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Adsorption study of *Nymphaea alba* for the removal of manganese from industrial waste water

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The application of adsorbents obtained from *Nymphaea alba* as a replacement for costly conventional methods of removing heavy metal ions from waste water has been reviewed. Detailed adsorption study of manganese on *N. alba* was investigated. Batch adsorption study was carried out as a function of amount of adsorbent, contact time, thermal treatment, pH and agitation speed. The adsorbent to solution ratio and the metal ion concentration in the solution affects the degree of metal ion removal. Instrumentation employed was atomic absorption spectrometer. *N. alba* was an excellent adsorbent as compared to number of other low cost adsorbents.

Key words: Manganese, low cost adsorbent, industrial waste water, *Nymphaea alba*.

INTRODUCTION

Pollution is the introduction of contaminants into the natural environment that causes adverse change. Water is contaminated by the discharge of industrial waste, untreated domestic sewage into surface waters. Point and non point sources are causes of pollution to our water resources due to tremendous population growth (Franklin, 1991).

Millions of people worldwide are suffering with the shortage of fresh and clean drinking water. Rapid industrialization, population expansion and unplanned urbanization have largely contributed to the severe pollution to water reservoirs and surrounding soils. It is well known that 70-80% of all illnesses in developing countries are related to water contamination. Pollutants discharged in wastewaters are toxic to aquatic life thus disturbing natural bio balance of water body in which the waste is being disposed (Sundarrajan et al., 2000, Ali, 2010).

Heavy metals are the major contaminant in industrial wastewater. The metals commonly include cadmium (Cd), lead (Pb), copper (Cu), zinc (Zn), nickel (Ni) and chromium (Cr). These metals deposit in human bodies either through direct intake or through food chains (Argun and Dursun, 2008). Polluted water can be treated by different remediation techniques, for example ion exchange, oxidation, electrodialysis, reverse osmosis, electrolysis and adsorption. The basic principles of these techniques used for the removal of pollutants are based on their chemical, electrical, physical, biological and thermal properties. Treatment costs of these technologies ranges from 10-450 US dollars per cubic meter of treated water except adsorption technique. The cost of water treatment using adsorption is 5.0-200 US dollars per cubic meter of water (Gupta et al., 2012). Adsorption is considered to be the best wastewater treatment technique due to its universality, ease of handling and inexpensiveness. Adsorption can remove soluble and insoluble pollutants. The removal capacity of this method is up to 99.9%. Therefore adsorption has been used for the removal of a variety of pollutants from different

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contaminated water sources (Ali et al., 2012).

Manganese is the part of natural environment. Asyndrome related to manganese chronic exposure to higher levels of manganese may result in the symptoms of lethargy, mask like face, tremors and psychological disturbances. Respiratory effects have also been reported in workers chronically exposed by inhalation (Flynn and Susi, 2009).

Water containing Mn has rust colour, that is the cause of staining of faucets, sinks, or laundry, and has an off-taste or odour. Manganese levels vary in different places in a water body. Infants should not drink water that is above the health advisory level of 300 µg/L (Agency for Toxic Substances and Disease Registry (ATSDR) 1997).

Due to over population and industrialization, demand for water is increasing day by day. So, alternate sources of clean water are needed and wastewater treatment may serve this purpose. Among various water treatment techniques, adsorption on activated carbon is on the top due to its universal nature. Activated carbon is the best adsorbent able to adsorb inorganic as well as organic pollutants that contaminate water resources. In addition to activated carbon, other adsorbents can also be used to remove toxic metal ion from waste water (Ali, 2010). Dead biomasses of different origin constitute cheap adsorbent for inorganic pollutants as well as organic contaminants in the industrial waste water (Panayotova and Velikov, 2008; Pesavento, 2003).

Plant wastes are inexpensive as they have no or very low economic value. Most of the adsorption studies have been focused on untreated plant wastes such as papaya wood, maize leaf, tea leaf powder, lalang leaf powder, rubber leaf powder, peanut hull pellets, sago waste, salt bush leaves tree fern, rice husk ash and Neem bark, grape stalk wastes, etc. Some of the advantages of using plant wastes for wastewater treatment include simplest of the technique, little processing, good adsorption capacity, selective adsorption of heavy metal ions, low cost, free availability and easy regeneration (Burkel and Stoll, 1999).

Nilofar flower grows abundantly near or in water bodies in normal climatic conditions of Pakistan (Figure 1). *Nymphaea alba* is large, cup-shaped, white flowers up to 20 cm across. *N. alba* (Nilofar flower) is easily available in Pakistan. It is present in ponds and lakes. The present paper describes the use of flowers of *N. alba* as an adsorbent from industrial waste effluents. It is highly economic, naturally occurring and effective adsorbent. It can be used not only for manganese but for other heavy metals like copper, cadmium, chromium, nickel, lead, iron, cobalt, zinc and mercury.

Figure 1. Nilofar flower in water bodies in normal climatic conditions of Pakistan.

METHODOLOGY

All the chemicals and solvents used in experimental work were highly purified and of analytical grade (Merck). Double distilled water was used for preparation and dilution of solutions. Atomic Absorption Spectrophotometer (Shimadzu, Japan AA7000F) was used for the determination of manganese contents. Fuel was acetylene and oxidant was air with the ratio of 1:3, pH meter was used to check pH ranges of solutions, Technico10S-207 Incubator Shaker was used for continuous shaking, Gallenkampe oven was used for heating purpose, Distillation assembly with water vacuum pump.

Preparation of adsorbent

N. alba from different ponds was washed with double distilled water. First it was dried in sun and then in oven at 50°C for one hour. After complete drying it was powdered using a mechanical grinder, sieved and stored to save it from moisture and contamination.

Adsorption experiment

Waste water samples were collected in plastic bottles from different industries and were refrigerated. The samples were doubly filtered before the treatment. Dilutions were made for each sample by diluting 10 ml of each sample to 100 ml. 50 ml of these effluents were transferred to different conical flasks. Atomic absorption spectrophotometer was used for the determination of Mn. Chemical compounds were ionized into free analyte by burners that provide the heat energy. Standard solutions of different concentrations were prepared and 50 ml from each solution was transferred to different conical flasks. Solutions were analysed for concentration of metals after filtration.

Various parameters that were used to check the adsorption behaviour of *N. alba* were:

1. Effect of concentration of adsorbent.
2. Effect of contact time.
3. Effect of temperature.
4. Effect of pH.
5. Effect of agitation speed.

A small portion of waste water was filtered off through membrane filter (0.45 µm).Filtered samples (50 ml) were transferred in Erlenmeyer conical flask. Total concentration of manganese in the samples was determined by means of atomic absorption spectrometer. Adsorption experiments were made at room temperature after using 50 ml of known concentration of

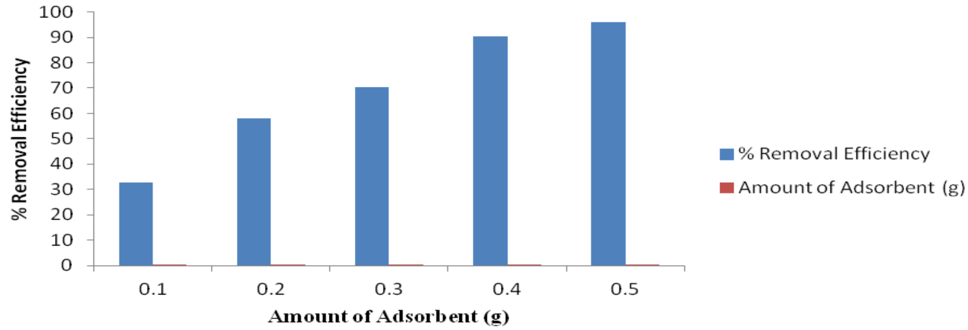

Figure 2. Effect of amount of adsorbent on adsorption of Mn.

manganese solutions in different flasks. Various amounts of adsorbent were put in each flask and these were shaken at 100 rpm Biosorption was monitored by measuring the decline in concentration of Mn in the samples by atomic absorption spectrometer. The effect of various other parameters on adsorption was also studied.

The effect of concentration of adsorbent

50 ml of 50 ppm solutions were taken in conical flasks. Different amounts of adsorbent (0.1 g, 0.2 g up to 0.7 g) were added in the solutions and were agitated at a speed of 100 rpm for 30 min. The solutions were double filtered and analysed by atomic absorption spectrophotometer.

The effect of contact time

50 ml of 50 ppm solutions were taken in conical flasks. 0.5 g of adsorbent was added in each flask and was shaken at 150 rpm for various time intervals (10, 20, 30, 40 up to 100 min). Then solutions were doubly filtered off and were analysed by atomic absorption spectrophotometer.

The effect of thermal treatment on Mn adsorption

50 ml of 50 ppm solution was taken in conical flasks. 0.5 g of adsorbent was added to the flasks. Flasks were agitated at 150 rpm for 100 min at various temperature ranges (10, 20 to 90°C). Solutions were filtered and analysed by atomic absorption spectrophotometer.

The effect of pH on Mn adsorption

50 ml of 50 ppm solutions were taken in conical flasks and pH of flasks was adjusted over a pH range of 1-10 by means of 0.1M NaOH/HCl solutions. 0.5 g adsorbent was added in each flask. Flasks were shaken in shaker at 150 rpm for 100 min at 70°C. Solutions were double filtered and analysed by atomic absorption spectrophotometer.

The effect of agitation speed on Mn adsorption

Adsorbent (0.5 g) was added in 50 ml of 50 ppm solution and pH was adjusted at 7. Flasks were agitated at 70°C for 100 min at various agitation speeds as 25, 50, and 75, 100 up to 225 rpm. Solutions were double filtered and analysed by atomic absorption spectrophotometer.

Removal of manganese from chemical industry

Waste effluent collected from a chemical industry near Muridke (District Sheikhpura) was treated using same method as used for manganese standard solutions. 50 ppm of diluted waste water was double filtered. Its concentration was measured by atomic absorption spectrometer.

RESULTS AND DISCUSSION

Removal of manganese (II) from industrial waste water through *N. alba* (Nilofar flower) is an efficient technique. *N. alba* is locally present in lakes and ponds in Pakistan. The use of *N. alba* for the removal of toxic heavy metal like copper, cadmium, chromium and manganese from different industrial effluent is very easy, efficient and adoptable method. Method adopted was to find the initial concentration of Manganese (II) in the solutions and then determining the concentration after treatment. The difference showed the removal of manganese metal from waste water.

Effect of various parameters on adsorption of manganese

Effect of amount of adsorbent

A 50 ml aliquot of sample solution containing 24.26 ppm Manganese (II) was transferred to each flask after filtration. Different amounts of adsorbent ranging from 0.2 to 0.7 g were added to 50 ml waste water. Solutions were shaken at 175 rpm for 100 min at 60°C. Samples were analysed by atomic absorption spectrometer. With varying amounts of the adsorbent, adsorption varied and the maximum adsorption of 96% was attained with 0.5 g of adsorbent per flask (Figure 2).

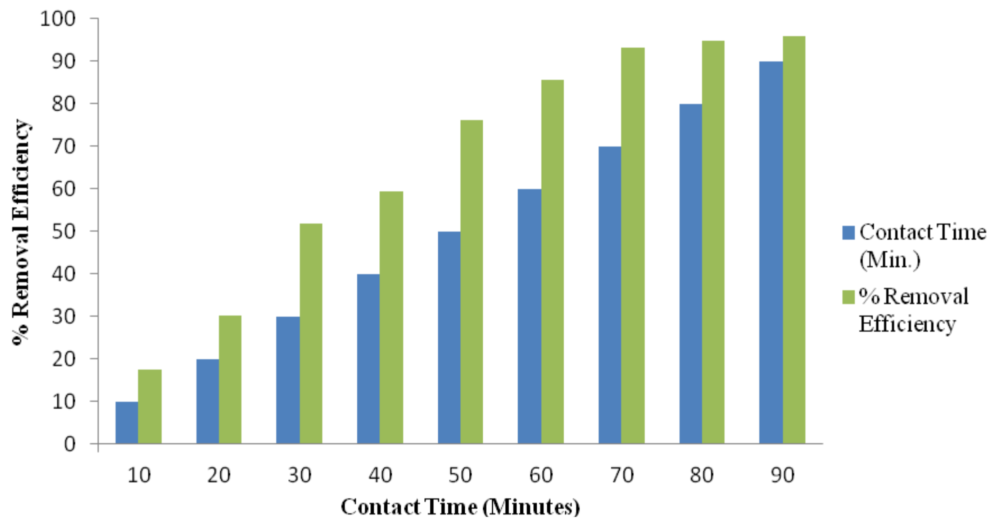

Figure 3. Effect of amount of contact time on % removal of Mn.

The effect of contact time on manganese adsorption

Effect of length of contact between the adsorbent and the solution was studied by keeping other parameters constant. Time duration varied from 20 to 140 min. Results revealed that more contact time resulted in better removal of metal ions from solution. The maximum removal of 96% was observed when contact time of 100 min after which there was insignificant change (Figure 3).

Effect of temperature on manganese adsorption

The effect of temperature was investigated using a temperature range of 10 to 90°C keeping all other parameters constant. To counter the evaporation at elevated temperatures (above 40°C), deionized water was added into flasks at regular short intervals to keep uniform volume through the experiment. Adsorption of Manganese (II) ions from waste water increased with increasing temperature and the maximum removal of 96% was observed at 70°C. A further increase in temperature did not enhance the adsorption (Figure 4).

Effect of pH on manganese adsorption

Waste water samples were treated at various pH ranges like 1 to 10. Maximum removal of 96% was seen at pH 7 (Figure 5).

Effect of agitation speed on adsorption of manganese

By shaking adsorbent and metal ions mix well and have more contact to interact. Waste water samples were shaken in incubator shaker at various speeds and it was found that the speed of adsorption increased by increasing the shaking and reached the maximum value at agitation speed of 150 rpm. At this speed, the maximum adsorption of 96% was observed (Figure 6 and Table 1).

Conclusion

N. alba can act as good adsorbent not only for the removal of manganese ions but also for various other toxic metals like lead, mercury, copper, chromium, cadmium, cobalt, nickel and iron. The removal of manganese (II) from industrial waste water through *N. alba* (Nilofar flower) was found to be an efficient technique. It was an efficient strategy and its performance was the best at temperature of 70°C and pH 7.0. The technique employed was very simple and environment friendly as no manmade chemicals were involved. This method can be adopted by various industries for the waste water treatment. The experimental parameters at temperature of 70°C, pH 7 and minimum amount of adsorbent level of 1.0% were considered to be 96% efficient in removing manganese (II) from industrial waste water. So industries can apply this methodology for removal of toxic metals from industrial waste water effluents, thus preventing land and water pollution.

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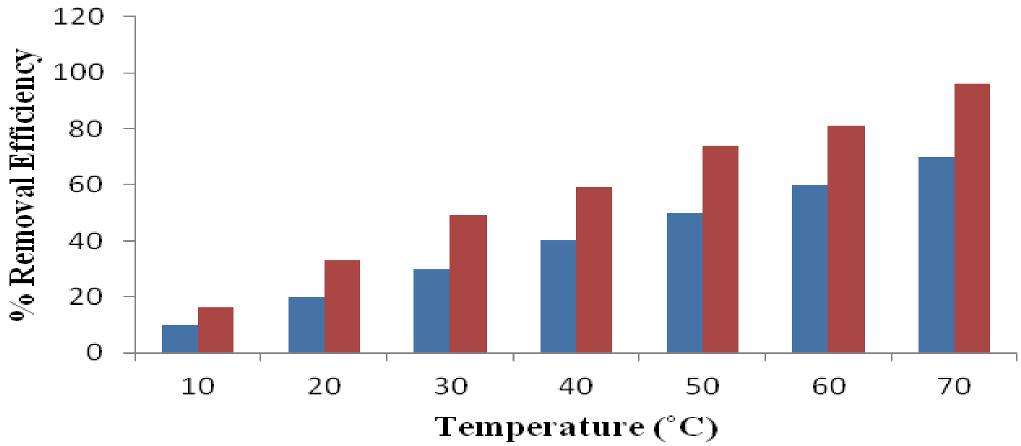

Figure 4. Effect of temperature on % removal efficiency of Mn.

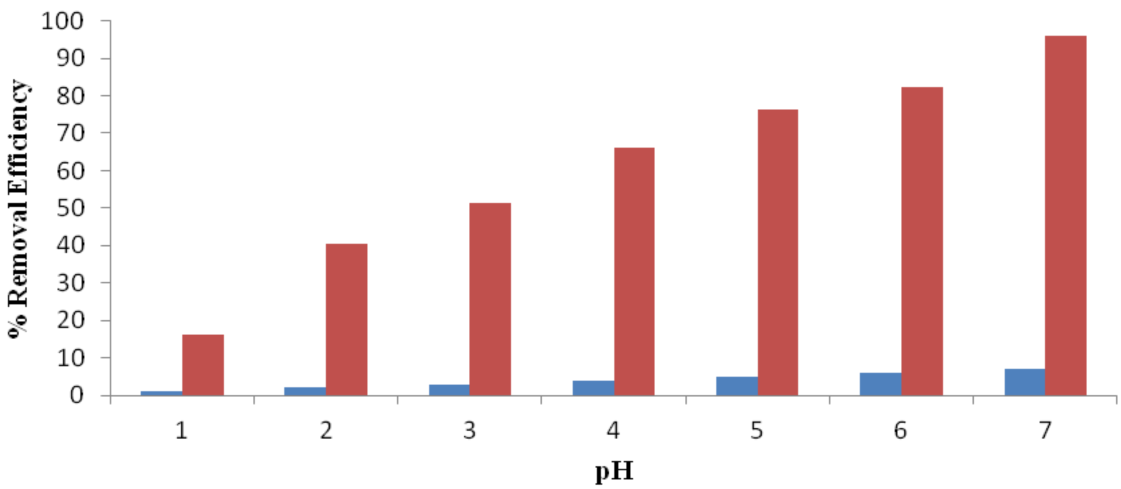

Figure 5. Effect of pH on removal of Mn.

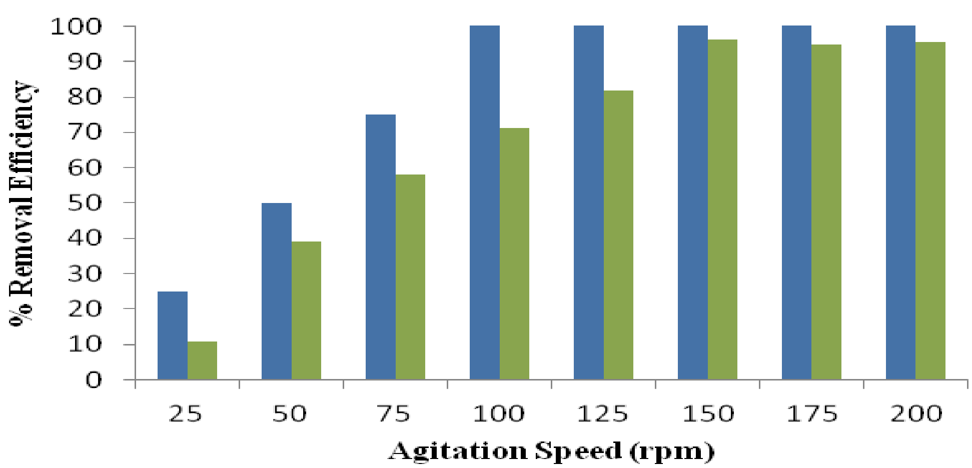

Figure 5. Effect of agitation speed on the removal of Mn.

Table 1. Concentration of manganese in different industrial waste water.

Industries	Concentration of Manganese (ppm.)
I	0.019
II	0.135
III	0.322
IV	5.445
V	18.325
VI	19.464
VII	0.039
VIII	24.268
IX	0.468
X	0.623

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REFERENCES

Agency for Toxic Substances and Disease Registry (ATSDR). (1997) Toxicological Profile for Manganese. U.S. Department of Health and Human Services, Atlanta, GA.

Ali I, Mohd A, Tabrez AK (2012). Low cost adsorbents for the removal of organic pollutants from waste water. J. Environ. Manage. 113:170-183.

Ali I (2010). The quest for active carbon adsorbents substitutes: Inexpensive adsorbent for toxic metal ions removal from wastewater, separation and purification reviews, 39:95-171.

Argun ME, Dursun S (2008). A new approach to modification of natural adsorbent for heavy metal adsorption. Bioresour. Technol. 99:2516-2527.

Burkel RS, Stoll RC (1999). Naturally occurring arsenic in sandstone aquifer water supply wells of North Eastern Wisconsin. Ground Water Monit. Remed.19:114-121.

Flynn MR, Susi P (2009). Neurological risks associated with manganese exposure from welding operations. Int. J. Hyg. Environ. Heal. 212:459-469.

Franklin LB (1991). Low cost adsorbents for the removal of organic pollutants from wastewater. Waste water engineering: treatment disposal and reuse.

Gupta VK, Ali I, Saleh TA, Nayak A, Agarwal S (2012). Chemical treatment technologies for waste-water recycling, *RSC.* 2:6380-6388.

Panayotova M, Velikov B (2008). Influence of zeolite transformation in a homoionic form on the removal of some heavy metal ions fromwastewater. J. Environ. Sci. Health. 38:545-554.

Pesavento M (2003). Adsorption of lead (II) and copper (II) on activated carbon by complexation with surface functional groups. Anal. Chem. Acta. 480:171-180.

Sundarrajan M, Fernandis AZ, Subrahmanyam G, Prabhudesai S, Krishnamurthy S, Rao K (2000). Over expression of G1/S cyclins and PCNA and their relationship to tyrosine phosphorylation and dephosphorylation during tumour promotion by metanil yellow and malachite green. Toxicol. Lett.116:119-130.