Removal of Chromium from Industrial Waste Water using Saw Dust and Rice Husk

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Abstract:- The principal aim of this research is to remove the chromium metals in industrial wastewater using sawdust and rice husk. Hexavalent chromium is a toxic industrial pollutant. Electroplating, leather tanning and textile industries release relatively large amounts of chromium in surface water. Chromium increases the risk of lung cancer. Rice husk is the coating on a seed or grain of rice. It constitutes about 20% of the weight of rice. Rice husk is a promising adsorbent material for removing different contaminants because it is a low-cost and renewable resource. Sawdust is a by-product of woodworking operations such as sawing, milling and routing. It contains 60.8% of carbon and 33.8% of oxygen.Limestone is a sedimentary rock composed primarily of calcite, a calcium carbonate mineral with a composition of $CaCO_3$. It acts as a secondary adsorbent. Industrial waste water is filtered using sawdust, rice husk and limestone. Industrial wastewater are coming inside the adsorption column. In this adsorption column, rice husk and sawdust are presented. It adsorbs Cr ions in industrial wastewater. After that the effluent went outside. Sawdust and rice husk act as an adsorbent and it adsorbs chromium ions. The results indicated that sand adsorbs 23.76% of chromium in industrial waste water. The rice husk adsorbs about 83.34% of chromium in industrial waste water. The sawdust adsorbs about 78.03% of chromium ions in industrial wastewater. The combination of rice husk and sawdust adsorbs about 97.10% of chromium in industrial wastewater. The combination of sawdust and rice husk adsorbed chromium ions comparatively higher than sand, rice husk and sawdust. The end result is the sawdust and rice husk will be the perfectadsorbent.

INTRODUCTION

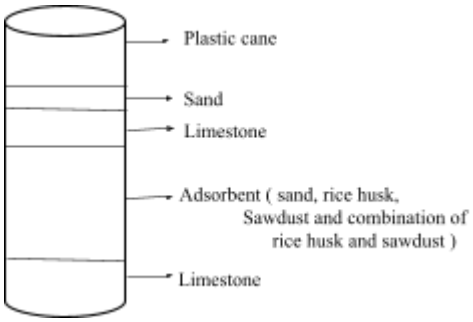
Chromium is highly toxic heavy metal that widely attracted industrial contaminant, released mainly from leather tanning, textile, metal processing, paint and pigments, dyeing and steel fabrication industries. Cr(VI) ions in waste water polluted by industrial foundations and other sources cause serious problems and toxic and non-biodegradable substances tend to accumulate in the virtual organs of humans. Cr(VI) is very much harmful to the human being as it is carcinogenic and also responsible for skin allergy, stomach problems and problems related to the lungs, etc. Rice husk (RH) is a by-product of the industrial processing of rice and approximately 20 wt % of bulk grain weight. Rice husk (RH) is a well-known and readily available agricultural waste, in the countries which produce rice in large amounts. More than 600 million tonnes of paddy production is recorded in the world, on average 20% of the paddy is husked. The rice husk (RH) production is more than 120 million tonnes/annum. It is also use-ful to make the bed for animals, as well as it is burned for energy generation or dumped as waste, while the industrial application is still minimal.The main compositions of RH are celluloses (25–35%), hemicelluloses (18–21%), lignin (26–31%), silica (15–17%), soluble (2–5%), and rest moisture. SiO_2, H_2O, Al_2O_3, Fe_2O_3, K_2O, Na_2O, CaO, and MgO are present in the RH as the chemical components. RH contains functional groups like carboxyl, hydroxyl, and amidogen, etc., and also contains numerous floristic fiber and protein which make RH as a suitable adsorbent. Several treatment procedures such as adsorption, chemical precipitation, electrocoagulation, ion exchange, electrodialysis, and membrane separation are available for removal of Cr from waste water. Simplicity and cost effectiveness adsorption plas an important role in the treatment of wastewater. Surface area, pH of the solution, temperature, nature, dose of adsorbent and interfacing substances affect the adsorption process. Natural adsorbents such as clay, zeolites, peat moss and chitin and agricultural wastes like neem bark, wanet shell, rice husk, spend tea waste, sugar industry waste, etc., are regarded as effective adsorbent for removing heavy metals like Cr, Pb, Cd. Cu, Zn, etc., from various industrial wastewater. In this experiment rice husk and saw dust act as an adsorbent and industrial waste water was filtered using saw dust, rice husk and limestones. This sawdust and rice husk are adsorbed Cr(VI) irons from the waste water. The results indicated that sand adsorbs 23.76% of chromium in industrial waste water. This sand adsorbs only the minimum number of chromium ions. The rice husk adsorbs 83.34% of chromium in industrial waste water. This adsorbs more number of chromium ions compared to sand. Only sawdust adsorbs 78.03% of chromium ions in industrial wastewater. It adsorbs more number of chromium ions compared to sand. But compared to rice husk, it adsorbs less number of chromium ions. The combination of rice husk and sawdust adsorbs 97.10% of chromium in industrial wastewater. Compared to rice husk, sawdust and sand, it adsorbs more number of chromium ions. The combination of sawdust and rice husk adsorbed chromium ions more than sand, rice husk and sawdust. Finally the rice husk and saw dust act as a perfect adsorbent and it also adsorbs high numbers of chromium ions.

MATERIALS ANDMETHODS

1) EXPERIMENTAL SETUP

In this model setup, four layers arethere. These layers are

- First layer
- Second layer
- Third layer
- Fourth layer



1. First layer:

This layer is fully covered with sand. Height of the layer is 3 Cm.. Inthis layer a minimum number of Cr ions are absorbed. Mostly thecolours of the waste water are filtered in this section.

2. Second layer:

The second layer is covered with limestones. Height of the layer is 5 Cm. In this layer only a minimum number of Cr ions are adsorbed. Limestone changes the waste water's pH level.

3. Third layer:

The third layer four adsorbents are used. These adsorbents are, sand,sawdust, rice husk and combination of sawdust and rice husk.

I. **Sand** - It adsorbs only minimum number of Cr ions. The volume of the sand will be changed accordingly.

II. **Sawdust** - It adsorbs more number of Cr ions compared to sand. The volume of sawdust will be changed accordingly.

III. **rice husk** - It adsorbs maximum number of Cr ions compared to sawdust. The volume of the rice husk will be changed accordingly.

IV. **combination of sawdust and rice husk** - The ratio of sawdust and rice husk is 1:2. It adsorbs more number of Cr ions compared to sawdust, rice husk and sand. The volume of combination of sawdust and rice husk will be changed accordingly.

Height of the layer is 18 Cm. Thislayer is the most important layer in this setup. Because most of the Cr ions are adsorbed in this section.

4. Fourth layer:

Fourth and final layer is covered with limestones. Height of the layer is 7 Cm. In this section only minimum no. of Cr ions are adsorbed. But the waste water's pH level has changed.

2) ADSORPTION PROCESS

Adsorption is a mass transferprocess that is a phenomenon of sorption of gases or solutes by solid or liquid surfaces. The adsorption on the solid surface is that the molecules or atoms on the solid surface have residual surface energy due to unbalanced forces.

Adsorption is a wastewater purification technique for removing a wide range of compounds from industrial wastewater. Adsorption is most commonly implemented for the removal or low concentrations of non-degradable organic compounds from groundwater, drinking water preparation, process water or as tertiary cleansing after, for example, biological water purification.

Adsorption takes place when molecules in a liquid bind themselves to the surface of a solid substance. Adsorbents have a very high internal surface area that permits adsorption.

In this experiment rice husk and sawdust act as an adsorbent. It is low cost and renewable source. Industrial wastewater are coming inside the adsorption column. In this adsorption column, rice husk and sawdust are presented. It adsorbs Cr ions in industrial wastewater. After that the effluent went outside.

3) CHROMIUM TEST

PROCEDURE

- Take a 50 mL sample or a portion diluted to 50mL. If chromium concentration is very low, take a higher volume, boil and reduce the volume to below 50mL cool. Make upto 50 mL.
- Add 6N H_2SO_4 in drops and adjust solution pH to 1.0 ± 0.3. Add 1 mL. Diphenyl carbazide solution, mix. Allow to stand for 10 minutes. Measure O.D. at 540 nm.
- Carry out a reagent blank with 50 mL distilled H_2O. Use this for a photometric setting.

CALCULATION

Chromium as Cr^{6+} mg/L = (O.D × slope × 50)/ (mL sample).

REAGENTS

SI. No.	Reagent	Preparation
1	$6NH_2SO_4$	Take 16.7 mL conc.H_2SO_4 and dilute to 100 mL.
2	Diphenyl Carbazide	Dissolve 250 mg 1,5 diphenyl carbazide in 50 mL acetone.
3	Stock chromium	Dissolve 141.4 mg K_2CrO_4 in 100 mL distilled H_2O (1 mL = 0.5 mg Cr).
4	Std. chromium	Dilute 1 mL stock to 100 mL (1 mL = 0.005 mg Cr).

CHEMICALS

Name of chemical	Formula	Quantity required for 100 samples/year
Conc. sulphuric acid	Con.H_2SO_4	40 mL
1, 5 diphenyl carbazide	$(C_6H_5N_2H_2)_2CO$	1 g.
Pot. Chromium	K_2CrO_4	0.7 g.
Acetone	C_2H_6O	200 mL

REPORTING

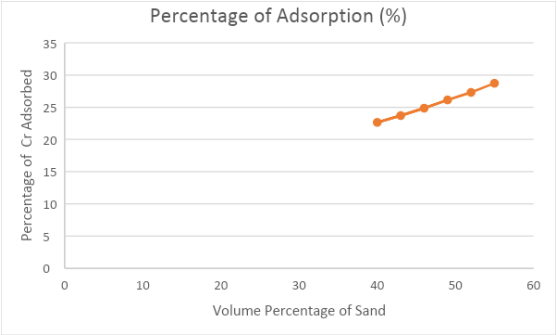
Chromium range	Report to nearest
0 - 1 mg/L	0.01 mg/L
1 - 10 mg/L	0.1 mg/L
> 10 mg/L	1.0 mg/L

RESULTS AND DISCUSSION

1) ADSORPTION USING SAND

Before Adsorption (mg/L)	Volume percentage of sand (%)	After Adsorption (mg/L)	Percentage of adsorption (%)
76.25	40	58.97	22.65
76.72	43	58.52	23.71
76.17	46	57.23	24.86
76.69	49	56.64	26.14
76.37	52	55.51	27.31
76.58	55	54.57	28.73

From the table, It were observed that the adsorption of sand before and after the adsorption process. It shows the percentage of adsorption in the adsorption process using sand. It shows that the percentage of adsorption increases with increasing the volume percentage of sand. Sand adsorbs 28.73% of Cr ions from the industrial waste water.

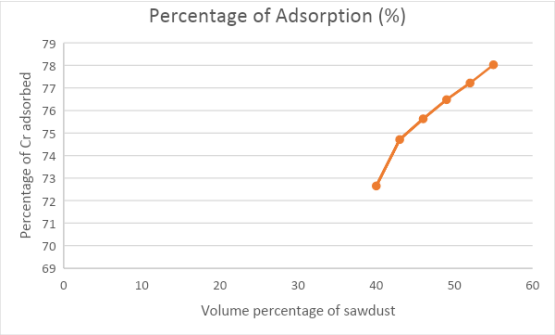


The above group is between Volume percentage of sand vs Percentage of Adsorption. In this Volume percentage of sand is in X-axis and Percentage of Cr ions adsorbed is in Y-axis. This graph clearly shows that the percentage of adsorption increases with increase in adsorbent volume percentage of sand. The sand adsorbs about 28.73% of Cr ions in industrial waste water.

2) ADSORPTION USING SAWDUST

Before Adsorption (mg/L)	Volume percentage of sawdust (%)	After Adsorption (mg/L)	Percentage of adsorption (%)
76.15	40	20.82	72.65
76.77	43	19.25	74.71
77.11	46	18.79	75.63
76.89	49	18.09	76.48
76.57	52	17.44	77.22
76.78	55	16.86	78.03

From the table, It were observed that the adsorption of sawdust before and after the adsorption process. It shows the percentage of adsorption in the adsorption process using sawdust. It shows that the percentage of adsorption increases with increasing the volume percentage of sawdust. Rice husk highly adsorbed 78.03% of Cr ions from the industrial waste water.

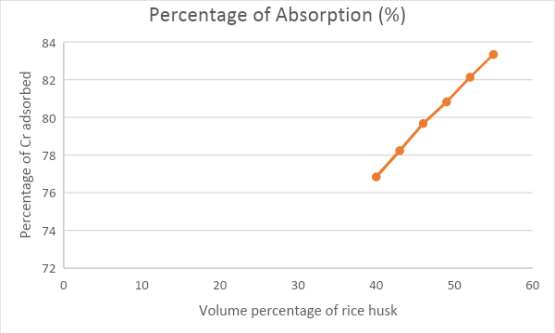


The above group is between Volume percentage of sawdust vs Percentage of Adsorption. In this Volume percentage of sawdust is in X-axis and Percentage of Cr ions adsorbed is in Y-axis. This graph clearly shows that the percentage of adsorption increases with increase in adsorbent volume percentage of sawdust. The sawdust adsorbs about 78.03% of Cr ions in industrial waste water.

3) ADSORPTION USING RICE HUSK

Before Adsorption (mg/L)	Volume percentage of rice husk (%)	After Adsorption (mg/L)	Percentage of adsorption (%)
76.41	40	17.90	76.84
75.88	43	16.51	78.23
76.32	46	15.51	79.67
77.15	49	14.79	80.82
76.48	52	13.66	82.13
76.82	55	12.79	83.34

From the table, It were observed that the adsorption of rice husk before and after the adsorption process. It shows the percentage of adsorption in the adsorption process using rice husk. It shows that the percentage of adsorption increases with increasing the volume percentage of rice husk. Rice husk highly adsorbed 83.34% of Cr ions from the industrial waste water.

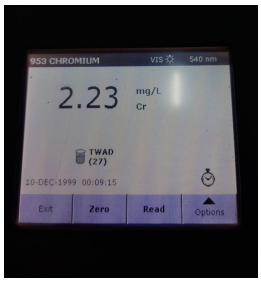


The above group is between Volume percentage of rice husk vs Percentage of Adsorption. In this Volume percentage of rice husk is in X-axis and Percentage of Cr ions adsorbed is in Y-axis. This graph clearly shows that the percentage of adsorption increases with increase in the adsorption volume percentage of rice husk. The rice husk adsorbs about 83.34% of Cr ions in industrial waste water.

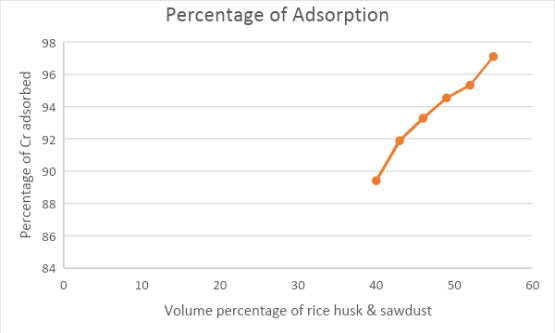
4) ADSORPTION USING RICE HUSK AND SAWDUST

Before Adsorption (mg/L)	Volume percentage of rice husk and sawdust (%)	After Adsorption (mg/L)	Percentage of adsorption (%)
76.18	40	8.27	89.41
76.59	43	6.22	91.89
76.25	46	5.12	93.28
75.89	49	4.14	94.54
77.12	52	3.61	95.32
76.94	55	2.23	97.10

From the table, It were observed that the adsorption of sand before and after the adsorption process. It shows the percentage of adsorption in the adsorption process using rice husk and sawdust. It shows that the percentage of adsorption increases with increasing the volume of rice husk and sawdust. Rice husk highly adsorbs 97.10% of Cr ions from the industrial waste water.



The above diagram shows the value of Cr ions present in wastewater, before and after the adsorption process using a combination of sawdust and rice husk as an adsorbent . Before the adsorption process, 76.94 mg/L of Cr ions are present in wastewater. After the adsorption process, only 2.23 mg/L of Cr ions are present in wastewater. Compared to these two diagrams, after the adsorption process, more Cr ions are adsorbed.



The above group is between Volume percentage of rice husk and sawdust vs Percentage of Adsorption. In this Volume percentage of rice husk and sawdust is in X-axis and Percentage of Cr ions adsorbed is in Y-axis. This graph clearly shows that the percentage of adsorption increases with increase in adsorbent volume percentage of rice husk and sawdust. The sand adsorbs about 97.10% of Cr ions in industrial waste water.

5) EFFECT OF VOLUME

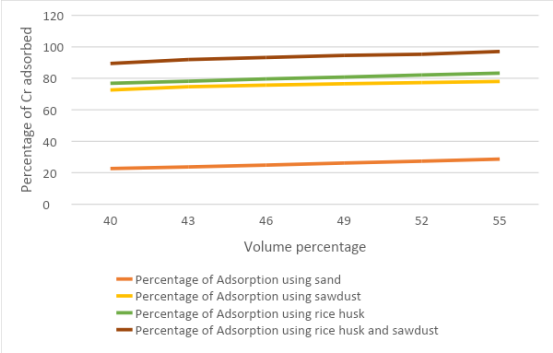
To study the effect of volume percentage on adsorption process, initially 40% of adsorbent like rice husk and sawdust are used. It adsorbs certain amount of Cr ions in industrial wastewater. After the increased in the adsorbent volume percentage from 40% to 43% then the adsorption rate is increased perpendicularly. It is similar to all adsorbents like sand, rice husk and sawdust. The result is that the percentage of adsorption rate increases with increase in adsorbent volume percentage.

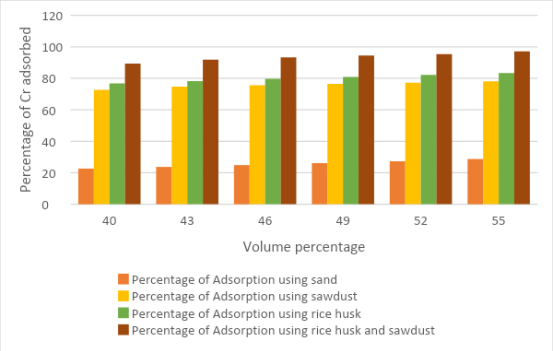
6) COMPARISON BETWEEN DIFFERENT ADSORBENTS

Volume percentage (%)	Percentage of Adsorption using sand (%)	Percentage of Adsorption using sawdust (%)	Percentage of adsorption using rice husk (%)	Percentage of adsorption using sawdust and rice husk (%)
40	22.65	72.65	76.84	89.41
43	23.71	74.71	78.23	91.89
46	24.86	75.63	79.67	93.28
49	26.14	76.48	80.82	94.54
52	27.31	77.22	82.13	95.32
55	28.73	78.03	83.34	97.10

Above table shows the value of the percentage of adsorption using sand, sawdust, rice husk and combination of sawdust and rice husk. In this table the percentage of adsorption increases with increase in volume percentage. so, the volume percentage is directly proportional to the adsorption percentage.

volume ∝ adsorption





The above graphs is between Adsorbent volume percentage vs Percentage of Adsorption. In this Volume percentage is in X-axis and Percentage of Cr ions adsorbed is in Y-axis. This graphs clearly shows that the percentage of adsorption increases with increase in volume percentage of rice husk and sawdust. Analysis of these graphs, combination of rice husk andsawdust are adsorbs more number of Cr ions compared to sand, rice husk and sawdust. In different volume percentages, the combination of rice husk and sawdust acts as a better adsorbent. Sand are adsorbs theminimum number of Cr ions in these figures. So, it is not a perfect adsorbent. The sawdust and rice husk adsorbs more than 50% of Cr ions in industrial wastewater. But a combination of sawdust and rice husk are adsorbed more number of Cr ions compared to sawdust and rice husk are individually Adsorbed. So, compared to rice husk and sawdust, the combination of rice husk and sawdust performed well.Finally, the combination of sawdust and rice husk acts as a good adsorbent.