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Removal of Arsenic through Biosorption by Activated Sludge

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ABSTRACT: The detrimental impact of presence of arsenic in the environment has an adverse influence on the human beings. In the present research, varieties of biomaterial are being developed to provide a wide platform for the removal of heavy metals and toxic elements. Some of these materials also could remove contaminants and toxicants form the environment. Studies have revealed that preparation of biosorbents is quite cost effective and efficient to remove metal pollutants form aqueous medium. In the present study, an attempt has been made to analyze the biosorption capacity of the biosorbent. The kinetics and adsorption isotherm has been established. It has been found that Langmuir isotherm could fit successfully to the above process and the reaction is found to be fit to first order kinetic model.

KEYWORDS: Biological Sludge, sedimentation, adsorption, ion exchange and membrane separation

I. INTRODUCTION

Arsenic contamination has given a tremendous health has and in Bangladesh and went Bengal in India, including some parts of Japan, Nepal as well. When exposed to arsenic contaminated water bodies, arsenic leads to various carcinogenic activities coming skin, blood caner, stomach cancer etc. Various methods such as oxidation, precipitation, coagulation, sedimentation, filtration, adsorption, ion exchange and membrane separation have already been implemented as the arsenic removal technology for water purification (1-4). All these methods are costly as compared to the present adsorption process adopted for arsenic purification. The main disadvantages of these methods are operating cost, incomplete removal, energy consumption is high and too these are generation of some residual pulp (5-6). In contrast the activated sludge process to treat the biomass contaminated waste water is highly efficient for water treatment through microbial biomass. During the study, several attempts have been made to develop a conventional method for arsenic treatment.

In the adsorption study, generally dead form of biomass are utilized for biosorption study(7-8). In the present investigation, an activated sludge, dumped as a waste, is being used as an adsorbent for arsenic removal. During the process, role of various parameters such as time of contact, pH of the parent solution, initial arsenic content, dosages of sorbent used are taken into consideration. The adsorption was tried to fit to Langmuir and Freundlich isotherms and the reaction kinetic were also carried out (9-10). It was found that the model fits well to Langmuir isotherm following 1st order kinetics.

Materials and Method: Aerobically activated sludge is being adopted in a botch system to carry out the biosorption study. The uptake of arsenic is being studied using dried aerobic activated sludge in batch experiments. For estimating the amount of arsenic present in the solution, EM Quant® strips have been used adequately in duplicate.

Result and discussions: During the study, the following parametric effect is being analyzed.

Role of pH on arsenic adsorption

The initial pH of the waste material and its effect on equilibrium uptakes has been studied as represented in Table-1. The data given in Figure-1 revealed that the arsenic up lake of the dried sludge is maximum at a pH of 3.8. The

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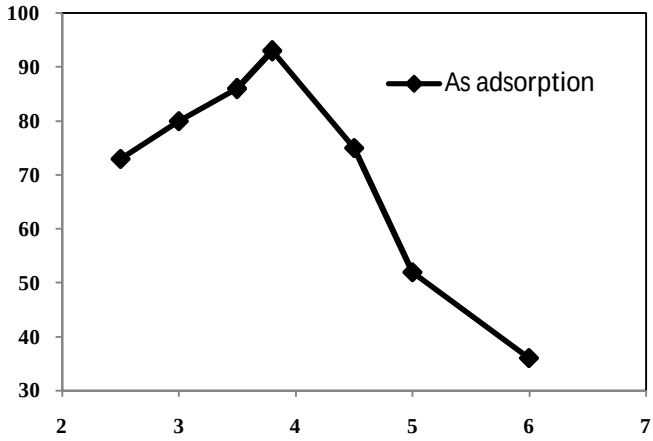
reduction in pH may be attributed to the presence of various components in the waste water system which hinders the precipitation of arsenic at high pH.

Condition
Concentration of As = 100 ppm
Estimation Technique= Quanta M
Contact time = 90 mins
Dosages of adsorbent =20 gm/ltr.

Table-1 Changes in Arsenic adsorption with pH

Sl No	pH	As adsorption
1	6.0	36
2	5.0	52
3	4.5	75
4	3.8	93
5	3.5	86
6	3.0	80
7	2.5	73

Figure-1 effect of pH on Arsenic adsorption



Role of contact time on arsenic adsorption
The contact time for adsorption has been carried out in the time range of 10 min to 120 min time as given in Table-2. The results obtained are represented in figure-2. The data revealed that 90 mins time of contact is found to be maximum to adsorb about 95% arsenic. Further enhancement in the contact time has no appreciable impact on arsenic adsorption. The conditions are mentioned therein.

Condition
pH = 4.0
Concentration of As = 100 ppm
Estimation Technique = Quanta M
Dosages of adsorbent = 20 gm/ltr

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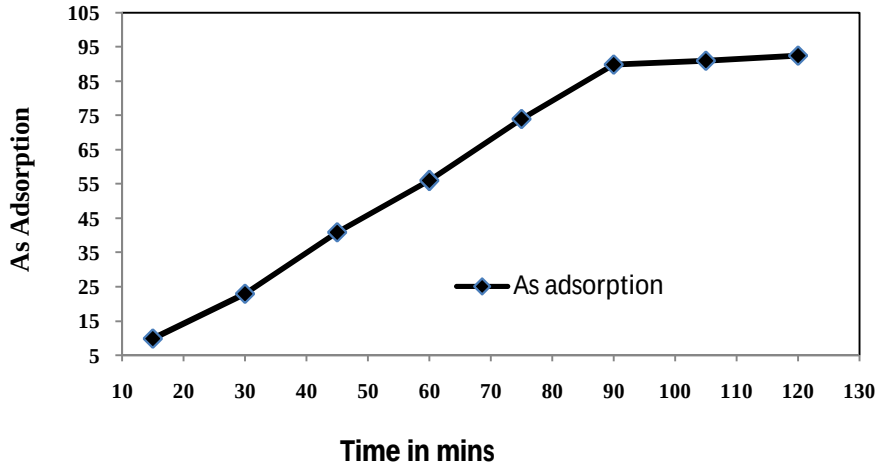
Table-2 Time of contact Vs As adsorption

Sl No	Contact time	As adsorption
1	15 mins	10 %
2	30 mins	23 %
3	45 mins	41 %
4	60 mins	56 %
5	75 mins	74 %
6	90 mins	90 %
7	105 mins	91 %
8	120 mins	92 . 6 %

Figure-2 Time of contact Vs Arsenic adsorption



Impact of arsenic concentration on the rate of adsorption

Studies have been carried out to estimate the impact of arsenic concentration in the waste solution and its affection the rate of adsorption. To carry out this analysis, the pH of the parental solution is kept constant at 4 with a time of contrast for 90 mins as given in table-3. The arsenic concentration for study was carried out by varying the concentration from 10pm to 250 ppm as represented in figure-3. The adsorption study revealed that Dried aerobic activated sludge could absorb a maximum of 100 ppm level of arsenic effectively with further rise in concentration of arsenic, there is drastic fall in the rate of arsenic adsorption which is attributed to the fact that excessive arsenic concentration may hinder further adsorption due to saturation of arsenic at the activated sites.

Conditions

Time of Contact = 90 mins.

pH = 4

Dosages of adsorbent = 20 gm/ltr

Table -3 Concentration of arsenic in the waste water

Sl No	As in ppm	% adsorbed
1	10 ppm	~ 100 %
2	20 ppm	~ 100 %
3	40 ppm	97 %

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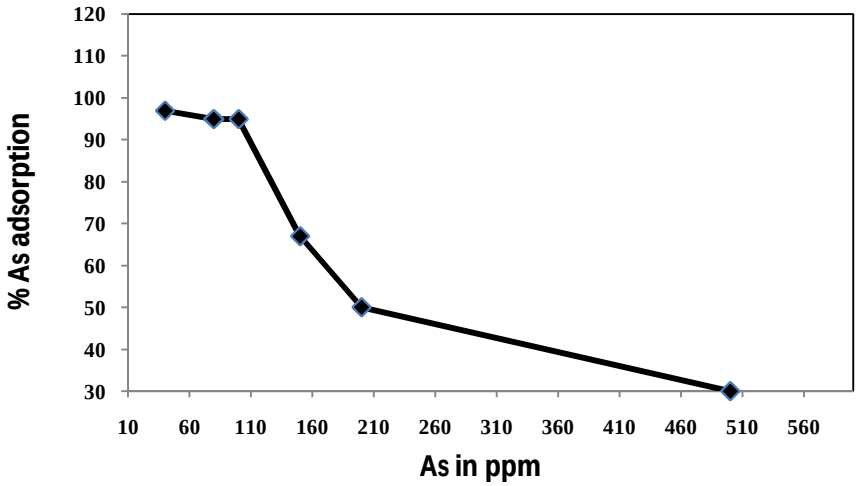
4	80 ppm	95 %
5	100 ppm	95 %
6	150 ppm	67 %
7	200 ppm	50 %
8	500 ppm	30 %

Figure-3 Effect of arsenic concentration on % adsorption



Impact of Dosages of adsorbent on arsenic adsorption

During the study, the use of dosages of adsorbent have been carried out variably as given in table-4. The concentration of arsenic and contact time is kept constant throughout the study at a constant pH. The data obtained are plotted in figure-4. The figure shows that 40 wt% of adsorbent dose is sufficient enough to recover almost 96% of the arsenic contaminant present in the waste water.

Table -4 Impact of adsorbent concentration on As adsorption

Sl No	As in ppm	% adsorbed
1	100 ppm	10 wt %
2	100 ppm	20 wt %
3	100 ppm	30 wt %
4	100 ppm	40 wt %
5	100 ppm	50 wt %
6	100 ppm	60 wt %
7	100 ppm	70 wt %
8	100 ppm	80 wt %

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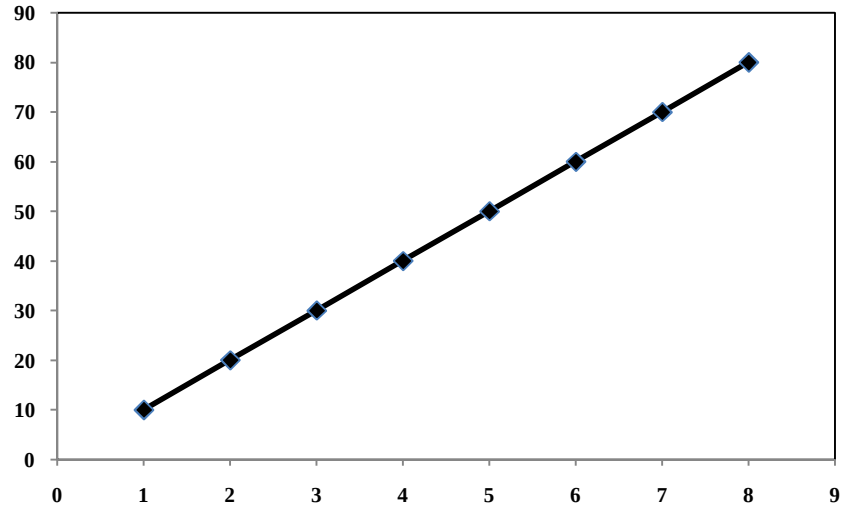
Figure-4 Role of adsorbent wt% on As adsorption



II. CONCLUSION

The above study revealed that by adoption of adsorption technique it is possible to remove arsenic from contaminated water sources. Aerobic activated dried sludge could prove to be highly potential to adsorb an appreciable quantity of arsenic.

The data obtained concluded that by using biosorption, optimization of the process parameter can be carried out to purity an arsenic contaminated water source. The parameters such as contact time, dosages of adsorbent, concentration of arsenic and pH of the parent solution are the major factors to influence arsenic adsorption. It has been found that at a pH of 3.8 with arsenic concentration within 100 ppm, adsorbent dose of 40 gm/litre with a contact time of 90 mins, it is possible to remove cent present of the contaminated arsenic from waste water sources.

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