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Comparison of Iron Removal Effeciency by Areation and Adsorption

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Abstract : *The growth in the industrial sector for the last few decades is the major cause for the wide varieties of environmental pollution. Among these pollutants, high concentration of iron causes objectionable bitter taste in water, objectionable reddish-brown or black colour to water, dangers to aquatics lives and also causes various kinds of health problems like cancer, kidney failure, metabolic acidosis, oral ulcer, renal failure and many more. Some observations noted in Kothamangalam area in Kerala, groundwater contains high amount of iron content. In this project we are discussing some low cost methods to reduce iron content in water .Aeration is one of the most common and often the first major process at the treatment plant. Aeration brings water and air in close contact and helps to remove dissolved metals through oxidation. Adsorption is another most useful and effective method. There are various adsorbents used for the removal of iron from waste water. In the present study we use Egg shell and Pongamia pinnata also known as Karanja tree bark as adsorbents for the removal of iron from groundwater.*

Keywords: *Adsorbent, Adsorption, Aeration, Eggshell, Pongamia Pinnata*

I. Introduction

Water is literally the source of life on earth. About 70 percent of the earth consists of water. But only one percent is accessible surface fresh water. Globally, most of the developing countries are geographically located in those parts of the world that are or will face water shortages in the near future. Moreover, the existing water sources are contaminated because of untreated sewage and industrial wastewater is discharged into surface waters resulting in impairment of water quality. Industrial effluents often contain various toxic metals, harmful dissolved gases, and several organic and inorganic compounds. These may accumulate in soil and water in excessive quantities in long-term use and ultimately causes adverse effects on living organisms. Heavy metal pollution is one of the important concerns of the day. The groundwater contains varying levels of toxic metal ions such as lead, copper, cobalt, cadmium, chromium, nickel, mercury, arsenic, zinc, iron, manganese etc. Such heavy metals in effluent are not easily degradable and hence adversely affect the soil and water dependents. Also they exhibit specific damaging effects on flora and fauna if the allowable limits are exceeded. The variable amounts of iron present in ground water. Iron is a natural constituent of soils and rocks. They are normally present in highly insoluble forms, but are brought into solution by anaerobic conditions or by the presence of carbon dioxide. Nuisance conditions can occur when the concentrations of iron exceed 0.3 mg/L. Iron exists in solution in the ferrous state, usually as ferrous bicarbonate. It can only remain in solution in the absence of oxygen, and generally when the pH is below 6.5. When such water is exposed to air, the soluble ferrous bicarbonate is oxidized to insoluble ferric hydroxide, making the water discolored. Once oxidized, these chemicals fall out of solution and become particles in the water and can be removed by filtration.

II. Materials And Method

2.1 Preparation of synthetic solution

Analytical grade Ferrous Chloride used to prepare synthetic solution. Distilled water was used to prepare synthetic solution of required iron concentrations. 0.1N HCl and 0.1N NaOH solutions were used to adjust the pH of the solution.

2.2 Aeration

Aeration brings water and air in close contact in order to remove dissolved gases (such as carbon dioxide) and oxidizes dissolved metals such as iron, hydrogen sulfide, and volatile organic chemicals (VOCs). Aeration is often the first major process at the treatment plant. Aeration brings water and air in close contact by exposing drops or thin sheets of water to the air or by introducing small bubbles of air (the smaller the bubble, the better) and letting them rise through the water. It helps remove dissolved metals through oxydation, the chemical combination of oxygen from the air with certain undesirable metals in the water. Once oxidized, these chemicals fall out of solution and become particles in the water and can be removed by filtration or flotation.

The efficiency of aeration depends on the amount of surface contact between air and water, which is controlled primarily by the size of the water drop or air bubble.

2.2.1 Aeration studies

Synthetic solution was prepared, the experiments were performed using four different contact times of aeration 0.5, 1, 1.5, 2 hrs. The solution was aerated for 0.5 hrs ad allowed to settle for the same time. The mixture was then filtered after 24 hours contact time and final concentration of iron in solution was determined by spectrophotometer. The procedure repeated by varying the contact time. Based on concentration of iron in solution, the iron removal efficiency by aeration was calculated. The experiment was also conducted by varying the pH.

2.3 Adsorbent

2.3.1 Pongamia Pinnata

Pongamia pinnata tree bark was Sun dried for 3 days. Then the bark was dried at 80°C for six hours in hot air oven and cut into 2 to 3 inch pieces. Dried bark was powdered. The powder was washed several times with distilled water to remove solubles, coloring matter and again dried in hot air oven at 60°C for 8 hours. The powdered bark was sieved (Indian Standard Sieve) and various fractions of adsorbent was separately stored in air tight containers. The particles having the diameter of 225 micron were selected, for which the particles passing through 300 microns and retained on 150 microns were selected.

2.3.2 Eggshell

The chicken eggshells were collected from kitchen waste and washed by distilled water for several times to remove the dirt particles. The eggshells were then dried overnight in the oven at 40°C. The dried eggshells were ground into small particles and stored in an airtight container for future use. The particles having the diameter of 225 micron were selected, for which the particles passing through 300 microns and retained on 150 microns were selected.

2.4 Adsorbate preparation

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2.5 Adsorption studies

The experiments were performed using five different amount of adsorbents 3, 6, 9, 12, 15 g/L. 3 g adsorbent was placed in a conical flask with 1L solution and the mixture was shaken in shaker. The mixture was then filtered after 24 hours contact time and final concentration of iron in solution was determined by spectrophotometer. The procedure repeated by varying the adsorbent dose. Based on concentration of iron in solution, the adsorption efficiency of eggshell powder and Pongamia pinnata powder were calculated. The experiment was conducted by varying the contact time and pH.

III. Results And Discussions

3.1 Concentration of adsorbents

The concentration of adsorbent was varied between 3g/L to 15g/L keeping all other parameters constant. From the graph, it was found that the adsorption rate of iron increases with increase in concentration of Pongamia pinnata tree bark up to 9g/L and the maximum removal was 76.25%.For eggshell,it was found that the maximum removal was 67.50% at 15g/L.

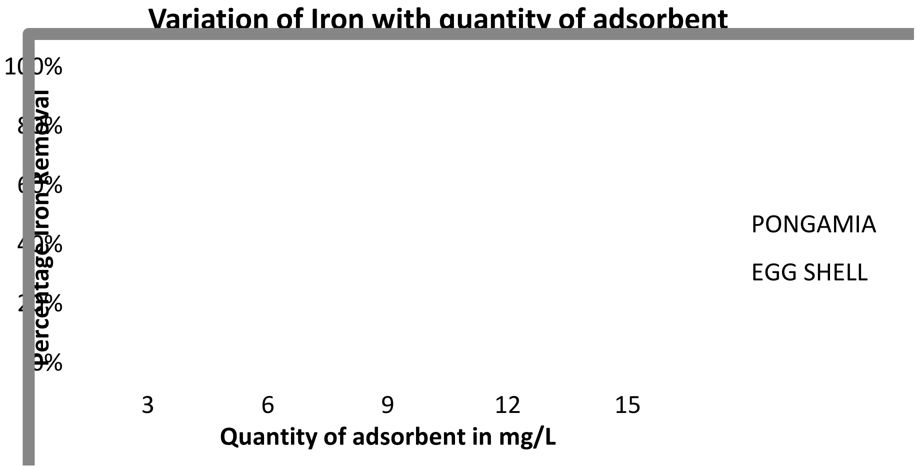

Fig.1. Effect of variation of Iron with quantity of adsorbent

3.2 Contact time

The contact time was varied between 0.5hrs to 2hrs for aeration. The maximum removal was obtained for 1.5 hrs aeration and the maximum removal is 66.72 %. For adsorption the contact time was varied from 1 to 4 hrs for the maximum removal concentration. The maximum removal was at 4 hrs. The maximum removal was 63.75% for Pongamia pinnata and 61.23% for egg shell.

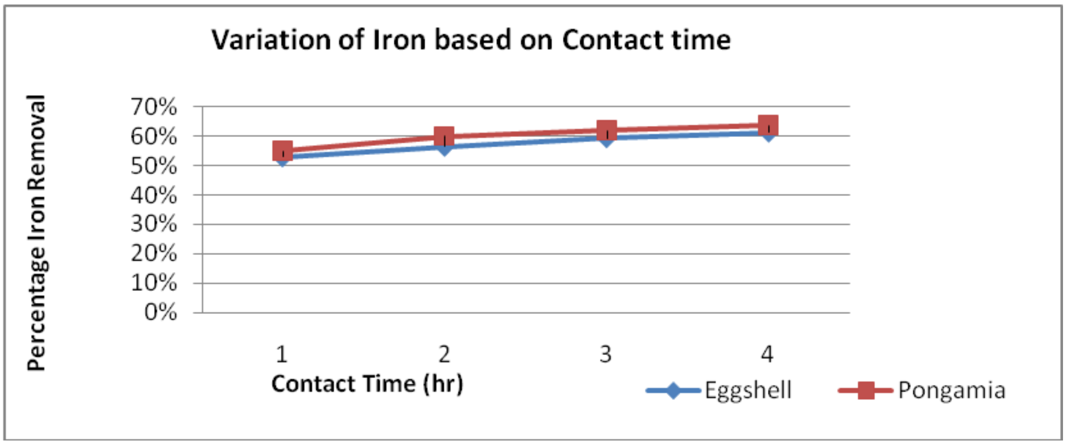

Fig.2. Effect of variation of Iron based on contact time

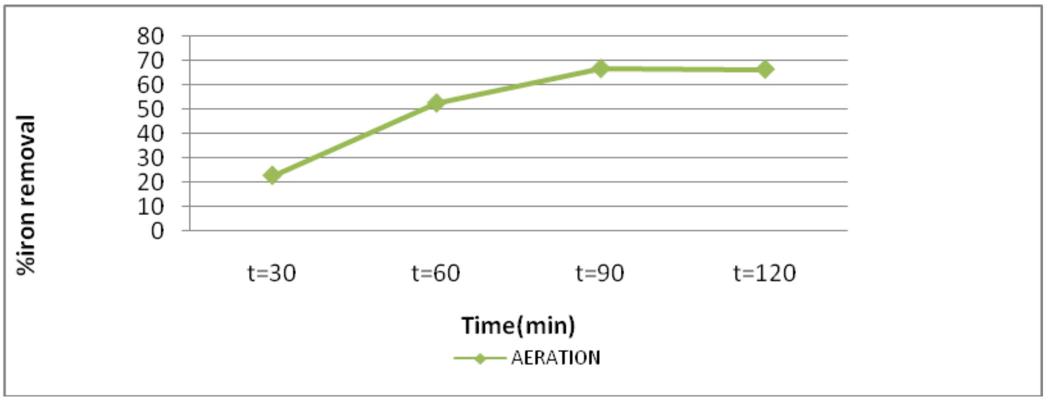

Fig.3. Effect of variation of Iron on aeration

3.3 pH

Adsorption and aeration studies were carried at different pH values in the range of 2 to 8. From the graph, it was observed the maximum removal of iron was at pH 6. The maximum percentage removal was 78.75% for Pongamia pinnata, 67.50% for eggshell and 72.50% for aeration.

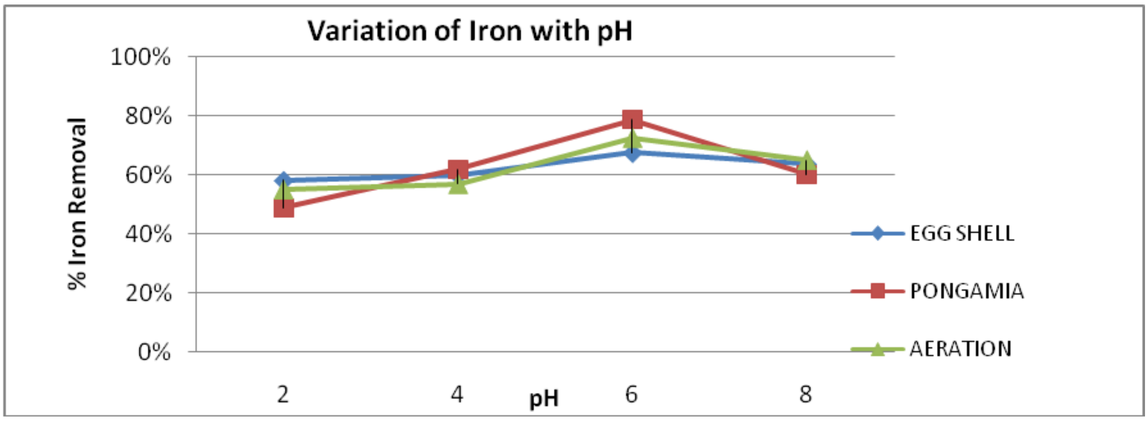

Fig.4. Effect of variation of Iron with pH

IV. Conclusion

For adsorption,as the concentration of adsorbent increases, more and more surface area will be available, which expose more active sites for the adsorption of iron. In the case of aeration, water and air in close contact by introducing small bubbles of air (the smaller the bubble, the better) and letting them rise through the water. It helps to remove dissolved metals through oxidation. The efficiency of aeration depends on the amount of surface contact between air and water, which is controlled primarily by the size of the water drop or air bubble.

From the experiment using Egg shell, 15mg/L of adsorbent were used with a contact time of 24 hrs and pH of 6 and in the case of adsorption using Pongamia pinnata, 9mg/L of adsorbent were used with a contact time of 24hrs and a pH of 6. Aeration is also a good method of removal of iron. For aeration, 1.5hrs contact time and pH of 6.

It was found that 67.50% of iron was removed by adsorption using egg shell and 76.25% by Pongamia pinnata. By aeration 66.72% of iron was removed. From the experiments, pongamia pinnata tree bark is more effective for removing iron from groundwater by adsorption. Its preparation is simple and economical. All of them can be effectively used as a viable and economic adsorbent for removal of iron from groundwater.

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