ANALYSIS OF PULP AND PAPER INDUSTRIAL EFFLUENT AND ITS TREATMENT A REVIEW

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Abstract: The pulp and paper industry is one of the water intensive industries around the world which produce a large quantity of wastewater. The effluents of these industries contains heavy metals, color, pH, high amount of BOD, COD, TSS, TDS etc. and are critical to the environment if its discharged without proper treatment. Different treatment method has been discussed in many research papers to treat the paper industry waste water but the best result is given by the adsorption method of treatment as it is more versatile, effective, simple and economical in comparison to the other methods.

IndexTerms - pulp and paper effluents, heavy metals, adsorption, phytoremediation, efficiency

I. INTRODUCTION

The pulp and paper industry is considered as 6th polluter industry among 17 polluting industries in the world as per MOEF (ministry of environment and forests) [1, 2]. Continent wise, Asia produces the largest pulp and paper in the world. The other two major continents are Europe and North America. China is the current world's largest producer country of pulp and paper after succeeded United States in 2009. India is ranking 20th in the list of paper production. The global production and consumption of paper is around 400 million metric tons each year. The annual pulp and paper production of china is approximately 99.3 million tons as per 2011 data. The demand grows with the increase in population although paper demands increases with the type and region. The world's paper demand was nearby (5-6) % each year. The capacity of the paper mill was estimated to increases from 8.3 million tons (2010) to 14 million tons (2020) [3]. The demand of paper in India increases from 3.8 million tons annually (2007) to 4.9 million tons annually (2010) [2]. The paper production in India is mainly dependent on agricultural waste due to the limited forests area. The raw material is divided as 70% from agricultural waste, bamboo, wood and 30% from waste paper recycling [4].
The main problem of the pulp and paper industry is the high consumption of raw water and production of large quantity of waste water [5]. The effluent production rate is around 1.5cubic meter/one ton of paper [6]. The pulp and paper wastewater contains color, heavy metals, chlorine, sulphur, high amount of BOD, COD, TSS, TDS, pH, DO etc. which are critical if it enters to the environment [7]. Most of industries don't follow the standard rules and directly dispose their effluents to the water bodies and land without giving proper treatment. It causes the contamination and affects the life of aquatic flora and fauna. Therefore, it is highly need to understand the characteristics of industrial effluents and develop the treatment methods which are economical and easy to treat the effluents.

II. CHARACTERISTICS OF PULP AND PAPER INDUSTRY EFFLUENTS

The influent of the pulp and paper industry contain dark color, TDS, TSS, high BOD & COD, chlorinated compounds, sulphur compounds, AOX (adsorbable organic halides), VOCs, metals which are not recommendable for directly discharge into the environment. The major steps in paper making are pulping and the bleaching process. High strength BOD, AOX and VOCs are produced in both the processes whereas chlorinated compounds and color are produced in the bleaching process.
In many researches it has been reported that the dark color of waste water inhibits the sunlight to reach the aquatic plants that are dwelling inside the river bed or water bodies and hence affects the rate of photosynthesis and fish population. In some places due to the irrigation with insufficiently treated paper mill effluent, it was found increase in the level of pH, electrical conductivity and heavy metal concentration in the soil.

III. VARIOUS TREATMENT METHODS

The treatment of waste water is dependent on its effluent characteristics. There are many methods to treat the pulp and paper effluents of which some techniques are discussed below.

3.1. ADSORPTION

It is an adhesion process in which one molecular species deposited over another molecule. The molecular species which is adsorbed are adsorbate and the surface where it occurred is an adsorbent.

Devaki R et.al (2017), examined the adsorption capacity of chemically activated, activated carbon prepared from banana trunk. The batch experiments were conducted to find out the adsorption abilities w.r.t. contact time, pH variation and dosage limit. The best results were obtained at the dosage of 3mg/50ml at pH of 6 and contact time of 180 minutes. The removal efficiencies are color (96.8%), COD (96.57%), TSS (82.6%) and TDS (86%).

C. B. Shivayogimath, Chidamber Joshi (2015), used mixed adsorbent of coconut shell and silica gel to remove the organic pollutants from the pulp and paper mill. The batch method was used to test the adsorbent ability of adsorption with respect to contact time, pH and dosage amount. The most favorable result was obtained at the contact time of 45minute, dosage of 50g/l and pH of 2. The efficiencies of pollutants removed were turbidity (72.51%), COD (88.6%), color (91.92%) and total carbon (92.5%).

Shivayogimath C.B et.al (2014), activated carbon prepared from teakwood saw dust was used as an adsorbent. The experiments were conducted using batch technique to understand the effect of dosage, contact time and pH on the adsorption process on the paper mill pollutants. The effective result was at dosage of 6mg/200ml, contact time of 6hrs and pH of 2. The percentages of pollutant removed are TDS (73%), color (83.19%), turbidity (85.03%) and COD (94.67%).

3.2. COAGULATION/FLOCCULATION

The process by which the sedimentation of tiny suspended solids in a solution is done by adding some chemicals is called coagulation. In coagulation there is a neutralization of charge but flocullation is a physical process and no charge neutralization takes place. The most common coagulant is Alum.

Pradeep Kumar et.al (2011), had done coagulation method to determine the COD and color removal from the pulp and paper effluents. The three different coagulants used were aluminum chloride, poly aluminum chloride (PAC), copper sulphate. The effluents collected were diluted with distilled water to make its COD reach 7000mg/l and other parameters like BOD, pH, TSS, TDS, conductivity and color were recorded before analyzing the COD and color removal efficiencies with all the coagulants. After addition of the coagulant to the effluent, pH was adjusted by adding NaOH(1M) or sulphuric acid(1M) solution. The mixing of the coagulants and effluents were done for 30 minutes and kept inactive for 6 hrs. The color was measured by UV spectrophotometer of 250nm and COD by dichromate open flux method. The optimal results were obtained at pH 4, 5 and 6 for Alcl3, CuSO4 and PAC. The removal percentages of the respective coagulants were COD (72%, 74% and 84%) and color (84%, 76% and 92%) at the dosage of 5g/l, 5g/l and 8ml/l.

3.3. ELECTROCOAGULATION

It's the method in which the electricity is passed to precipitate the dissolved and suspended solid. The electrocoagulation's percentage removal for TSS, BOD and bacteria is more efficient than chemical coagulation and sedimentation.

Deepak Sharma (2014), reported high removal of color (92%), BOD (85%) and COD (89%) from pulp and paper effluent by using aluminum electrode at an electrode distance (1.5cm), temperature (28degree Celsius), pH (7) and current density (25mA/cm2).

3.4. PHYTOREMEDIATION

It is the technique in which we use living plant to degrade or remove contaminants of soil, water and air. It is an economical and solar energy dependent technique. We only need to focus on the factors on which different plant can give us optimum results.

B. Ashok Kumar et.al (2014), examined the phytoremediation method by using Croton sparsiflorus plant to remove the heavy metals from paper mill effluent. In this experiment the other materials used apart from paper mill effluents and seeds of sparsiflorus plants are garden soil and vermicompost cowdung. The seeds of the Croton sparsiflorus were put in different experimental pots with different concentrations of the soil mixtures (consists of garden soil, vermicompost cowdung and paper mill effluents) namely A (A1,A2,A3,A4), B (B1,B2,B3,B4), C (C1,C2,C3,C4), D (D1,D2,D3,D4), E (E1,E2,E3,E4) and F (F1,F2,F3,F4). The study was conducted for 60 days where plants were harvested at the duration of days (15, 30, 45 and 60). After harvesting the plant the soil had been analyzed by AAS (atomic absorption spectroscopy). The results of experiment were good for those pots where there were more vermicompost cowdung along with the garden soil. This suggests that phytoremediation method is more effective if the growth condition of plant is good.

V K Verma et.al (2005), studied the heavy metals (Zn and Pb) absorption by water hyacinth for 20 days. The technique is basically called as phytoremediation. The water hyacinth was collected, cleaned, grown and maintained in the laboratory conditions along with the effluent sample. They found that absorption ability of the plant depends on the duration, concentration of the effluent sample and the heavy metal ions size. The plant absorbed more metal concentration at the low effluent concentration and vice versa. The reason for decreasing uptake rate by plant at the higher concentration of effluent was due to the Toxicity of the effluents. The maximum uptake efficiencies for the duration (0, 5, 10, 15 and 20) in days and concentration of effluent in percentages (0, 5, 15, 20 and 25) were Pb (80.3%) and Zn (73.4%).

3.5. CHEMICAL OXIDATION

Basically oxidation is the loss of electron. The main reason for chemical oxidation is to degrade the organic/inorganic pollutants and make it easy for biological degradation process. It involves addition or generation of oxidant (ozone, H2O2, Cl2O2, Cl2, O2, hydroxyl radical etc).

Parveen Kumar et.al (2011), reported that the treatment of paper industry effluents with UV/TiO2/H2O2 for 4 hours at pH (7), dosage (0.5g/L TiO2 and 15mM/L H2O2). The organic load removals of primary clarified effluents were BOD (42.9%), COD (52.9%) and color (89.2%). The result of pollutant removal for bio treated effluents were BOD (52.7%), COD (74.8%) and color (95.4%). The treatment with UV/TiO2/H2O2 is more efficient than the UV/TiO2 system of treatment. Both the treatment increases the biodegradation of organic matter and hence improves the quality of waste water.

IV. CONCLUSION

The review from various paper and processes indicated that the adsorption process is more convenient for the treatment of pulp and paper effluents. It has the high potential for removing BOD, COD, TSS, TDS, color and heavy metals which can decrease the toxicity to the water and the soil. There is a need for many researches on this field of treatment because it gives good results, simple to operate, energy efficient and the cost of adsorbent is comparatively very low as compared to the other method of treating the waste water effluent.

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