technology and growth in the textile industry are increasing the influx of dyes into wastewater. These toxic substances accumulate in the environment and cause multiple damages to the ecosystem. More than 400,000 tons of reactive dyes are used each year to dye cellulose fibres, mainly cotton. In addition, dyeing 1 kg of cotton can produce 200 kg of wastewater containing up to 50% of the first dye put into the dye bath and up to 100 g / l of salt. On the other hand, most industrial dyes are synthetic dyes, so it took a long time to decompose. Textile dyes cause serious environmental problems all over the world due to their carcinogenic effects on biological systems. Effective removal of these dangerous dyes from industrial wastewater is the greatest challenge in improving the quality of aquatic ecosystems.

Many techniques for treating aqueous staining media, including chemical precipitation, ultrafiltration, aerobic and anaerobic microbial degradation, electrocoagulation / flotation, advanced oxidation processes, electrochemical treatment, reverse osmosis and adsorption have been developed and most of them have been found to be effective. When removing the dye. However, they are expensive, require high energy consumption and uptime, and in some cases can produce large amounts of secondary sludge that must be properly treated to prevent contamination, so industrial use is limited has been done.

Therefore, adsorption has long been recognized as an easy and economical way to remove fibre dyes. Due to its efficiency, high selectivity, low cost, ease of use, simplicity, and availability of inexpensive adsorbents,

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adsorption can be seen as a promising alternative for removing dyes from aqueous solutions. (Tounsadi, 2020)

II. WET PROCESS IN THE TEXTILE INDUSTRY

On the basis of fiber manufacture, the textile industry can be divided into two main processes, such as dry and wet weaving processes. Dry processing mainly generates solid waste, while liquid waste is mainly generated in wet processing steps. Including gluing, decoupling, degreasing, bleaching, mercerizing, dyeing, finishing and printing.

During fiber formation, the consumption of drinking water, various chemicals and dyes as well as the waste water discharge from wet processing steps depend on the operation. It is necessary to adopt economic practices for the use of water in the textile industry (Adane, 2021). The fig below shows us the steps involved in wet process.

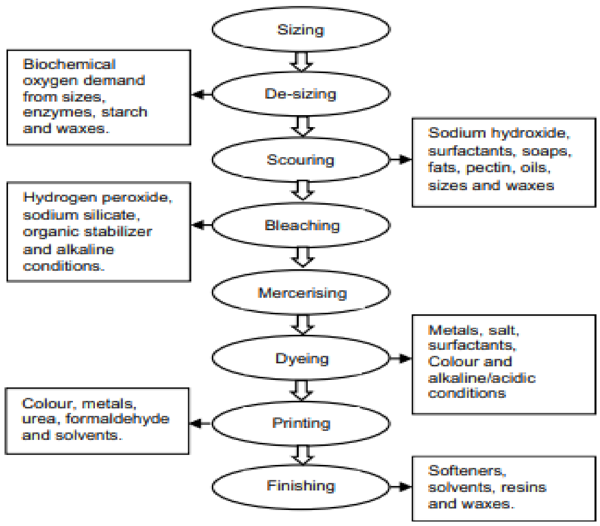

Fig 1. Wet process (Yaseen, 2019).

1. Sizing and desizing process:

In wet processes, various chemicals such as starch, enzymes, waxes and ammonia are used in the fiber sizing process. The wastewater from the unit sizing and sizing processes has a strongly dominant biological oxygen demand (BOD) in the range of 300 to 450 ppm and a solution with a pH value of 45 (Adane, 2021)

2. Bleaching process:

The bleaching process is one that makes whiteness by removing natural dyes from fabric (Adane, 2021)

3. Mercerization process:

In the mercerization process, the caustic soda treatment process is applied to cotton fibers in order to improve the properties of the fiber, such as strength and shine, and to permanently give a higher affinity for dyes and other finishing chemicals. (Adane, 2021)

4. Dyeing and Printing Process:

Dyeing is a process in the textile industry in which a chemical or physical affinity between the fiber and the dye is combined. Dyeing is the process of dipping fabric in a dye solution to fold the color into the fiber. (Adane, 2021)

5. Finishing process:

The finishing process in the textile industry serves to improve the defined properties of fibers. These processes include softening, the antibacterial effect, impregnation and UV protection, which is given to the fabric in the finishing process. (Adane, 2021)

III. TREATMENT METHODS

1. Adsorption Experiments:

The natural minerals M1 and M2 used in this study were collected from the bleaching and tablet areas (Morocco). The natural material was washed several times, mainly with distilled water, dried at 100 ° C. for 24 hours, then pulverized and sieved to reach an average diameter of 80 µm. During the adsorption experiment, Sigma-Aldrich HCl (0.5 M) and NaOH (0.5 M) were used to prepare the pH solution without further purification. The adsorption test for M1 and M2 was carried out using a mass of adsorbent mixed with a solution of fibre wastewater at room temperature with constant agitation. To study the kinetics of adsorption, 5 ml samples were taken every 10 minutes and their concentrations were measured. (Assila, 2020)

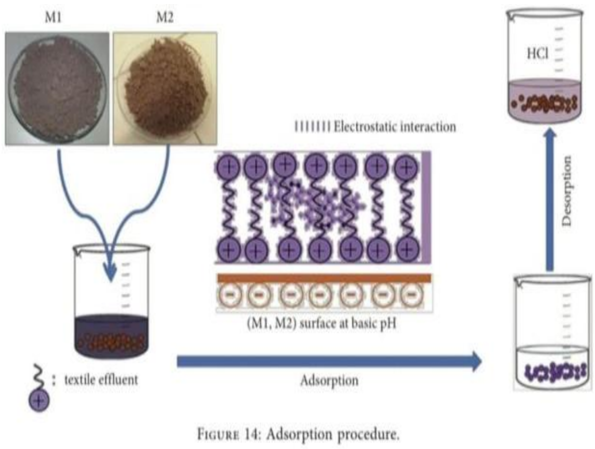

Fig 2. (Assila, 2020).

From this we can conclude that the wastewater solution examined is purple, indicating the presence of significant amounts of dye and suspended solids (MES). The pH of the wastewater is about 6.2, so there is no need to neutralize it. Conductivity of about 252 µs • cm-1 at 22 ° C.

This is explained by the low presence of ions. Wastewater also has a very low biochemical oxygen demand (BOD5) of 20 mg • L-1 and a chemical oxygen demand (COD) of 440 mg • L-1. The values of these two parameters indicate that the wastewater is not overly contaminated with organic or mineral substances. The effect of contact time on absorption was investigated by adding 1 g of adsorbent to 1 litre of a 10-fold diluted solution of fibre waste aqueous solution (pH 2) at room temperature. The results obtained show that the adsorption of wastewater on the two adsorbents M1 and M2 goes through two stages. The first is a rapid phase as soon as there is strong adsorption of up to 61% for M1 and up to 46% for M2 in one hour. The second is the late phase with over 60 people. Percentages can vary significantly between M1 and M2 up to 240 minutes.

This is due to the large number of free adsorption sites available on the surface of the two adsorbents in the early stages of adsorption. However, the remaining vacant remote areas are difficult to occupy due to the formation of repulsive forces between the solid surface wastewater and the aqueous phase wastewater. When 3 g • L-1 was used as the dose of M1 or M2 and the concentration dilution factor was set to 10 at room temperature, the effect on the adsorption experiment of the pH solution of fibre waste water was investigated. The pH range of the solution was adjusted from 2 to 12 using HCl (0.5 M) and NaOH (0.5 M). The adsorption rate is observed to increase with increasing pH of the dye solution, peaking at pH 10 of M1 and M2 at 93% and 86%, respectively. (Assila, 2020)

2. Pilot Treatment Plant:
Pilot treatment plant was prepared and treatment was given to treated municipal wastewater. Units in recycling plant comprises Municipal treated water storage tank, Oil & Grease removal unit, Slow Sand filter (SSF), Granular Activated Carbon filter (GAC), Chlorination unit Cationic Exchange Resin (SAC) and Anionic Exchange Resin (SBA)

Fig 3. (Chougule, 2014).

Experimentation was carried out for total 12 days. First 4 days plant was utilized only to pass the waste water through the pilot treatment plant. Then different parameters were observed for next 8 days continuously. Analysis of Total Dissolved Solids (T.D.S.), Hardness, Oil and grease, PH, Chlorides, Alkalinity, Sulphates, Nitrates, Suspended Solids (S.S.), Biochemical Oxygen Demand (B.O.D.), Chemical Oxygen demand (C.O.D.), Electrical conductivity (E.C.), Most Probable Number (M.P.N.) and other important parameters is carried out (Chougule, 2014) From this we can conclude that the potential of using purified municipal wastewater for industrial water supply is interesting in order to conserve water resources and at the same time support economic development.

Small industries in textile processing buy this water more expensively and treat it again with the necessary treatment as an additional cost. It is possible to reduce the water consumption in cotton pretreatment by reusing the same bath. The same washing and bleaching bath can be used up to 6 or 4 times. Water saving is achieved by reusing the same bath several times for cotton pretreatments such as degreasing and bleaching (Chougule, 2014)

3. Sawdust Method:
The sawdust was collected from Shanti Sawmill, Daund, which is used as an absorbent. The sawdust was collected from the local sawmill and sieved through a 0.5mm mesh.

Then, it was washed with distilled water to eliminate the particles adhering to the surface and dried at a temperature of 60800 C in an oven. (Shaikh, Water conservation in textile industry, 2009)


Fig 4.

This study was meted out in 2 steps. The primary step consisted of the characterization of the effluent samples. The associate analysed parameters were the pH, TSS, TDS and Color. Within the second step physicochemical treatments like adsorption were applied to wastewater so as to scale back pH, TDS, TSS and Color. The sawdust was collected from the native saw mill and sieved through a mesh of size 0.5 mm. Then, it absolutely was washed with distilled water to get rid of the surface adhered particles and dried at a temperature of 60-800C in an oven [12]. A part of effluent was termed as sawdust treated effluent and therefore the different half was termed as untreated effluent.
The sawdust treated and untreated effluent were analysed for pH, TSS (Total suspended solids), TDS (Total dissolved solids).

From this we will conclude that try are created for finding out the removal of ph, TDS, toxic shock and Color from textile effluent by exploitation sawdust as adsorbent. From the experimental finding it's been discovered that sawdust is often used as a good adsorbent for removal of TDS, TSS and Color from textile effluent. The utmost color removal potency was observed up to 65% for sawdust. It's found that pH is reduced from 7.9 to 7.2, the maximum % removal of 45.50% was observed for TSS & the maximum percent removal of 27% was observed for TDS. Also, the Color of textile effluent changes from Dark Brown to lightweight Khaki.

IV. USE OF RECYCLED EFFLUENTS

Reuse of water jet weaving wastewater (Shaikh, Water conservation in textile industry, 2009) The jet weaving waste will be reused within the jet looms. Alternatively, it can be reused within the desizing or scouring process, on condition that in-line filters take away material impurities and oils.

Reuse of bleach bath (Shaikh, Water conservation in textile industry, 2009) Continuous or batch procedures are accustomed prepare cotton and cotton blends, and that they are usually the mill' major water users. As a result of the waste stream is continuous, has usually consistent properties, and is typically simple to become independent from different waste streams, continuous operations are significantly easier to adapt to effluent recycling/reuse. Use j-box and kier drain waste water to saturators, recycling continuous scour wash water to batch scouring, recycling washer water to instrumentation and facility cleaning, reusing scour rinses for desizing, reusing mercerizes wash water or bleach wash water for scouring are all samples of waste stream utilise in a very typical bleach unit for polyester/cotton mix and 100% cotton fabrics.

Preparation chemicals, however, should be chosen in such the way that utilize doesn't produce quality issues admire spotting. Batch scouring and bleaching are less straightforward to adapt to use of waste streams as a result of streams occurs intermittently and aren't simply segregated. With applicable holding tanks, however, bleach tub reuse will be practiced in a very similar manner to dye bath reuse and a number of other items of kit are currently out there that has necessary holding tanks.

Reuse of final rinse water from dyeing for dye bath make-**up (Shaikh, Water conservation in textile industry, 2009)**
The rinse water from the last rinse in a batch dyeing process is fairly clean and can be used directly for further rinsing or to prepare subsequent dyebaths. Several textile and carpet mills use this rinsing water to make dyebaths.

Reuse of soaper wastewater (Shaikh, Water conservation in textile industry, 2009)
The coloured waste product from the soaping operation may be reused at the rear grey washer, that doesn't need water of a really high quality. Alternatively, the wastewater can be used for improvement floors and instrumentality within the print and color shop

Reuse of dye liquors (Shaikh, Water conservation in textile industry, 2009)
The feasibleness of dye liquor utilize depends on the dye used and therefore the shade needed on the material or yarn moreover because the variety of process involved. it's already been applied while disperse colouring polyester, reactive dyeing cotton, acid dyeing nylon and basic dyeing acrylic, on a good variety of machines.

However, commission dyeing wherever the shades required are way more varied and unpredictable would build the reuse of dye liquor difficult. But, given the correct conditions dye liquor may be reused up to ten times before the extent of impurities limits further use.

Reuse of cooling water (Shaikh, Water conservation in textile industry, 2009)
Cooling water that doesn't is available in contact with material or method chemicals are often collected and apply directly. Examples embrace condenser-cooling water, water from cool bearings, heat-exchanger water, and water recovered from cooling rolls, yarn dryers, pressure colouring machines, and air compressors. This water can be wired to plight storage tanks for reuse in operations reminiscent of dyeing, bleaching, rinse and clean-up wherever heated water is needed or used as feeding water for a boiler.

Reusing wash water (Shaikh, Water conservation in textile industry, 2009)
The most in style and flourishing strategy applied for reusing wash water is counter- current laundry. The counter-current washing methodology is comparatively easy and inexpensive. For each water and energy savings, counter-current washing is used often on continuous preparation and dye ranges. Clean water enters at the ultimate wash box and flows counter to the movement of the material through the wash boxes.

With this method the smallest amount contaminated water from the final wash is reused for the next-to-last wash and then on till the water reaches the primary wash stage, wherever it's finally discharged. Direct counter-current washing is currently typically built into the method flowchart of recent textile mills. It's conjointly simple to implement in existing mills wherever there's a synchronous process operation.

V. CONCULSION

The aim of this review work was to know the wet process of textile industry and appropriate wastewater treatment technologies, which are removing effluents from the wastewater of textile factories to mitigate water pollution. Various technologies and methods have been observed to remove dyes from water in the textile factories in this review paper.

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