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ADSORPTION OF COPPER FROM METAL INJECTION MOLDING INDUSTRY EFFLUENT USING RICE HUSK AS ADSORBENT

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ABSTRACT

In the present study, rice husk as an adsorbent has been used for removing copper from metal injection molding industry effluent. Adsorption was carried out in a batch experiment with initial concentration of copper by varying the amount of adsorbent, pH and reaction time, under constant shaking of 100 ml sample in a heavy rotatory shaking apparatus for 2 hours. After treatment, the result revealed that about 93.32% of copper was reduced at pH7 with 8 gm rice husk. Physico-chemical analysis before and after treatment was also carried out. Brunauer Emmett Teller (BET) analysis was carried out for Specific surface area, Pore volume and Average pore diameter of rice husk. Scanning Electron Microscopic (SEM) analysis was carried out for structural and morphological characteristics of rice husk. To determine the concentration of copper before and after treatment, Atomic Adsorption Spectrophotometer was used.

KEY WORDS : Rice husk, Copper, Atomic adsorption spectrophotometer, Scanning electron microscope.

INTRODUCTION

Heavy metals are the elements which have a high specific gravity eg. arsenic, iron, lead, cadmium and mercury (Lide, 1992). Some elements are very important to our wellbeing in small amount but in large concentration may cause chronic and acute toxicity due to their property of bioaccumulation and persistence (Sharma *et al.*, 2005). Copper is released into the environment by both anthropogenic and natural geological processes and is essential to plants and animals including human beings in low doses but in high concentration it causes severe toxicity (Sandeep *et al.*, 2016). Copper is one of the heavy metal which is used in manufacturing process in metal injection molding industry.

MATERIALS AND METHODS

Adsorbent

Rice husk was collected from a local rice mill and it was washed with distilled water, dried in an oven at about 60 ^{0}C for 4h. Again it was washed with acetone and NaOH (0.3M) to remove dirt and other contaminants, dried in an oven at about 60 ^{o}C for 4h and crushed until powdered particles were obtained. The powdered sample was examined by XRD (X-Ray Diffraction) SEM and BET analysis to know the degree of crystallization, i.e. crystal structure, compositions, and size.

Characterization of rice husk Scanning Electron Microscope (SEM)

The SEM image of powdered rice husk is shown in Fig: 1 which indicates the aggregation particles and cluster shape with sharp edge.

Bet Surface Analysis

Brunauer Emmett Teller (BET) analysis was carried out for the Specific surface area (13.38m^2/g), Pore volume (0.022cc/g) and Average pore diameter (1.557nm) of rice husk.

(*Research Scholars, **Associate Professor)

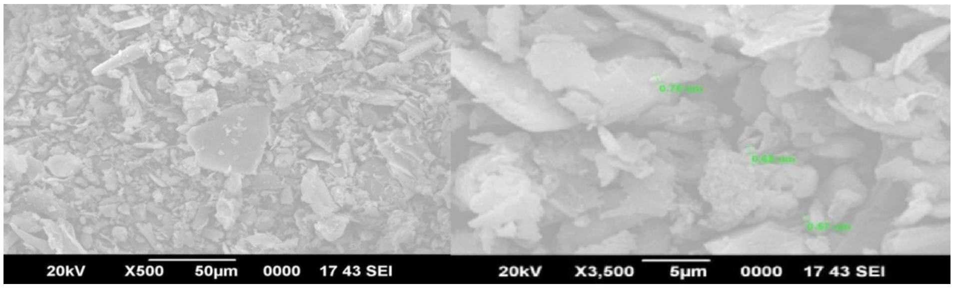

Fig. 1. Scanning Electron Micrograph of powdered rice husk.

Instrumentation

1.	**Heavy metal analysis (Cu)**	- Atomic Adsorption Spectrometer
2.	**The morphology of rice husk powder**	- Scanning Electron Micrograph
3.	**A Specific Surface Area (SSA)** Nitrogen adsorption–desorption (NOVA-	- Brunauer–Emmett–Teller (BET) at 77 K, 1000- Version 3.70 Instrument)
4.	**Characterization of rice husk**	- X- Ray diffraction (Rigaku) using Cu-K∝ Diffractro meter radiation (105406A^o) in a θ–2θ configuration
5.	**The average size of rice Husk powder**	- Calculated using Debye Scherrer's formula equation

X- Ray diffraction (XRD)

The average crystalline size of powdered rice husk was examined by X- Ray diffraction (Rigaku Diffractro meter) using Cu-K radiation (105406A^o) in a configuration. Crystalline size was calculated using Debye Scherrer's formula equation (Eq2) and result was found to be around 28 nm.

$$D= (K\lambda \ /(\beta cos\theta)) \qquad \text{(Eq.1)}$$

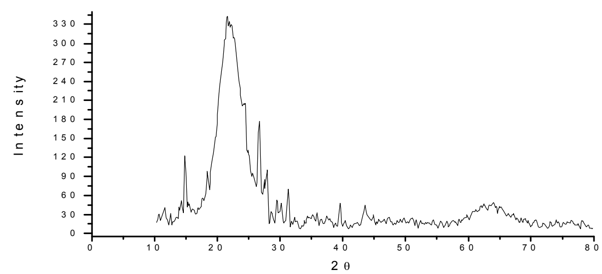

Fig 2. XRD of the powdered rice husk

To determine the adsorption capacity of copper, batch experiment was conducted. A known weight of rice husk with 100 ml effluent of different concentration, i.e 25%, 50%, 75% and raw in a conical flask was kept for treatment in heavy rotatory shaking apparatus for 2 hours. pH was adjusted by HCL and NaOH. After 2 hours the samples were filtered using whatman No 41 filter paper. Physico-chemical analysis was carried out before and after treatment and copper was measured by AAS (Table 1).

Initial concentration of copper was found to be 14.83±0.01 in 25% concentration, 19.24±0.01 in 50% concentration, 23.07±0.02 in 75% concentration and 25.35±0.01 in raw (100% concentration) effluent. After treatment with rice husk, concentration of copper was reduced to 5.04±0.01 (66.01%) in 25% concentration, 8.16±0.01 (57.58%) in 50% concentration, 13.06±0.01 (43.38%) in 75% concentration and 18.12±0.01 (28.52%) in raw effluent. Maximum reduction of copper 5.04±0.01 (66.01%) was found to be in 25% concentration (Fig. 3). Based on this result effect of adsorbent was carried out. Removal of copper was calculated by using this formula

Table 1. Characterization of Metal Injection Molding Industry Effluent

S.No	Parameters	Before treatment	After treatment
1	pH	1	7
2	Temperature (^{0}C)	28.9	24.1
3	Biological Oxygen Demand (mgL^{-1})	35	24
4	Chemical Oxygen Demand (mgL^{-1})	1250	984

$$\text{Percent removal} = \frac{(Co - Ci)}{Co} \times 100 \qquad \text{(Eq 2)}$$

Where, Co is initial concentration and C_i is final concentration of copper.

The effect of adsorbent was carried out with different dosage of rice husk from 1-10g/100 ml at pH7 in conical flasks in a heavy rotatory shaking apparatus for 2 hours. The result revealed that the adsorption capacity increased from 11.61±0.01 (21.71%) to 0.99±0.005 (93.32%) with 1 to 8 g of adsorbent and decreased upto 1.33±0.05 (91.03%). Maximum reduction of copper was 0.99±0.005 at 8gm/100ml in 25% concentration (Fig.4) which indicated that the percentage removal of copper increased with increasing dose of adsorbent.

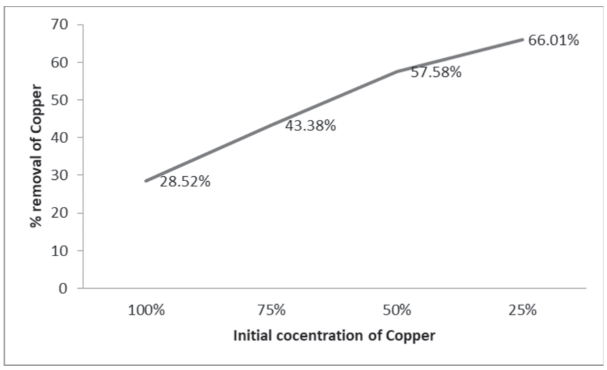

Fig. 3. Removal of copper with rice husk at different effluent concentration

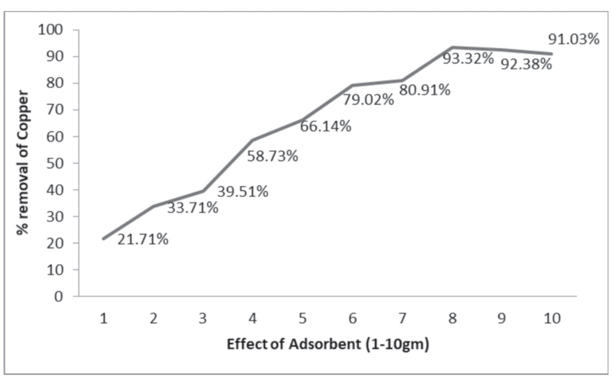

Fig. 4. Removal of copper at different adsorbent dosage (1-10g/100mL at pH7)

The effect of pH was observed at different ranges i.e. 1, 3, 5, 7 and 11 with 8 g/100ml in 25% concentration. During treatment, copper removal increased from 8.82±0.005 (40.52%) at pH1 to

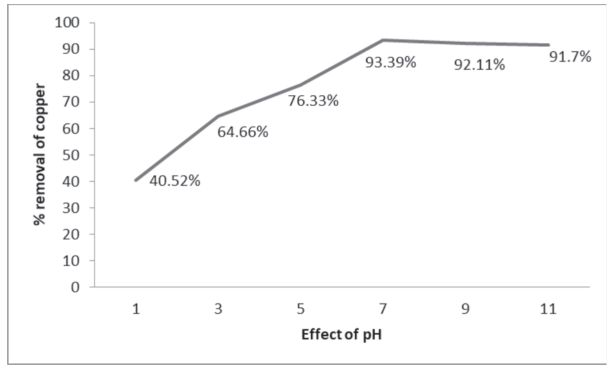

Fig. 5. Effect of pH on the adsorption of copper

0.98±0.005 (93.39%) at pH 7. Maximum removal of copper was found 0.98±0.005 (93.39%) at pH 7 and it gradually decreased 1.23±0.011 (91.7%) at pH 11. This is because on the surface of the adsorbent, hydrogen ions compete very strongly and pH affects the ionization of functional groups (Mas Rosemal *et al.*, 2011).

CONCLUSION

Adsorption of copper from metal injection molding industry effluent using rice husk as adsorbent has been investigated. Maximum removal capacity of copper was obtained at pH 7 for 8g of rice husk/100 ml in 2 hours at 25% concentration. The adsorption process depends on the initial concentration, adsorbent dosage, contact time, temperature and pH. Adsorption process is user friendly and hence recommended for waste water treatment in industries.

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