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Synthesis of adsorbent from agricultural waste to remove heavy metal ions from waste water

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ABSTRACT

Water pollution is a global concern and it is the high time that we realize the gravity of the situation. Removing pollutants from the water is most important today. Developing a cost effective and environmentally safe method is a challenging task for chemical engineers. The presence of heavy metal ions greatly influences the quality of water and the removal of this kind of pollutant is of prime importance. Using many methods by which adsorbents can be manufactured such as enhancement of porosity or activating the adsorbent by carbonization.

Key wards: Agricultural Waste, carbonization, Adsorption isotherms, Langmuir isotherm equation.

INTRODUCTION

1.1 Prelude

Saving water to save the planet and to make future of mankind safe is what we need now. With the growth of mankind, society, science, technology, our world is reaching to new high horizons but the cost which we are paying or will pay in near future is surely going to be too high. Among the consequences of this rapid growth is environmental disorder with a big pollution problem. Anthropogenic activities have caused a great harm to the quality of our lifeline, i.e. water. Because of fast depletion of freshwater resources, there seems to be a crisis of the same. Water pollution is a global concern and, it is the high time that we realize the gravity of the situation. Removing pollutants from the water is crying need of the hour and developing a cost effective and environmentally safe method to achieve the same is a challenging task for chemical engineers. After all, it is the future of mankind, which is at stake.

1.2 Background of Present Research

Now – a – days, a large amount of waste water having heavy metal ions is generated by many industries like textile, dye, battery, automobiles and so on [1]. The presence of heavy metal ions greatly influences the quality of water and the removal of this kind of pollutant is of prime importance. Owing to the hardness possessed by heavy metal ions they are difficult to treat with municipal waste treatment operations [2]. Even a small quantity of heavy metal ion causes high

undesirability. Moreover, the harmful effects caused by presence of heavy metal ions in water are aesthetically unpleasant [1]. They can have very harmful effects when exposed to human beings, animals, plants and many more. In addition to that, many heavy metal ions are considered to be toxic and even carcinogenic.

Few decades earlier presence of heavy metal ions in waters their effects and consequences were not given much importance. With the growing health concerns, it was in the 80s when people started paying much attention to the heavy metal ion waste that are present in water [3]. An indication to the magnitude of this problem can be inferred from the fact that almost all the waste water produced by the industries are directly discharged into aqueous effluents [4, 5]. With the increased stringent laws on industrial discharge, it has become very important to treat this waste water. Because of their detriment and large-scale distribution in the ecological environment, their separation and determination has become one of the important studies of environmental analysis. Of prime importance is the need for clear information on the safety related properties of the metal ions and the measure to be taken for lowering their exposure. If all these elements are seriously considered, then the technical use metal ions and the handling involved might be possible without much health danger.

1.3 Research Objectives

Several physical and chemical methods such as coagulation/flocculation treatment, oxidation methods, membrane filtration and adsorption have been reported to be investigated for the removal of heavy metal ions from industrial effluents [6-9]. Among the studied methods, removal of heavy metal ions from adsorption is found to be most competitive one because it does not need a high operating temperature and several other impurities can be removed simultaneously [1]. The versatility of adsorption is due to its high efficiency, economic feasibility and simplicity of design [10]. As there are various parameters to effect adsorption process such as charge, density and structural stability of the adsorbent so, in the thrust of a comprehensive study, we have selected two waste containing heavy metal ion of lead and other of copper respectively for this present study.

Several adsorbents made from various agricultural wastes such as corn husk, rice husk, groundnut shell, sugarcane bagasse have been used for the purpose of checking the removal of copper and lead heavy metal ions from water. One of the conventional and most studied adsorbent is Activated Carbon (AC). The reasons for this popularity are its high adsorption capacity, high surface area and microporous structure but the cost of activated carbon or for the process of activation is very high [2].

Thus, our objective is to study the effects of adsorbents made from agricultural waste like rice and corn husk in removal of heavy metal ions i.e. lead and copper ions without activation and also to remove the heavy metal ions effectively from

the waste water and also to find the adsorption isotherms.

MATERIALS AND METHODS:

2.1 Materials

2.1.1 Required Chemicals

1. 0.01M zinc sulfate solution
2. 0.01M EDTA
3. pH 10 Buffer solution
4. 0.01M Lead acetate solution
5. Distilled water
6. EBT
7. 0.01M Copper sulfate solution

2.1.2 Raw material

Corn husk, Rice husk

2.1.3 Equipment used

1. Gasifier
2. Sieve shaker
3. 250 ml conical flask
4. Magnetic stirrer
5. 1000 ml beaker
6. UV Spectrometer

2.2 Method of Synthesis

There are many methods by which adsorbents can be manufactured such as enhancement of porosity or activating the adsorbent by carbonization. Activated carbon can be produced by increment in porosity and also by carbonization. Some adsorbents can be produced from different agricultural waste by gasifying the agricultural waste.

2.2.1 Production of adsorbent from corn husk

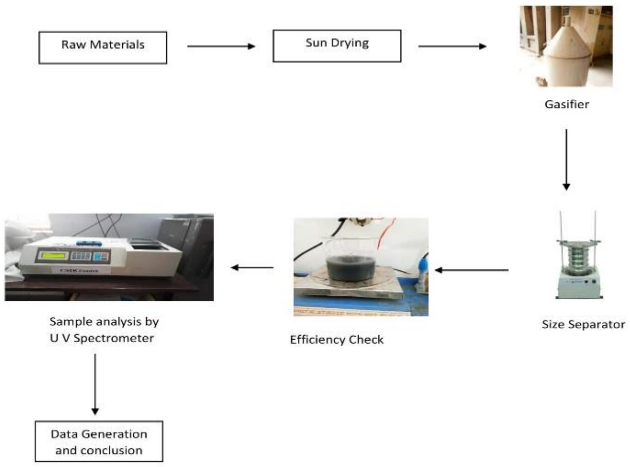

Fig 2.1: Experimental procedure

Initially the raw material (agricultural Waste) is dried in the sun, then the dried waste is burned in gasifier and the ash from the gasifier is collected. This ash works as adsorbent. Then with the help of sieve shaker the ash (adsorbent) is maintained in proper mesh size. This adsorbent can be used directly to remove heavy metal ions without activation. The adsorbent is added in the reactor having waste containing heavy metal ions. By giving the proper residence time the heavy metal is adsorbed on the adsorbent. The percentage removal can be measured from the UV spectrometer and then the data are generated. From the data isotherms are plotted.

RESULTS AND DISCUSSION:

Data's for removal of lead and copper ions using rice and corn husk were generated based on that isotherms are plotted and the satisfactory conclusion is obtained from the generated results.

3.1 Experimental Data for Copper and Lead Using Rice Husk

3.1.1 Experimental data for copper

Table 3.1: Data for copper using rice husk

Time (min)	Concentration (mg/lit)	% Removal
0	30	0
5	12.954	56.82
10	10.809	63.97
15	8.733	70.89
20	7.407	75.31
30	6.171	79.43
40	5.307	82.31
50	4.716	84.28
70	4.089	86.37
90	3.657	87.81

3.1.2 Experimental data for lead

Table 3.2: Data for lead using rice husk

Time (min)	Concentration (mg/lit)	% Removal
0	30	0
5	7.926	73.58
10	3.987	86.71
15	2.541	91.53
20	2.292	92.36
30	2.076	93.08
40	1.875	93.75
50	1.701	94.33
70	1.611	94.63
90	1.473	95.09

3.1.3 Results for lead and copper using rice husk

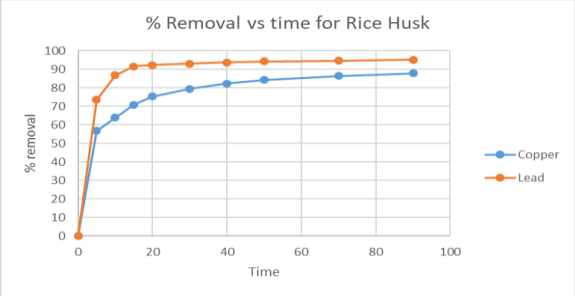

Fig 3.1: Graph of %Removal vs Time for rice husk

From the above graph we can say that adsorbent made from rice husk removes lead more effectively compared to copper.

3.2 Experimental Data for Copper and Lead Using Corn Husk

3.2.1 Experimental data for copper

Table 3.3: Data for copper using corn husk

Time (min)	Concentration (mg/lit)	% Removal
0	30	0
5	9.654	67.82
10	6.915	76.95
15	5.442	81.86
20	4.446	85.18
30	3.891	87.03
40	3.426	88.58
50	2.961	90.13
70	2.433	91.89
90	2.121	92.93

3.2.2 Experimental data for lead

Table 3.4: Data for lead using corn husk

Time (min)	Concentration (mg/lit)	% Removal
0	30	0
5	10.815	63.95
10	8.154	72.82
15	6.321	78.93
20	5.418	81.94
30	4.731	84.23
40	4.176	86.08
50	3.621	87.93
70	3.291	89.03
90	3.081	89.73

3.2.3 Results for lead and copper using corn husk

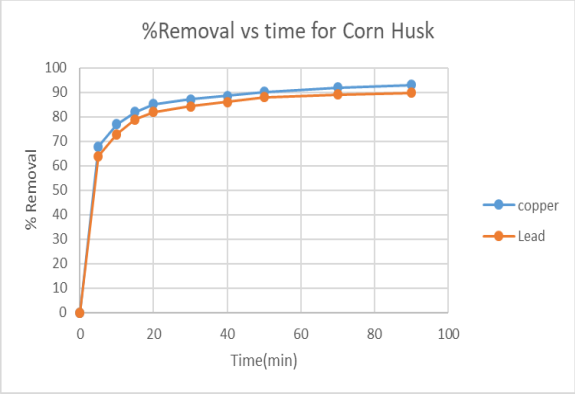

Fig 3.2: Graph of %Removal vs Time for corn husk

From the above graph we can say that adsorbent made from corn husk removes copper more effectively compared to lead.

3.3 Experimental Data for Isotherm of Corn Husk

3.3.1 Experimental data for copper

Table 3.5: Isotherm data for copper using corn husk

Initial Conc.(C) (mg/lit)	Q = X/M	% Removal	C/Q
20	17.322	86.61	1154.601
40	32.368	80.92	1235.788
60	45.138	75.23	1329.257
80	46.632	58.29	1715.56
100	50.31	50.31	1987.676
120	53.388	44.49	2247.696
140	57.918	41.37	2417.211
160	60.528	37.83	2643.405
180	61.038	33.91	2948.983
200	61.86	30.93	3233.107

3.3.2 Experimental data for lead

Table 3.6: Isotherm data for lead using corn husk

Initial Conc.(C) (mg/lit)	Q = X/M	% Removal	C/Q
20	17.782	88.91	1124.733
40	34.036	85.09	1175.226
60	48.546	80.91	1235.941
80	48.728	60.91	1641.767
100	51.32	51.32	1948.558
120	54.192	45.16	2214.349
140	59.038	42.17	2371.354
160	62.848	39.28	2545.825
180	63.63	35.35	2828.854
200	64.38	32.19	3106.555

3.3.3 Isotherm of corn husk

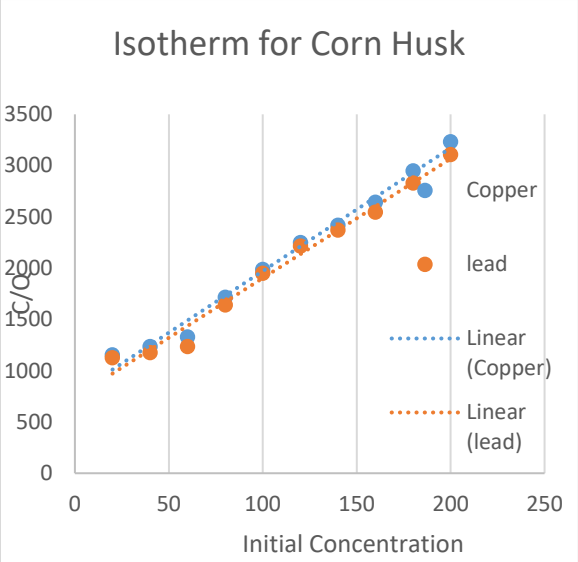

Fig 3.3: Langmuir isotherm of corn husk

From the above graph it shows that experimental data are fitted into following Langmuir isotherm equation

$$C/Q = 12.01 \times C + 770.17$$

Where,

C = Initial concentration of the solution

Q = X/M = grams of adsorbate per gram of adsorbent

3.4 Experimental Data for Isotherm of Rice Husk

3.4.1 Experimental data for copper

Table 3.7: Isotherm data for copper using Rice husk

Initial Conc.(C) (mg/lit)	Q = X/M	% Removal	C/Q
20	16.262	81.31	1229.861
40	31.156	77.89	1283.862
60	43.548	72.58	1377.79
80	44.896	56.12	1781.896
100	49.73	49.73	2010.859
120	51.852	43.21	2314.279
140	55.482	39.63	2523.341
160	57.792	36.12	2768.549
180	59.364	32.98	3032.141
200	62.48	31.24	3201.024

3.4.2 Experimental data for lead

Table 3.8: Isotherm data for lead using rice husk

Initial Conc.(C) (mg/lit)	Q = X/M	% Removal	C/Q
20	19.146	95.73	1044.605
40	37.208	93.02	1075.038
60	55.104	91.84	1088.85
80	56.328	70.41	1420.253
100	58.32	58.32	1714.678
120	58.932	49.11	2036.245
140	60.508	43.22	2313.744
160	64.784	40.49	2469.746
180	67.014	37.23	2686.006
200	67.78	33.89	2950.723

3.4.3 Isotherm of rice husk

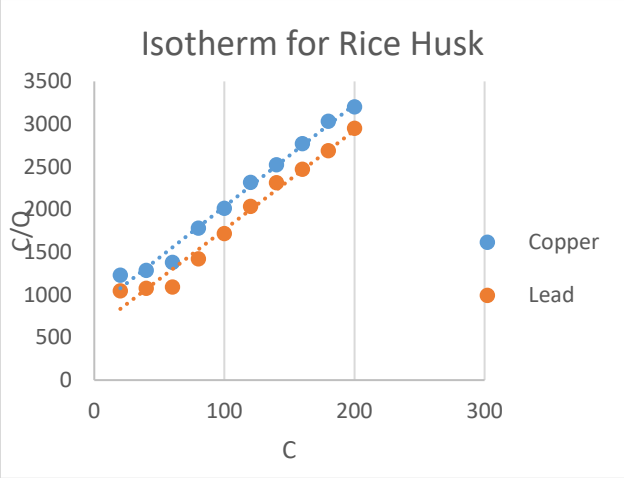

Fig 3.4: Langmuir isotherm of rice husk

From the above graph it shows that experimental data's are fitted into following Langmuir isotherm equation

$$C/Q = 11.958 \times C + 837.03$$

where,

C = Initial concentration of the solution

Q = X/M = grams of adsorbate per gram of adsorbent

CONCLUSION:

By doing this experiment we have concluded that with increase in contact time conc. of lead and copper decreases in water in presence of Ash of Corn Husk and Rice Husk as Adsorbent and the experimental data that has been obtained also says the same. Also from the obtained experimental data it is being concluded that when the mixed adsorbent of Corn and Rice husk is made both ions i.e. lead and Copper are effectively removed and Rice husk removes lead effectively and Corn husk removes copper effectively. Hence mixed Ash from Corn Husk and Rice Husk can be used as effective adsorbent for removal of lead and copper ions simultaneously from water.

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