Removal of Iron from synthetic waste water using Sawdust and Rice husk

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Abstract*—This study mainly dealt with removal of iron from ground water sources by using locally available low cost materials such as sawdust, rice husk and lime stone. In this process, we fabricated a filter tube of length 60 cm and diameter 150mm in which the adsorbent materials (sawdust and rice husk) mixed at varying proportions was sandwiched between limestone aggregates. The sample we used for this filtration process was synthetically prepared iron solution of 1000ppm by dissolving 3.5713g of Ferric Sulphate salt in 1l of distilled water. The filtration process was done at various surface loading rates ($1.715m^3/m^2/hr$ and $1.357m^3/m^2/hr$) and at different proportions 1:1, 1:1.5, 1.5:1, 2:1 and 1:2 denoting the ratio of sawdust is to rice husk. As a result, we obtained the high reduction of iron concentration at surface loading rate $1.357m^3/m^2/hr$ at proportion 1:1.5 denoting ratio of sawdust is to rice husk.

Key words: Saw dust, Rice husk, Iron, Lime stone

1. Introduction

The iron occurs mainly as magnetite (Fe3O4, 72.4% Fe), hematite (Fe2O3, 69.9% Fe), goethite (FeO(OH), 62.9% Fe), limonite (FeO(OH)·n(H2O)) or siderite (FeCO3, 48.2% Fe). Hematite or Magnetite is found in forms of rocks. Iron in the form of ferrous dissolve in water but when it is exposed to atmosphere the ferrous ion oxidize to ferric ion which does not dissolve in water forming reddish brown colour.

At present in India, about 99% of iron ore is produced by Karnataka, Orissa, Chhattisgarh, Goa and Jharkhand. Studies states that due to the presence of Iron ores in rural areas of those states has high content of iron of about 10 mg/l. But according to Indian Standard Code IS10500, the concentration of iron in drinking water should not exceed 0.3mg/l.

Iron is an essential nutrient. According to World Health Organisation, the minimum daily requirement of iron for every human being range from 10 to 50 mg/day. The drinking water containing 0.3mg/l of iron contributes 0.6 mg to the daily intake. This improves the haemoglobin and prevents anaemia. But excess iron intake causes chronic iron overload results primarily from a genetic disorder (haemochromatosis) characterized by increased iron absorption.

Iron Bacteria are group of small organisms that converts ferrous iron to ferric state through their metabolic reactions. These organisms causes corrosion on attacking steel pipe to obtain iron. Heavy growth of these organisms forms a gelatinous mass that attack ferric hydroxide and clog the pipes and plumbing fixtures. Figure 1 shows the pipe affected by Iron Bacteria.

Figure 1 Pipe affected by Iron Bacteria

There are several studies carried out to provide techniques for the removal of iron. Traditionally ion exchange is the suitable method for the removal of iron when the iron is present at low concentrations. This method is not suitable for the high concentration of iron when it is precipitated at large amounts in water. Iron

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in the ground water can also be removed by using softeners. But using softeners causes foul smell. The most widely used method of removing iron from water is by simple filtration. The filtration media used for iron filtration includes manganese greensand, Birm, MTM, multi-media, sand, and other synthetic materials. But these materials are not easily available in rural areas for small scale filtration unit in every residents.

This study focusses on the removal of iron from the ground water using locally available adsorbent materials like sawdust, rice husk and lime stone. These materials act as an adsorbent material that adsorbs iron from synthetically prepared iron water. The filtration process is carried out at various surface loading rate and at different proportions of sawdust and rice husk.

2. Materials and Methods

The objective of this study is given below.

- To reduce the concentration of iron using locally available adsorbent materials like saw dust and rice husk from synthetically prepared iron solution.
- To compare the percentage reduction of concentration of iron using sawdust, rice husk and mixed sawdust and rice husk at different proportions as a filter media.

2.1 Preparation of Synthetic iron water

Iron(III) sulfate (or ferric sulfate), is the chemical compound with the formula Fe2(SO4)3, the sulfate of trivalent iron. Usually yellow, it is a rhombic crystalline salt and soluble in water at room temperature.3.5713 g of ferric sulphate (Fe2 (So4)3) was dissolved in 1 L of water to make 1000ppm of iron solution as 1000 ppm = (1000 mg / L Fe) * (1 g Fe / 1000 mg Fe)*(398.88 g Fe/2*55.845g Fe) *X* 1 L = 3.5713 grams. The preparation of standard iron solution is shown in the figure 2.

Figure 2 Standard Synthetic Iron Solution

2.2 Preparation of Limestone adsorbent

Limestone is a sedimentary rock composed mainly of minerals calcite and aragonite, which are different crystal forms of calcium carbonate (CaCO3). Lime stones are used as a building material and as a raw material in manufacture of cement.

The stones used in this study was bought from the local market and the aggregates are hand broken and sieved. The aggregates retained in16mm sieve and passed in 20 mm sieve are taken and they are washed and oven dried at 60 degree for one hour. Figure 3 shows the image of Limestone.

Figure 3 Lime stone

2.3 Preparation of Saw dust Adsorbent

Sawdust is a by-product of cutting, grinding, drilling, sanding, or otherwise pulverizing wood with a saw; it is composed of fine particles of wood. Saw dust is used for manufacturing particle board and it is also used as a fuel.

The saw dust used in this study was bought from the local market. The saw dust is sieved in 2mm sieve and washed using water until the colour of washed water is normal. Then the saw dust is dried under sun for 3 days and then they are used in filter media. Figure 4 shows the image of Sawdust.

Figure 4 Saw dust

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2.4 PREPARATION OF RICE HUSK ADSORBENT

Rice husks are the hard protecting coverings of grains of rice. In addition to protecting rice during the growing season, rice husks can be put to use as building material, fertilizer, insulation material or fuel.

The rice husk was bought from the local market. The rice husk is washed and dried under sun for 3 days before using in filter media. The figure 5 shows the image of rice husk.

FIGURE 5 RICE HUSK

2.5 SETTING UP OF FILTER

The filter tube was fabricated using plastic sheet of 3mm thickness of height 60cm and diameter 150mm. The outlet is fixed to the tube at one end. The layers of filter media are laid using sand, lime stone aggregates, rice husk and saw dust. The sand layer was laid on the top for 5cm. then the next layer was limestone aggregates laid for 10cm. The middle layer is laid for about 30cm using rice husk and sawdust at different proportions. Then the final layer was again limestone aggregates laid for about 10cm. Figure 6 shows the image of filter tube and the filter media.

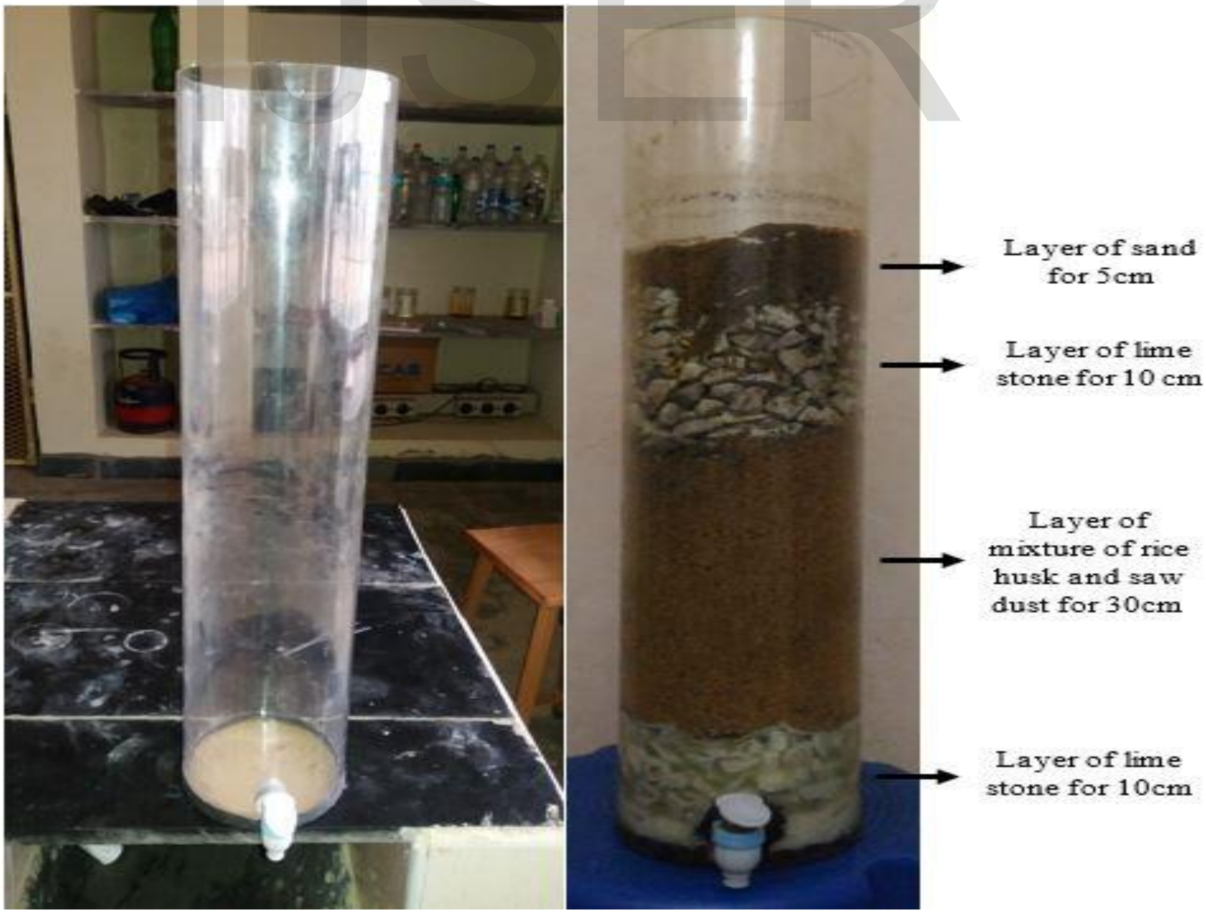

FIGURE 6 FILTER TUBE AND FILTER MEDIA

2.6 Filtration Process

The filtration process was carried out at two different surface loading rate. They are 1.715m^3/m^2/hr and 1.357m^3/m^2/hr. These two rates are changed by adjusting the closure of a vessel. The process was done repeatedly to determine the maximum removal percentage of iron by changing the proportions of saw dust and rice husk.

2.7 Collection of effluent

The effluent was collected after every trial of a proportion at two different surface loading rates. The collected effluent image is shown in the figure 7

Figure 7 Collected Effluents

2.8 Testing of Effluents

The collected effluent are tested using spectrophotometer. The values of standard calibration curve are taken by preparing standards at 0, 10, 20, 30, 40, 50, 60, 70, 80, 90mg/l and noting the absorbance at wavelength 508nm.

The influent taken for each test was also tested along with the effluents taken to know the initial concentration of iron before sending to filter media. From the effluent testing we determined the absorbance of the effluent and correlating them with standard calibration curve we found the concentration of iron in the effluent. The figure 8 shows the spectrophotometer.

Figure 8 Spectrophotometer and Standards solution for calibration curve

3. Results and discussions

The top and bottom layer of filter media is laid by lime stone of 10cm thickness and the middle layer is laid by mixing saw dust and rice husk at ratio 1:1, 1:1.5, 1:2, 1.5:1 and 2:1 for 30 cm thickness. Each layer is separated by a cotton cloth and the synthetically prepared waste water is allowed to pass through sand layer of 5cm thickness before it passes the top layer of lime stone.

The initial and final concentration of iron content can be determined by calibration curve and the percentage removal of iron can be determined by the following formula.

Percentage removal= ((c1-c2)/c1)*100

In which c1 denotes the initial concentration of iron in ppm and c2 denotes the final concentration of iron in ppm. The results of the experiments was listed below in tables according to the proportion of materials used.

Following Table 1 denotes the initial and final concentration of iron at proportion 1:1 denoting sawdust is to rice husk.

Surface Loading Rate	Initial Concentration (ppm)	Final Concentration (ppm)	Percentage Removal of Iron
1.715m^3/m^2/hr	31	26	16%
1.357m^3/m^2/hr	31	20.8	32.9%

Table 1 Percentage Removal of Iron at proportion 1:1

Following Table 2 denotes the initial and final concentration of iron at proportion 1:1.5 denoting sawdust is to rice husk.

Surface Loading Rate	Initial Concentration (ppm)	Final Concentration (ppm)	Percentage Removal of Iron
1.715m^3/m^2/hr	31	12.8	58.7%
1.357m^3/m^2/hr	31	6	80.64%

Table 2 Percentage Removal of Iron at proportion 1:1.5

Following Table 3 denotes the initial and final concentration of iron at proportion 1:2 denoting sawdust is to rice husk.

Surface Loading Rate	Initial Concentration (ppm)	Final Concentration (ppm)	Percentage Removal of Iron
1.715m^3/m^2/hr	30	20.6	31.33%
1.357m^3/m^2/hr	30	7.2	76%

Table 3 Percentage Removal of Iron at proportion 1:2

Following Table 4 denotes the initial and final concentration of iron at proportion 1.5:1 denoting sawdust is to rice husk.

Surface Loading Rate	Initial Concentration (ppm)	Final Concentration (ppm)	Percentage Removal of Iron
1.715m^3/m^2/hr	29	23.6	18.62%
1.357m^3/m^2/hr	29	18	37.93%

Table 4 Percentage Removal of Iron at proportion 1.5:1

Following Table 5 denotes the initial and final concentration of iron at proportion 2:1 denoting sawdust is to rice husk.

Surface Loading Rate	Initial Concentration (ppm)	Final Concentration (ppm)	Percentage Removal of Iron
1.715m^3/m^2/hr	27	24.6	8.88%
1.357m^3/m^2/hr	27	20.02	25.85%

Table 5 Percentage Removal of Iron at proportion 2:1

Following Table 6 denotes the initial and final concentration of iron for using only saw dust as filtration media

Surface Loading Rate	Initial Concentration (ppm)	Final Concentration (ppm)	Percentage removal of Iron
1.715m^3/m^2/hr	31	27	13.33%
1.357m^3/m^2/hr	31	27.7	10.64%

Table 6 Percentage Removal of Iron using saw dust filter media

Following Table 7 denotes the initial and final concentration of iron for using only rice husk as filtration media

Surface Loading Rate	Initial Concentration (ppm)	Final Concentration (ppm)	Percentage removal of Iron
1.715m^3/m^2/hr	31	25.2	21.25%
1.357m^3/m^2/hr	31	24.8	22.5%

Table 7 Percentage Removal of Iron using rice husk filter media

From the above result of every experiment two graphs were plotted comparing the percentage removal of iron at the particular surface loading rate.

Figure 9 denotes the graph showing the variations of percentage removal of iron at surface loading rate 1.715m^3/m^2/hr for all the five proportions of sawdust and rice husk.

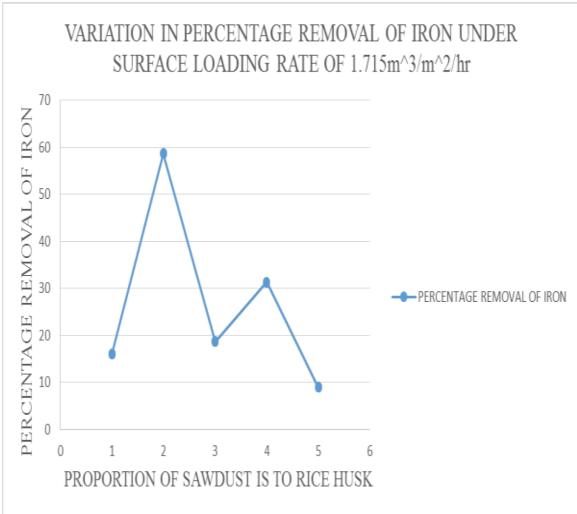

FIGURE 9 GRAPH SHOWING VARIATIONS OF PERCENTAGE REMOVAL OF IRON AT DIFFERENT PROPORTIONS FOR SURFACE LOADING RATE 1.715m^3/m^2/HR

Figure 10 denotes the graph showing the variations of percentage removal of iron at surface loading rate 1.357m^3/m^2/hr for all the five proportions of sawdust and rice husk.

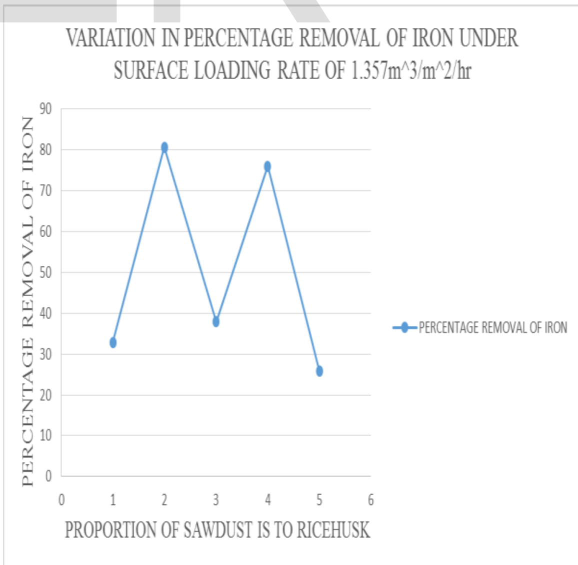

FIGURE 10 GRAPH SHOWING VARIATIONS OF PERCENTAGE REMOVAL OF IRON AT DIFFERENT PROPORTIONS FOR SURFACE LOADING RATE 1.357m^3/m^2/HR

Figure 11 shows the comparison of percentage removal of iron on using saw dust, rice husk and mixture of both at 1:1.5 at surface loading rate 1.715m^3/m^2/hr.

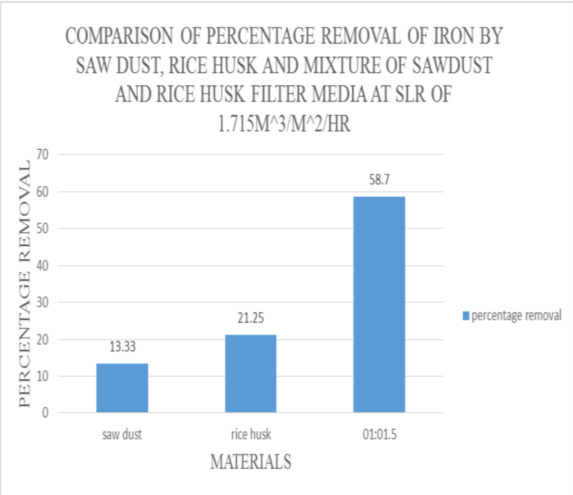

FIGURE 11 GRAPH SHOWING COMPARISON OF PERCENTAGE REMOVAL AT SURFACE LOADING RATE 1.715m^3/m^2/HR.

Figure 12 shows the comparison of percentage removal of iron on using saw dust, rice husk and mixture of both at 1:1.5 at surface loading rate 1.357m^3/m^2/hr

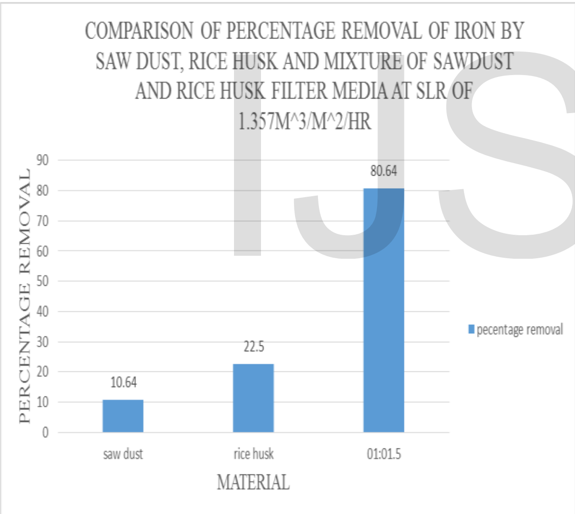

FIGURE 12 GRAPH SHOWING COMPARISON OF PERCENTAGE REMOVAL AT SURFACE LOADING RATE 1.357m^3/m^2/HR

All the above graphs shows that the highest percentage removal of iron of 80.64% is possible if the saw dust and rice husk are mixed at 1:1.5 proportion at surface loading rate 1.357m^3/m^2/hr. However the materials rice husk and saw dust alone can remove iron to some extend but if they are mixed at suitable proportions the percentage removal of iron increases more. The materials used for this filtration technique are locally available cheap material. So this type of media can easily be fabricated in residents for filtering the ground water in small scale in rural areas near iron ore mining places.

CONCLUSION

Removal of iron was very successfully observed with absorbent materials sawdust and rice husk, which makes the treatment of iron even possible in rural areas near iron ore mining where there is high concentration of iron. The experiment was initially done by varying the proportions of sawdust and rice husk used. The results showed that there is about 80% removal of iron when the sawdust and rice husk are mixed at the ratio 1:1.5 at surface loading rate 1.357m^3/m^2/hr. Then the comparison is made by conducting the filtration by using the materials separately without mixing. Finally we resulted that the mixing of materials yields high removal efficiency than using separately.

REFERENCES

[1] Pragati, Prof. Sumint Singh Trivedia, Laxikant Pandey, “Removal of Zinc from Synthetic Waste Water By Saw Dust As An Adsorbent,” International Journal of Innovative Science, Engineering & Technology, Vol. 2 Issue 6, June 2015.

[2] Larous , Meniai A H, “The use of sawdust as by product adsorbent of organic pollutant from wastewater: adsorption of phenol,” Energy Procedia 18 (2012) 905 – 914.

[3] Adeyi, A. A., Mohammed, I. A., Yusuff, A., Olateju, Popoola, “Textile Waste Water Treatment and Colour Removal Using Chemically Activated Sawdust,” Journal of Bioprocessing and Chemical Engineering Volume 1 / Issue 3 ISSN: 2348 –3768.

[4] Asmita Lakhote, Prashantkumar Ahire, Pritesh Dabholkar, Vishwas Dhadambe, Suresh Gharat,. “Comparative Analysis of Design of Water Filter for Rural Areas” - International Journal of Innovative Research in Advanced Engineering (IJIRAE) ISSN: 2349-2763 Issue 12, Volume 3 (December 2016).

[5] Maebh A, Grace, Eoghan Clifford, Mark G Healy,. “The potential for the use of waste products from avareity of sectors in water treatment processes” - Journal of Clean Production. 137 (2016) 788-802.

[6] BULUT Yasemin, TEZ Zeki,. “Removal of heavy metals from aqueous solution by sawdust adsorption” - Journal of Environmental Sciences 19(2007) 160–166.

[7] Bhagirathi Behera, Mira Das, Ajaya Chanda,. “Assessment of ground water quality in and around Bacheli and Kirandula area, Dantewada district, Chhattisgarh, India.” - International Journal Of Environmental Sciences Volume 3, No 6, 2013.

[8] G.Sunpriya Achary,. “Studies on Ground Water Pollution due to Iron Content in Bhubaneswar, Odisha, India.” - International Journal of Current Engineering and Technology. E-ISSN 2277 – 4106, P-ISSN 2347 – 5161.

[9] Abhijeet kumar,. “Development of low cost filter using herbal technique” - Department of civil engineering National institute of technology Rourkela– 769008. (2013-2014).

[10] IS 10500-2012 Indian Standared code for Drinking Water