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Waste water treatment process using Nano TiO_2

N. Saravanan [a], K.S.K. Sasikumar [b]

[a] Professor, Department of Mechatronics Engineering, K.S. Rangasamy College of Technology, Tiruchengode 637215, India
[b] Professor, Department of Mechanical Engineering, Kongu engineering College, Perundurai 638052, India

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ABSTRACT

Textile industry outlet Waste water contain a several mixture of polluting substances involving solvents, detergents and dyes. Textile manufacturers are in a situation to sort out this issue by adopting a suitable treatment technology for textile effluent. Notably the application of ceramic Nano Filtration (NF) plays a significant role in recycling the specific waste in the textile industry thereby paving way to waste recycling instead of being disposed of in land whereas it seems to be impossible for most of the conventional technologies in treating this textile effluents. The Initial performances of commercial NF membranes have been studied thoroughly pertaining to Total Dissolved Solids (TDS), Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) rejection. The outcome showed that maximum separation of dye and salts where achieved by some of the commercial membranes while some achieved higher flux owing to the inconsistent parameters of textile waste water and NF membranes chosen. These work forefronts and studied the problem associated with textile waste water and waste water recycling using the ceramic nano filtration membrane.

Selection and peer-review under responsibility of the scientific committee of the International Conference on Nanotechnology: Ideas, Innovation and Industries.

1. Introduction

Nanotechnology has occupied a prominent place recently and established as the most active research fields in the areas of modern science, technology and engineering. Nanotechnology deals with structures with size ranges between 1 and 100 nm and involves developing materials or devices within that size. Automation and industrialization has deepened its roots in creating a significant impact on ecosystem which has resulted in rapid deterioration of water quality. The industrial effluents released threatens the environment due to its effluent characteristics. The effluents particularly from textile, leather and paint acts as potential carcinogens and proves to be more hazardous and toxic compounds targeting the nearby water bodies. Considering both volume and composition, the wastewater produced by the textile industry contributes more as water pollutants. Effluent from dyehouses contain high concentrations of both inorganic and organic chemicals [1–4]. Today more than 9000 types of dyes have been incorporated in the color index. Owing to their low biodegradability, a convention biological treatment process seems to be non-effective in treating dye wastewaters, especially the reactive dyes. Usually Physical or chemical processes are used to treat them. However, these processes are costly and cannot be used effectively to treat the wide range of dye wastewater. The conventional chemical methods were chemical coagulation, flotation, chemical oxidation and adsorption out of which adsorption are most used technique for removing color from wastewater. This method is expensive but yields higher effectiveness [5,6]. The industries expecting cost effective and user friendly methods. Membrane separation process is one of the popular methods often being used in the textile industry. Although this technique requires relatively high initial setup cost, it is outweighed by the significant cost savings achieved through the reuse of salts and water. Operating costs are normally reduced by the use of pre-filters, regular cleaning to eliminate membrane-fouling problem, and choosing the most appropriate membrane system. Ultra Filtration (UF), Nano Filtration (NF) and Reverse Osmosis (RO) have been widely used techniques for the full scale treatment and reuse of chemicals and water [7–9]. The membrane surface can be contaminated and its pores can be clogged by the materials in the feed water, resulting in a decreasing flux. Fouling behavior of different membranes varies pertaining to their cut off values and their material properties, such as hydrophobicity. Solution chemistry is also takes a significant role in membrane fouling. A pretreatment process is

E-mail address: saranvimal@gmail.com (N. Saravanan).

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Table 2.1
Characterization of Waste Water.

Parameter	Raw Effluent (mg/l)
PH	10–12
TDS	4100
COD	1100
BOD	400

Table 2.2
Bio Chemical Oxygen Demand.

B.O.D Range	Report to nearest Value (mg/l)
0–10	0.1
10–100	1
100–1000	5
>1000	10

therefore needed before the solution is applied to the membrane process for removing the materials from the feed solution that give rise to the membrane fouling. The study involves coagulation and sedimentation process for pretreatment so as to remove colors and organics from the feed waters of the membrane process. After precipitation effluents were filtered using filter papers to stain the flocs remained in the solution and used as feed solutions of the membrane process. This present work mainly focused on the determination of optimum conditions for the pretreatment [10].

2. Materials and methods

2.1. Nano titanium dioxide

The phenomenon of photo catalytic splitting of water on a TiO_2 electrode under ultraviolet light. Photo catalysis using Titanium dioxide (TiO_2) is a contaminant treatment process that has earned much attention in the research field for more than two decades. TiO_2 has become renown photo catalyst material for both air and water purification. It seems to be very active in bacterial destruction even under limited ultraviolet light available in regular fluorescent lights. Based on this technology several commercial products have been developed for antibacterial applications in hospital and other bacteria prone environments. TiO_2 can exist both in crystalline and amorphous forms. TiO_2 has been wide range of uses such as pigment and in sunscreens, paints, ointments, toothpaste etc. These application can be roughly divided into "energy" and "environment" categories, many of which depend not only on the properties of the TiO_2 material itself. Thus the performance of TiO_2 based devices is largely influenced by the sizes of the TiO_2 building units, apparently at the nanometer scale [3].

2.2. Characterization of waste water

The discharged wastewater containing artificial dye molecules, salts and other constituents were considered for this study. The wastewater can be characterized into various parameters such as pH, Total Dissolved Solids (TDS), Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD). Different Parameters of discharged wastewater is given in Table 2.1.

2.2.1. Total dissolved solids (TDS)

Estimation of Total dissolved solids is done by adopting the following methods: Water sample of 100 ml or lesser volume is taken in a pre-weighted evaporating dish. Dry it over a water bath. Keep it at 180c + 2c for one hour. The same is cooled in a desiccator. Note down the final weight. The Total Dissolved Solids at 180C is calculated by dividing the difference between final weight and initial weight with volume of sample multiplied by thousand.

2.2.2. Biochemical oxygen demand (BOD)

Estimation of Biochemical Oxygen Demand is done as follows: Water sample of 1 l or a sufficient portion diluted to 1 l measuring jar is taken in two BOD bottles with the sample by siphoning preventilated H_2O should be used for dilution. Determine initial sample BOD bottle (d1), Incubate another BOD bottle for 5 days at 20 °C and find the final BOD as (d2) in mg/l with the difference in initial BOD of the bottle and final BOD of the bottle multiplied with dilution factor. Different ranges of BOD values are given in Table 2.2.

2.2.3. Chemical oxygen demand (COD)

The sample is taken for Chemical Oxygen Demand estimation and it is done as follows: A 100 ml or 200 ml sample is taken. Use 0.00417 m. $K_2CR_2O_7$ reduce the total volume to 150 ml by boiling in the refluxing flask, open to the atmosphere without the condenser attachment. After the volume is reduced to 150 ml condenser is attached and refluxed for 2 h and then 150 ml is added and Titrated against 0.025 m. FAS with ferroin indicator. A blank digestion is carried out to find out chemical oxygen demand.

3. Results and discussions

3.1. Effect of pH and TDS

The pH values of textile effluents were measured before and after the treatments using pH meter. The result of pH was shown in the Fig. 3.1(a). The pH values before the treatment shows higher than after treatment. The TDS removal before and after the treatment with different time periods were depicted in the graph 3.1 (b). The results show that the TDS showed a gradual reduction after the treatment was carried out. The nature of the membrane

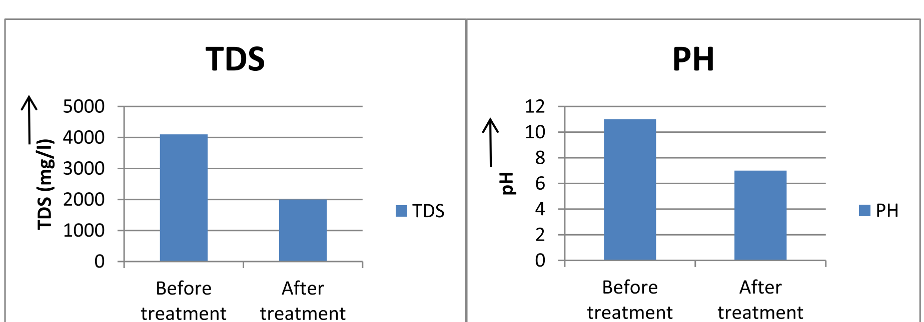

Fig. 3.1. (a) Effect of pH; (b) Effect of TDS.

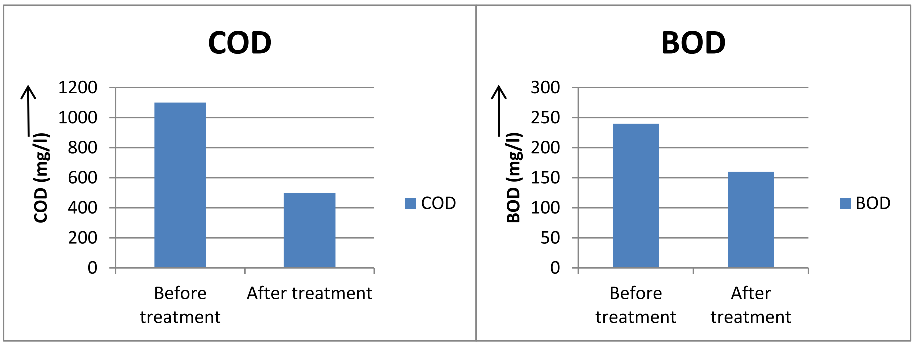

Fig. 3.2. (a) Effect of COD; (b) Effect of BOD.

preparation, dye concentration and pH that the dye removal can affect in different concentrations.

3.2. Effect of COD and BOD

In results COD and BOD removal for effluents before the treatment were obtained lesser than after the treatment and results showed that COD and BOD could be removed completely by ceramic Nano Filtration membrane for textile effluents. It is concluded that Nano filtration system has been proven to be well suited for the treatment of high dye and salt concentration of textile wastewater and the parameters in steps were optimized. The removal of COD and BOD before the treatment and after the treatment were shown in Fig. 3.2(a) and (b). The results show that the removal after the treatment were obtained lesser than that of after the treatment.

4. Conclusions

Textile wastewater typically consists of different types of dyes, detergents, grease and oil, heavy metal, inorganic salts and fibers in amounts depending on the process. The effluent is generally characterized using parameters such as BOD, COD, Total Dissolved Solids (TDS), pH and color. In this study the Nano-TiO_2 membrane was used as filter in the effluent water treatment. The results proved that pH of the treated water was dramatically reduced to nearly neutral pH (6.5) from base pH (12). The COD and BOD values were reduced to 480.160 mg/l, 1100.240 mg/l respectively. From this result we concluded that Nano-TiO_2 acts as an effective membrane for effluent water treatment.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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