Treatment of Oman Pharmaceutical Industry Wastewater Using Low Cost Adsorbents

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Abstract—The treatment of Oman pharmaceutical industry wastewater was performed using low cost natural adsorbent prepared from date palm seeds. Batch experimental studies were carried out to investigate the degradation of pollutants present in the wastewater and the effect of various parameters was evaluated. The optimum contact time was found to be 60 min and the treated effluent parameters, pH, biological oxygen demand (BOD), chemical oxygen demand (COD) and total dissolved solids (TDS), total suspended solids (TSS) and turbidity were found to be substantially reduced.

Keywords—Wastewater, Low Cost Adsorbents, BOD, COD, TDS, TSS

I. Introduction

The treatment of pharmaceutical wastewater to the required effluent standards has always been a tough task due its complexity in nature. A typical pharmaceutical industry is characterized by high values of Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), turbidity, Suspended Solids (SS) and it may contain various refractory organic materials that cannot be degraded easily. The organic chemicals present in the pharmaceutical industries wastewater are complex in nature and mostly resistant to biological degradation. The effect of pharmaceutical wastes in the environment is a raising concern about the potential environmental consequences and it has an impact on the surface water, aquatic species, human health and surrounding lands, which may cause a serious problem to drinking water directly or indirectly. The effect of these contaminants depends upon the processing technology, nature of chemicals used, size, the complexity and characteristics of wastewater discharged. Various techniques employed in the treatment of pharmaceutical wastewater such coagulation, flocculation, sedimentation, sand filters, activated carbon adsorption, aerobic and anaerobic biological contactors and able to achieve the treated effluents to allowable limits for reuse purposes [1-2]. Various studies reported [3-8] on the treatment of pharmaceutical wastewater using advanced techniques like membrane bioreactor, advanced oxidation and in the present study, the pharmaceutical industry wastewater was treated using activated carbon prepared from date palm seeds and the effect of contact time, pH, dosage and particle size in removal of pollutants was evaluated.

II. MATERIALS AND METHODS

A. Materials

The required amount of date seeds was collected from Oman local market; washed with distilled water and dried under sun. After drying, 1.5 kilo grams of date seeds was taken and soaked in 400 ml of phosphoric acid (H_3PO_4) and kept for 24 hrs. After that, a batch of date seeds was poured in a metallic cylinder and it was kept in the furnace at 400 ^oC for 4 hrs to produce the activated carbon from date palms seeds. Then carbon taken from the furnace was washed with distilled water till the pH shows 7. After washing, the activated carbon dried in drying oven at 105oC for 1 hr, then grind using blender. By using sieve trays, two different sets of activated carbon of different sizes were prepared, which was subsequently used in the treatment studies.

The pharmaceutical wastewater was collected from the National Pharmaceutical Industry located in Al Rusyl, Oman. The rotatory shaker model Rotaterm (P Selecta make) was used to stir the samples at 100 rpm. The pH of the samples was measured using digital pH meter MK VI model and turbidity was measured by turbidity meter. Chemical Oxygen Demand (COD) was measured using COD digester model Orion COD 125 and photometer model Orion AQ 4000 and Biological Oxygen Demand (BOD) was measured using Dissolved Oxygen meter.

B. Methods

The samples of wastewater from pharmaceutical industry are taken in conical flask placed in a shaker at about 100rpm, kept for five different durations to reach the optimum time for equilibrium adsorption by activated carbon particles. An optimum time of 60 minutes was found out from the initial equilibrium studies and it was fixed for all the rest of experiments. The samples were analyzed for Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), pH, turbidity and its variations with respective contact time, size of adsorbent, dosage of adsorbent was evaluated. The initial characteristics of collected sample have been shown in table 1.

TABLE I. INITIAL CHARACTERISTICS OF COLLECTED SAMPLE EFFLUENT

Parameters	Value
pH	5.95
DO (ppm)	1.84
TDS (ppm)	10.0
TSS (ppm)	6.0
COD (ppm)	354
BOD (ppm)	1.3
Turbidity (NTU)	4.0

III. Results and Discussions

A. Effect of contact time

Samples in five labeled conical flasks (60min, 90min, 120min, 150min and 210min) were kept for shaking on the orbital shaker at about 100 rpm by adding 0.2g 600µm size activated carbon. After each time designated, it was taken out from the shaker, filtered and analyzed for various parameters. The optimum contact time was found to be 60min because the percentage reduction in most of the parameters remains constant and it seems equilibrium was reached by that contact time.

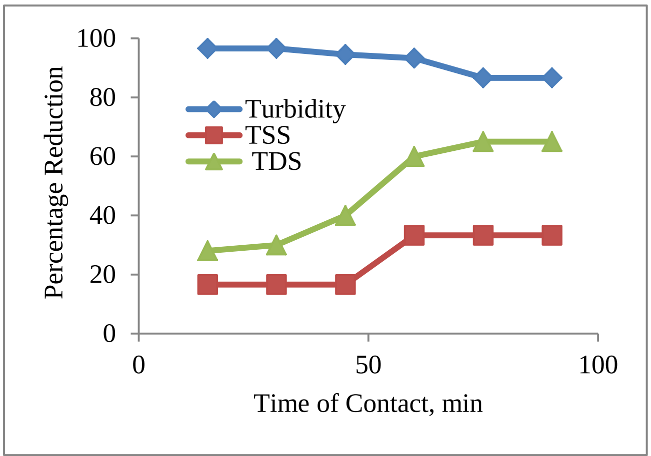

Fig. 1. Percentage Reduction of Turbidity, TSS and TDS with respective to time

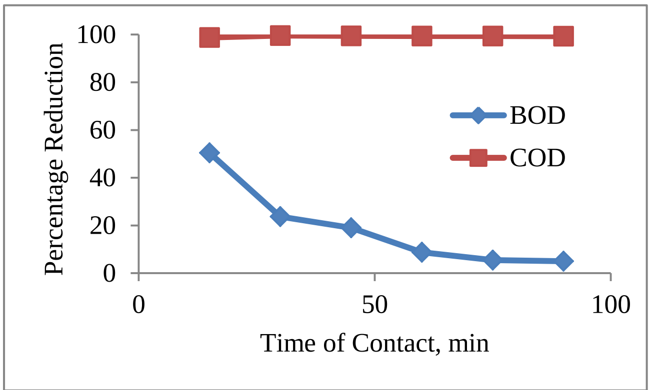

Fig. 2. Percentage Reduction of BOD and COD with contact time.

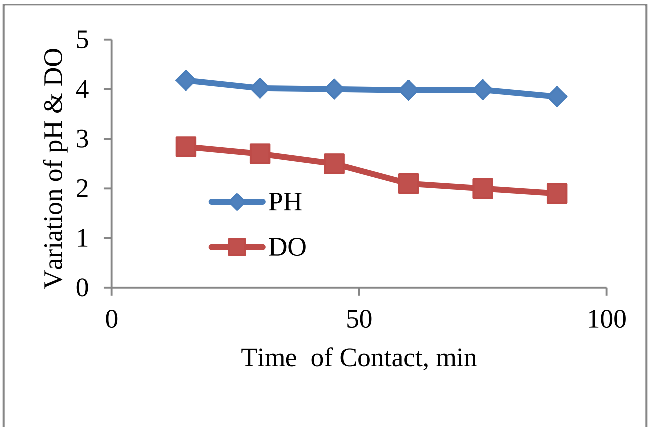

Fig. 3. Variation of pH and DO with contact time

Fig. 1 shows the percentage reduction of turbidity, total suspended solids, total dissolved solids and it was observed that the reduction of turbidity was higher initially and then decreases whereas a reverse trend was observed in the case of TSS and TDS. An optimum of 94% reduction in turbidity, 60% in TDS and 34% in TSS was achieved after 60min of contact time.

Fig. 2 shows the percentage reduction of BOD and COD with respective time. Reduction of BOD was higher initially and then reduced to reach an optimum of 21%, whereas almost complete reduction was observed in COD after 60min contact time.

Fig. 3 shows the variation of pH and DO with respective time and it was observed that the variation of pH was marginal and there is a slight decrease in DO.

B. Effect of adsorbent size

Samples in five labeled conical flasks (75µm, 150µm, 300µm, 425µm and 600µm) were kept for shaking on the orbital shaker at about 100 rpm by adding 0.2g activated carbon in each flask. The shaking was allowed for 60min then it was taken out from the shaker, filtered and analyzed for various parameters. The percentage reduction in parameters was increased with increase in size of the adsorbent up to 400µm and then it was stable. This indicates that 400µm adsorbent size can be considered as optimum. A maximum of 96% reduction in Turbidity and TSS, 90% in TDS, almost 100% reduction in COD, 90% in BOD was observed as shown in Fig. 4-5. pH and DO slightly increased with increase in adsorbent size as shown in Fig. 6.

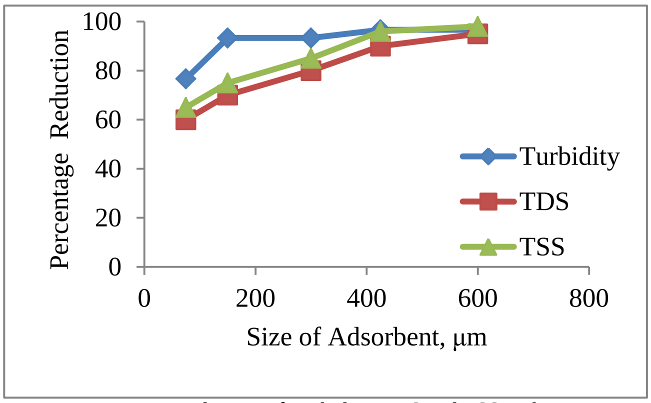

Fig. 4. Percentage Reduction of Turbidity, TDS and TSS with variation in adsorbent size

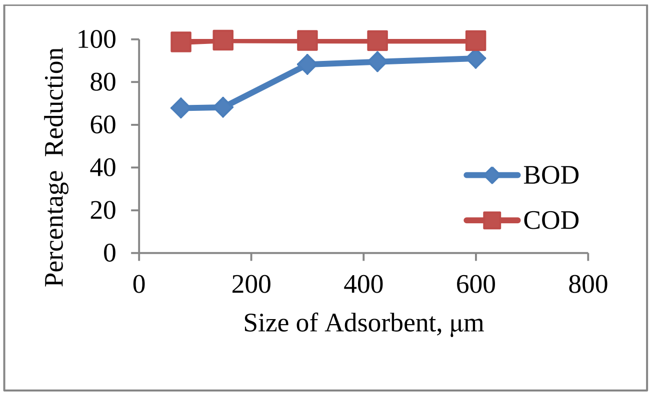

Fig. 5. Percentage Reduction of COD and BOD with variation in adsorbent size

C. Effect of adsorbent dosage

Samples in five labeled conical flasks (0.5g, 1.0g, 1.5g, F2.0g and 2.5g) were kept for shaking on the orbital shaker at about 100 rpm by adding 0.2g 400µm size activated carbon in each flask. The shaking was allowed for 60min then it was taken out from the shaker, filtered and analyzed for various parameters. The percentage reduction in parameters was decreased with increase in the dosage of the adsorbent up to 2g and then it was stable. This indicates that 2g of adsorbent dosage can be considered as optimum. A maximum of 95% reduction in Turbidity, 90% in TSS, 70% in TDS, almost 100% reduction in COD, 87% in BOD was observed at 0.5 dosage of adsorbent as shown in Fig. 7-8. pH and DO dropped significantly with increase in adsorbent dosages as shown in Fig 9.

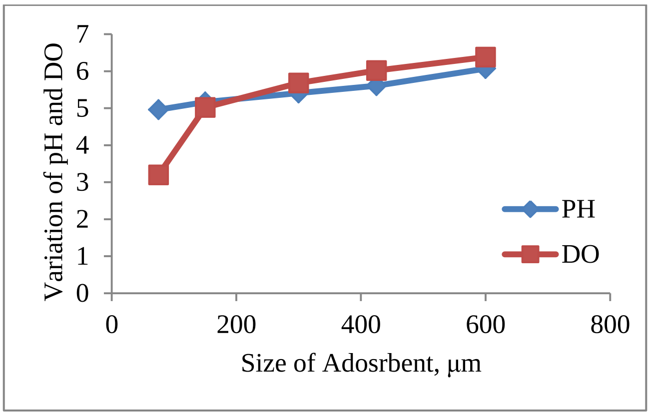

Fig. 6. Variation of pH and DO with adsorbent size

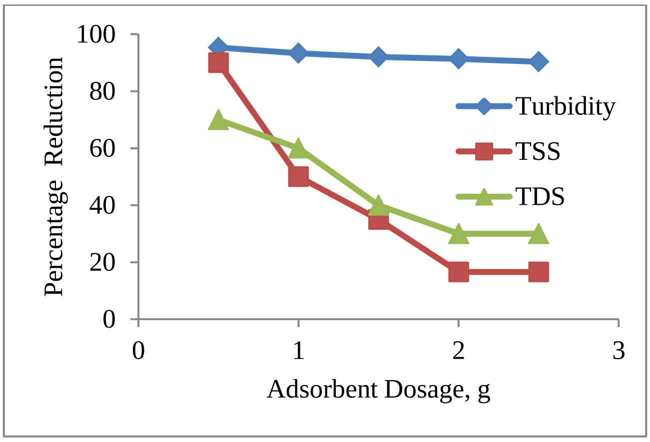

Fig. 7. Percentage Reduction of Turbidity, TDS and TSS with variation in adsorbent dosage

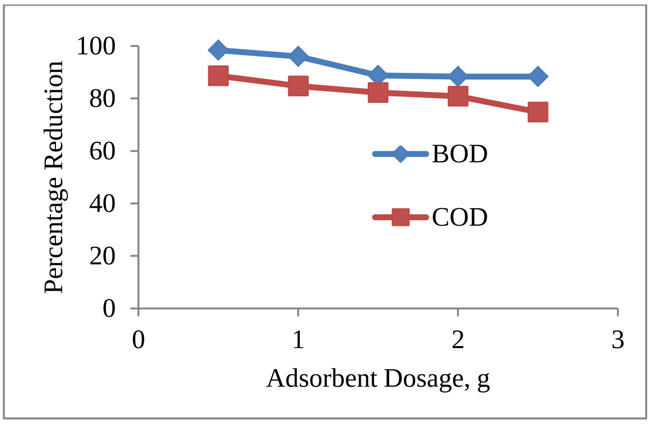

Fig. 8. Percentage Reduction of COD and BOD with variation in adsorbent dosage

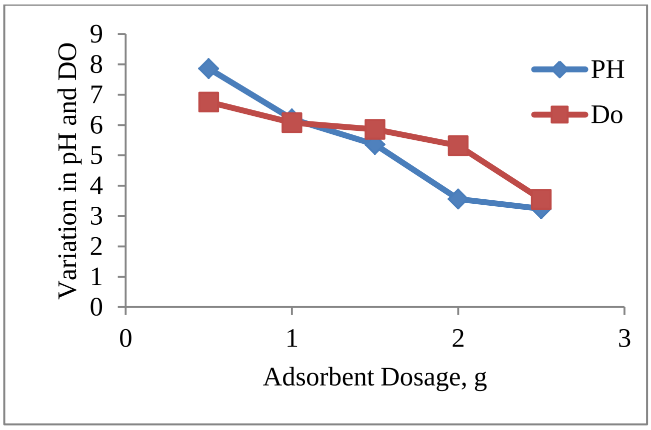

Fig. 9. Variation of pH and DO with adsorbent dosage

IV. CONCLUSION

Treatment of pharmaceutical wastewater collected from the industry in Oman was carried out using date palm activated carbon. It was observed substantial reduction in the pollutants in terms of COD, BOD, TDS, TSS and turbidity. The optimum contact time was observed to be 60 min. With increase in size of the adsorbent, the percentage reduction in TDS, TSS, turbidity, COD and BOD was increased and it was opposite in case of adsorbent dosage. pH and DO was marginally decreased with increase in size but with increase in dosage, it was dropped steeply.

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