Toxic Effects Of Industrial Effluents On Rat: Analysis And Remediation Methods

M Ravibabu, C Nagaveni, K Jamil

Citation

M Ravibabu, C Nagaveni, K Jamil. *Toxic Effects Of Industrial Effluents On Rat: Analysis And Remediation Methods*. The Internet Journal of Toxicology. 2006 Volume 3 Number 2.

Abstract

The study deals with toxic effects of industrial effluents on rat, analysis and remediation methods. The effluents were collected from the common effluent treatment plant located near Hyderabad and the chemical parameters assessed in the effluents were significantly higher than compared to ordinary water. The COD, BOD, Chlorides, sulfates, phosphates and total solids were much higher than the standard quantity as per the prescribed norms. The presence of various components that are present in the effluents inhibits the growth of various organisms in the aquatic environments. The toxicity of these effluents on rats and the LC 50 values were determined. Experiment was also conducted for remediation of the effluents using physical methods like activated charcoal solution in various pH ranges and time periods and biological methods using the aquatic weed like water hyacinth as a biological pollutant remover. After treatment, parameters like COD, pH and TSS were determined by standard procedures. Based on the effects recorded from these effluents, it is therefore concluded that treatment of the effluent is essential, before releasing into the environment.

INTRODUCTION

Pollution is an undesirable change which has a detrimental effect on the organisms that are depending on the environment. These changes can be temporary or permanent depending on the extent to which pollution has taken place. Pollution has crept in all three constituents of the atmosphere viz., air, water and soil. Absorption techniques for the treatment of liquid industrial waste are surface phenomena where a suitable adsorbent is taken and the given effluent is kept in contact with or without stirring. The organic and inorganic load of the effluent gets adsorbed on to the adsorbent. Adsorbent studies are very much useful in evaluating the treatment effluent in terms of the toxicity reduction. The kinetics of adsorption, intra-particle diffusion studies, langmuir adsorption isotherms and equilibrium studies of adsorption have come a long way in evaluating the adsorption efficiency.

MATERIALS AND METHODS

Biological treatment can be done making use of organisms like bacteria, fungi, algae and plants like water hyacinth [1,2,3]. The reduction of toxicity takes place either by adsorption or biodegradation. Bio-adsorption is the simple uptake of the constituents of the effluent by the organism without any usage in its metabolism. Biodegradation means the breaking down of the constituents of the effluent into different fragments which will be either taken as a substrate by the organism or simply remain in the system i.e., metabolism of the constituents by the organism or simple cleavage by them into simpler fragments by the release of enzymes. Biological treatment can also be done by the aerating the effluent in an open system, where in the microorganism interact with the effluent with or without aeration. Also biological treatment is quite cost effective less polluting when compared to other methods of treatment. The different method of biological treatment includes trickling filters, aerated lagoons, anaerobic digestion, rotating biological contractor and oxidation ponds. Depending on the sample nature suitable method should be selected from the above biological treatment systems. The material and methods have utilized phytoremediation i.e., plants for treating aquatic wastes and effluents [4,5,6], and compared it with the physical method. For reducing higher amounts of pollutants in the effluents the biological methods as mentioned above were also tried.

Physical method using Activated Coconut Carbon (ACC): Activated carbon is a suitable adsorbent, with thorough literature search revealed the use of activated carbon to remove waste from portable water and color from oil production waste. The physical method consisted of

applications of powdered activated carbon involving three distinct steps:

- Flash mixing to furnish rapid dispersal of the carbon throughout the wastewater.
- Contact mixing: when the activated carbon is kept suspended by mixing the wastewater for the required contact time.
- Liquid-solid separation: where by the activated carbon is removed from the treated wastewater, after a period of time.

Normally these three operations are carried out in three separate vessels in series. The liquid-solid separation step is gravity settling followed by granular media filtration. Granular media filtration is required because as little as 10-15 mg/lit. of .activated powdered carbon will imparts a dark-hazy appearance to the treated wastewater, which will settle down eventually and clear treated upper layer can be decanted.

CHEMICAL ANALYSIS OF THE EFFLUENT

The effluents were collected from a common effluent treatment plant (Effluent Treatment Plant Geedimetla, Hyderabad). The effluents contain chlorides, sulfates, phosphates and dissolved solids and other pollutants in higher amounts. Chemical analysis was done by standard procedures [$_7$]

- Physical parameters: color, pH, temperature, turbidity, conductivity, total suspended solids (TSS) and total dissolved solids (TDS).
- Chemical parameters: total alkalinity, total hardness, Mg hardness, chlorides, sulfides, total nitrogen, sodium, potassium and phenols (compounds).
- Biological parameters: phosphates, dissolved oxygen (DO), carbon oxygen demand (COD) and biological oxygen demand (BOD).

CONTROL METHODS

Activated Coconut Carbon (ACC): Experiment: 50 ml of effluent was taken in a 100 ml beaker and stirred with powdered ACC with the help of magnetic stirrer. The contents were filtered thought watman filter paper (#1) and the residual COD of the filtrate was determined as per the standard procedure. The treatment was done at different pH conditions viz., 3.0, 7.9 and 10.5 and adsorbent for a 2 hrs time period. Experiments were also carried out taking, different quantities of activated carbon (ACC) in each case and the reduction of COD and color was determined spectrophotometrically (OD values).

Biological method: (Phytoremediation) The effluent in various dilutions like raw (without dilutions), 1:1 and 1:2 dilutions were prepared using distilled water, making the volume to three liters in glass containers (beakers) then the water hyacinth plants were placed in these sample containers. The degradation of the pollutants was monitored after 3 days and 6 days. After 3 days the plants were removed from the treatment container and then the treated effluent was subjected to centrifugation. The supernatant of the test solutions were analyzed for parameters like pH, TDS and COD.

DETERMINATION OF INDUSTRIAL TOXIC EFFLUENT ON RAT

Alteration in the chemical composition of a natural aquatic environment by industrial effluents usually induces changes in the behavioral and pathological aspects of the inhabitants particularly rats. Effluents released from tanneries pulp factories, paper mills, sugar factories etc., have large amount of toxic chemicals, and may cause death of organisms. The levels of toxicity may either increase or decrease, when the effluent is stored. In the present investigation an attempt has been made to study the storage effect of the industrial effluents obtained as mentioned above on rats. As mentioned earlier from effluent treatment plant contains chlorides, sulfates, phosphates and TDS in high amount as mentioned earlier. About 5 liters of effluent from the tank was collected in clean containers. The experiment was carried out as described below.

The study was carried out on albino rats Swiss strain weighing 100-150 g. The rats were reared in a temperature controlled room (26? C ± 2? C) and were fed standard diet and water throughout the experimental period except prior to the administration of the effluent when they were fasted over night. The effluent aliquots were administered orally in the required doses in the rat holding cages. The rats were kept under observation following the effluent administration and had access to food and water, the observations were recorded for a period of 7 days. The protocols for acute toxicity study were carried out as per OECD guidelines [$_8$]. The mortality data was calculated as per the method described by Finney

method [9].

RESULTS AND DISCUSSION

Analysis of various parameters of the effluents before treatment are presented in table 1.

Figure 1

Table 1: Analysis of various parameters of the effluents before treatment

Parameters	Readings
PH	7.9
Color	18.6 (Y+5R using Tinto meter)
Temperature	34° C
Conductivity	0.095μΩ
Total Solids (TS)	37.1ppm
Total Suspended Solids (TSS)	0.202ppm
Total Dissolved Solids (TDS)	36.898ppm
Chlorides	1799.42ppm
Sulfates	6982.867ppm
Phosphates	6125ppm
Phenols	0.02349 mg
COD	7050 mg/lit
DO	6.6 mg/lit
BOD	1055.25 mg/lit

Abbreviations:
ppm: parts per million
mg/lit: milligram per liter
COD: carbon oxygen demand
DO: dissolved oxygen
BOD: biological oxygen demand

Toxic effects and symptoms recorded in rats were: Dullness, bulging of eyes, lacrimation, urination, shivering and reduction in body weight (Table 2).

Figure 2

Table 2: Effects of effluents in rats

Effluents Conc.	Wt. of Rats Initially (g) (before treatment)	Av. wt. (g) of rats after 3 days	Av. wt. (g) of rats after 6 days	No. of rats		Mortality (%)
				Used	Dead	
Control (only	124	130	140	10	0	0
100 ppm	120	126	125	10	3	30
150 ppm	132	132	130	10	5	50
200 ppm	136	135	132	10	7	70
Undiluted	130	127	123	10	10	100

LC 50± (ppm) = 144.39±22.59 (calculated by Finney's method)

The manifestations of the above symptoms were maximum at higher doses of the effluent (i.e., 150 and 200ppm) and the survivability decreased. These results suggested that as exposure period and doses increased, mortality also increased. High mortality in higher concentrations (100% and 150ppm) of effluents may be due the metal salts present in the effluent along with other toxic components. The data obtained suggested that the maximum survival time and the duration of storage is inversely proportional to each other. This may also be due to the presence of organic pollutants, which gradually deplete the oxygen content from the medium giving an unpleasant odor. It is known that decrease of dissolved oxygen in the medium considerably increase the toxicity.

It is seen from the results presented in this study that the effluents collected from the effluent treatment plant, contains high quantities of TTS, TDS and other contaminants like sulfates, chlorides, COD, BOD and salts, which contribute to the hardness of the effluent, and overall hazardous to the living creatures.

The polluted effluent was treated by physical and biological methods and data were compared (Figures 1-5).

Figure 3

Figure 1: Variation of OD (color of effluent) at different pH values and different weights of Activated Charcoal in gram at 2 hr. time period.

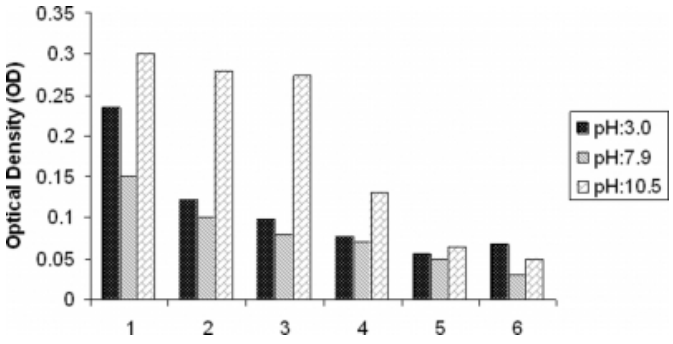


Figure 4

Figure 2: COD values before and after treatment, i.e., after using water hyacinth plants

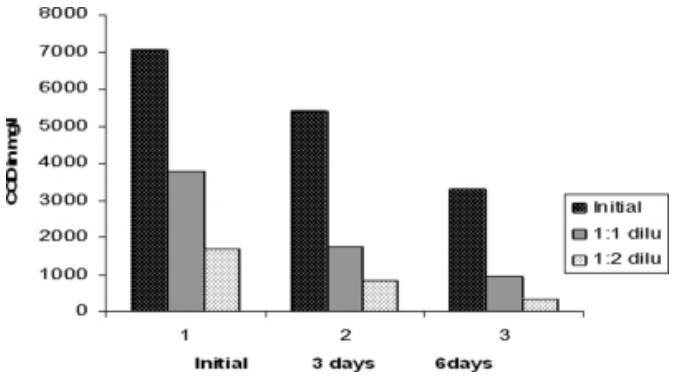


Figure 5

Figure 3: Reduction of TSS after using water hyacinth

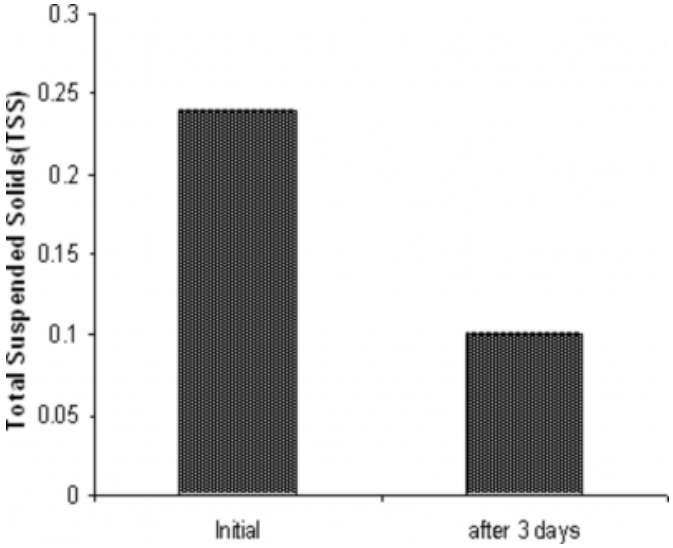


Figure 6

Figure 4: Reduction of pH values after using water hyacinth for treatment.

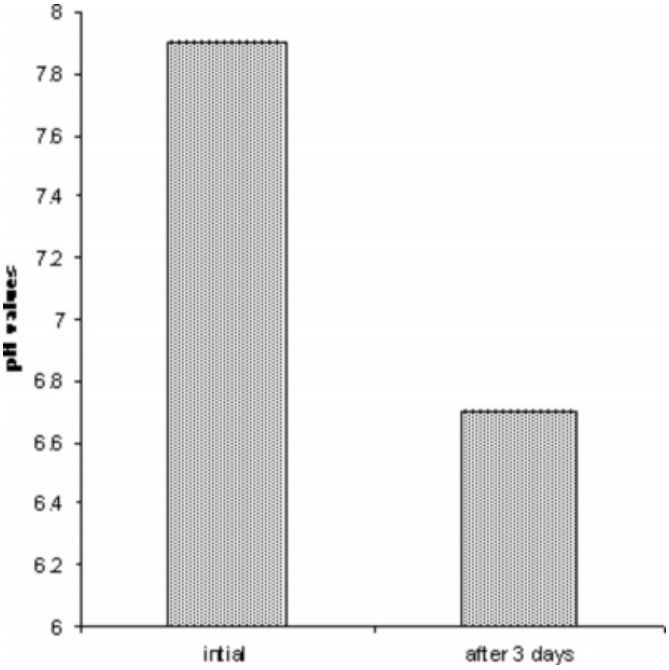
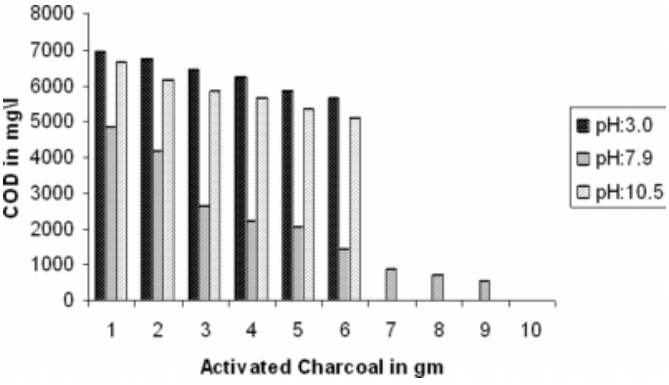


Figure 7

Figure 5: Reduction of COD at different pH by activated carbon treatment.



The physical method using ACC showed a reduction of COD at pH 7.9 (using ACC l0 g, 2 hrs time for 100 ml sample) whereas with biological treatment using water hyacinth plants, reduction in color of effluents and other parameters were recorded. Similar observations [$_{10}$] using pH with water hyacinth treatment the COD values recorded drastically from about 7050 ppm to about 3800 ppm in 6 days also the diluted effluents showed a much greater reduction to less then 900 ppm in 6 days. Similarly TSS showed a reduction from 0.202 ppm to 0.120 ppm. Also the pH reduction was close to neutral from an alkaline status (7.9 pH).

The toxic effect of undiluted effluent fed to rats showed 100% mortality, whereas with diluted effluent the toxicity was around 50% to 70%. One more important observation was that the body weight of the rats also showed a decrease. The effluents on the physical parameters of the rats have been recorded in table 2, which shows that the effluents are highly toxic to animals. Hence remediation methods are suggested for treating the effluents. Also out of the two methods used for remediation biological treatment was found to be more superior.

ACKNOWLEDGMENT

First two authors would like to thank Director, IICT for providing infrastructure and facility to do experimental work also thank to Dr.Singara Charya, Coordinator Environmental Science, Kakatiya University, Warangal. The authors wish to thank to anonymous reviewers for their assistance, suggestions and comments that improved this paper.

References

1. Jamil K, Jyothi KN. Biological control of Eichhomia crassipes (Mart) Solms. Indian J Life Sci 1990; l (10): 83-98.
2. Jamil K. Changes in water quality due to the presence of aquatic plants: an environmental concern. In: Recent Trends in Limnology.(Ed. N.K.Shastry). pp.29-36.(chapter).Mahajan, SP. (Ed.) in Pollution control in process industries, vol-4, Tata McGraw Hill publishing company Ltd., New Delhi. 1991.
3. Jayanth KP. Successful biological control of water hyacinth (Eichhornia crassipes) by Neochetina eichhorniae (Coleoptera: Curculionidae) in angalore, India. Trop Pest Manag 1988; 34:263-266.
4. Jamil K, Jamil MZ, Rao PVR, Thyagarajan G. The role of water hyacinth in abating aquatic pollution. J Pol Res 1985; 4 (2): 67-75.
5. Jamil K, Madhavendra SS, Jamil MZ, Rao PVR. Studies on water hyacinth as biological filter for treating contaminants from agriculture waste and industrial effluent. J Environ Sci Health (Part B), 1987; 22 (1): 103-112.
6. Soltan ME, Rashed MN. Laboratory study on the survival of water hyacinth under several conditions of heavy metal concentrations, Adv Environ Res 2003; 7: 321-334.
7. American Public Health Association. Standard Methods for the Examination of Water and Wastewater, 18th ed., APHA, Washington, DC. 1992.
8. Busvine JR. OECD guideline for testing of chemicals acute oral toxicity section pp:401.1984.
9. Finney DG. Probit analysis. London: Cambridge University Press.1971
10. Jamil K, Jamil MZ, Rao PVR, Thyagarajan G. Eichhornia crassipes (Mart) Solms in relation to pH. Indian J Botany, 1985; 8(2): 156-158.

Author Information

M. V. Ravibabu
Research scholar, Department of Civil Engineering, Indian Institute of Technology-Roorkee

C. H. Nagaveni
Asst Prof., G Narayanamma Institute of Technology and Sciences (GNIT&S)

K. Jamil
Former Deputy Director & Area leader, Biology and Biotechnology Division, Indian Institute of Chemical Technology (IICT)