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REDUCTION OF HEAVY METALS FROM TEXTILE EFFLUENT WITH ACTIVATED CARBON FROM WHEAT HUSK

TANMAYEE PANIGRAHI[1] AND RM. NARAYANAN[2]

[1]Assistant Professor, Department of Chemical Engineering, [2]Professor, Department of Civil Engineering, Dr. MGR Educational and Research Institute, University, Maduravoyal, Chennai 600 095, T.N., India

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ABSTRACT

Textile industries are known to be huge platform for providing employment without any skill perfection but at the same time they also hold the tag of prime offender in polluting the environment. They are immensely responsible for discharging the heavy metals to the aquatic bodies. Heavy metals such as Copper (Cu), Lead (Pb), Cadmium (Cd), Chromium (Cr), Arsenic (As), Zinc(Zn), Iron (Fe), Mercury (Hg), and Sulphur (S) are widely used in textile industries. These heavy metals are the great threat for the environment and ecology. This proposed work is done to evaluate the efficiency of wheat husk in removing of heavy metals from textile Effluent. Wheat husk was subjected to different steps of physical and chemical treatment and was converted into activated carbon. Textile effluent was collected from Tirupur area in Tamilnadu which is very famous for the cotton industries. Batch studies were done by taking 10 g of wheat husk with 200 mL of the textile effluent to evaluate change in the Heavy metal concentration from initial state to final state in the collected sample from textile effluent. The pH of the sample was varied from 4.5 to 7.5 and the adsorption capacity of wheat husk was analyzed for Arsenic, Mercury Chromium and Lead. Initial characterization of Heavy metals is done by using PERKIN ELMER OPTIMA 5300 DV ICP-OES. The results show that this low cost and eco-friendly adsorbents can effectively used for the removal of heavy metals.

KEY WORDS : Adsorption, Activated carbon, Wheat husk, Heavy metals

INTRODUCTION

Textile industry is one of the largest chains of industries which are the source of employment for different group of population which also greatly influence the world's economy. But with passage of time these textile industries have become prime offenders in polluting the environment, i.e about 30% of usable water is being polluted by the discharge from the textile industries. Textile use lots of water in washing and scoring processes and in return this huge amount of untreated water is being discharged to the water bodies which also carry lot of chemicals that is being used for dying of fibers.

Different types of dyes like Acid dyes, synthetic dyes, chemical dyes, Reactive dyes, direct dyes, naphtha dyes and indigo dyes are used for dying fibers in textile industries (Yaseen and Scholz, 2019). Huge tons of water is used to load chemical and rinse the final product which force the waste water to contain lots of chemicals and heavy metals to flow in aquatic bodies. These heavy metals are highly toxic in nature and put the environment in a great risk (Ali *et al.,* 2019) . More amount of Arsenic can cause risky complications in human body and can permanently damage integumentary, Respiratory and also affect the nervous system (Mohammed Abdul *et al.,* 2015). High concentrations of chromium and specially hexavalent chromium are highly carcinogenic. Mild symptoms for exposure to chromium cause dizziness and eye irritation and prolonged intake can cause liver and kidney damage (Achmad *et al.,* 2017). Lead is more abundantly found in Earth's crust and causes a great damage to environment and human health due to its toxic nature and its stability

nature. When lead is found in excess quantity its risk factor also increases and can cause mental abnormality among children (Tiwari *et al.*, 2013) .Lead also increases the soil infertility by affecting the physiological changes in the function of organisms (Tiwari *et al.*, 2013). Mercury exits naturally but it is the man made mercury which causes environmental damage by disturbing the atmosphere soil and water cycle and which in return affects the human health. Mercury can be ingested by human being through Fish, wildlife and contaminated seafood. Mercury has direct adverse affect on the neurological system of both children and adult (Rice *et al.*, 2014). Removal and reduction of these heavy metals have become an inevitable for researchers.

Numerous processes have been employed with varying degree of success in overcoming the dyes and heavy metals from textile effluent. Many expensive processes such as ion exchange, solvent extraction, thermal treatment, microbial reduction, and electro dialysis are done for successive removal of heavy metals and dyes from textile effluent. Adsorption is found to be efficient method in removing heavy metals from waste water (Gunatilake, 2015). Many agriculture wastes and domestic wastes are used as adsorbents for the adsorption of heavy metals. Low cost adsorbents are derived from different agriculture waste such as coir pith (Lim and Aris, 2014), neem bark powder (Mohan *et al.*, 2007), tea waste (Ahluwalia and Goyal, 2005), peanut shell (Ugwekar and Lakhawat, 2012) etc for removing dyes and heavy metals from textile effluent.

Wheat husk is the outer covering of the wheat and which is being discarded when wheat is being processed. This is found in abundant quantity near a wheat and rice dealers. This part of the wheat grain is considered as the waste and in this present work it is modified and processed through thermal and chemical treatment for removing the heavy metals from the textile effluent. Wheat bran **A**ctivated carbon treated with perchloric acid was used to remove Methylene Blue from aqueous solution (Banerjee *et al.*, 2014). SEM study of modified wheat husk indicates that it has a rough surface which is perfect for adsorption (Banerjee *et al.*, 2014). In this work activated carbon was prepared from wheat husk with Phosphoric acid and was subjected to thermal treatment for the activation of wheat husk.

MATERIALS AND METHODS

Activated carbon from Wheat Husk

The wheat husk used in the present investigation was obtained from the local countryside. The collected materials were washed with distilled water for several times to remove all the dirt particles. Then it was dried at 70 °C for 24 hrs. Then it was grounded to get reduced sized particles. The grounded wheat husk was sieved to get uniform particle size of 150 meshes. Chemical treatment of wheat husk was done by soaking 50 gm of wheat husk in 70 mL of Phosphoric acid (30%) for 1 hrs. Then it was dried in Muffle furnace at 500°C for 50 minutes. Pyrolysis happens in high temperature which converts dried material into activated charcoal.

Flow Diagram of wheat husk to activated carbon

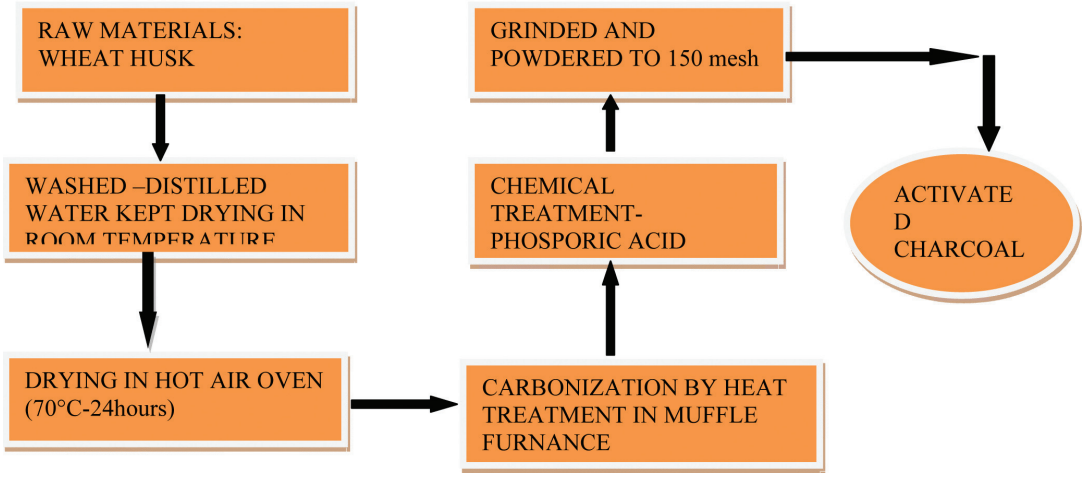

Fig. 1. Reduction Percentage of heavy metals after treatment

Experimental Method

The initial concentration of the heavy metals was analyzed using PERKIN ELMER OPTIMA 5300 DV ICP-OES to find out the concentration of Copper (Cu), Lead (Pb), Cadmium (Cd), Chromium (Cr), Arsenic(As), Zinc(Zn), Iron (Fe), Mercury (Hg), Magnesium (Mg) and Sulphur (S).200 mL the textile effluent collected from Tirupur stretch was take in beaker and was treated with 10gm and 20 gm of wheat husk activated carbon for around 6hrs. The treated sample was again evaluated to find the final concentration of heavy metals. The pH of water was changed from 4 to 7 to find the optimum pH to find the removal of heavy metals.

RESULTS AND DISCUSSION

By analyzing the result, we can see that heavy metals like Copper(Cu), Cadmium (Cd), Iron (Fe), Arsenic (As), Chromium (Cr), Sulphur (S), Lead (Pb) and Mercury (Hg) are reduced with wheat husk adsorbent in fig 4.The comparison between the untreated sample and treated sample in shown in Table 1.

Change in heavy metal concentration with pH

Adsorption of Arsenic, Cadmium, Mercury and lead was observed with different pH values ranging from 4.5 to 7.5. pH of the sample solution were adjusted by adding sodium hydroxide Hcl as required. 100 mL of solution was taken in conical flask and the pH of each conical flask was maintained. 10 gm of activated carbon of wheat husk was added to each conical flask and treated for a constant time period of 6hrs. The treated sample was tested for the adsorption efficiency of the heavy metals. All heavy metals behaved differently with different value of pH. The concentration of heavy metals at different pH values are given in Table 2.

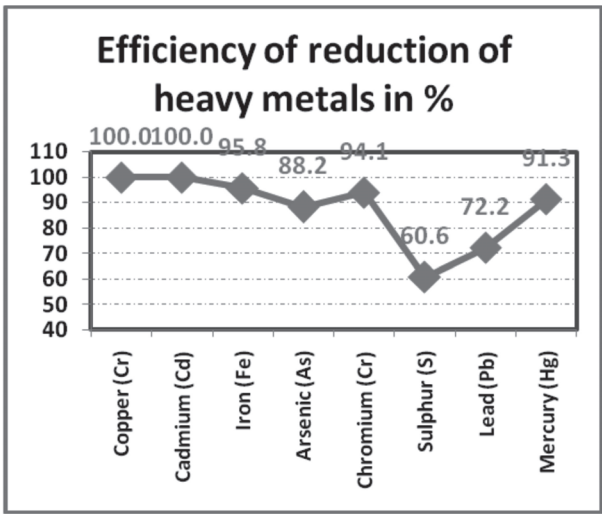

Fig. 2. Change of concentration Arsenic with Ph

From Table 2 it was found that removal of heavy metals from the textile effluents was more efficient with acidic nature of the sample. Removal of Arsenic was high at pH value of 4.5 with about 0.004 mg/L. Removal of Mercury and Chromium was favorable when the pH value was at arrange of 5.5 and mercury removal was maximum of 0.335mg/L and chromium removal was 0.004 mg/L. Whereas Lead was removed to its maximum of

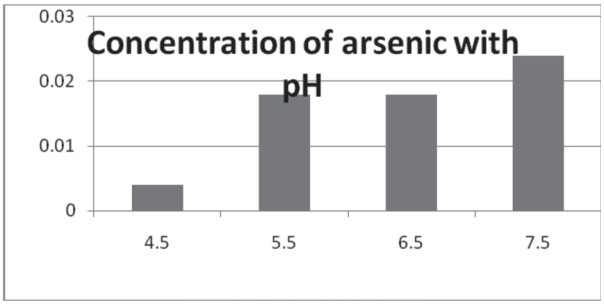

Fig. 3. Change of concentration of Chromium with pH

Table 1. Comparison of treated and untreated effluent

Heavy Metals	SAMPLE 1 (Initial heavy metal conc without treatment)	SAMPLE 2 (Final heavy metal conc Treated effluent)	Efficiency of reduction of heavy metals in %
Copper (Cr)	0.178 mg/L	-0.213 mg/L	100
Cadmium (Cd)	0.008 mg/L	-0.002 mg/L	100
Iron (Fe)	1.132 mg/L	0.048 mg/L	95.759
Arsenic (As)	0.034 mg/L	0.004 mg/L	88.23
Chromium (Cr)	0.102 mg/L	0.006 mg/L	94.12
Sulphur (S)	97.13 mg/L	38.23 mg/L	60.64
Lead (Pb)	0.018 mg/L	0.005 mg/L	72.22
Mercury (Hg)	3.862 mg/L	0.335mg/L	91.32

Table 2. Change of Heavy metals with pH values

pH	Arsenic		Mercury		Chromium		Lead	
	Before treatment conc in mg/L	After treatment conc in mg/L	Before treatment conc in mg/L	After treatment conc in mg/L	Before treatment conc in mg/L	After treatment conc in mg/L	Before treatment conc in mg/L	After treatment conc in mg/L
4.5	0.034	0.004	3.862	0.426	0.102	0.004	0.018	0.014
5.5	0.034	0.018	3.862	0.335	0.102	0.004	0.018	0.005
6.5	0.034	0.018	3.862	0.421	0.102	0.018	0.018	0.005
7.5	0.034	0.024	3.862	1.328	0.102	0.102	0.018	0.016

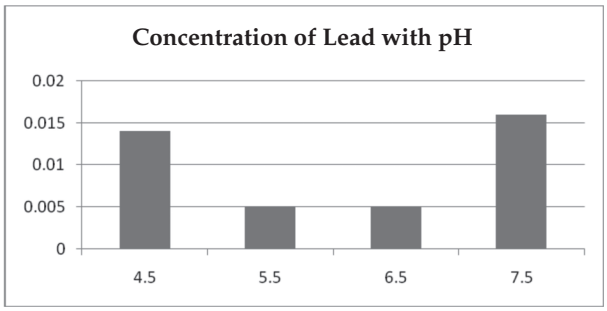

Fig. 4. Change of concentration of Lead with pH

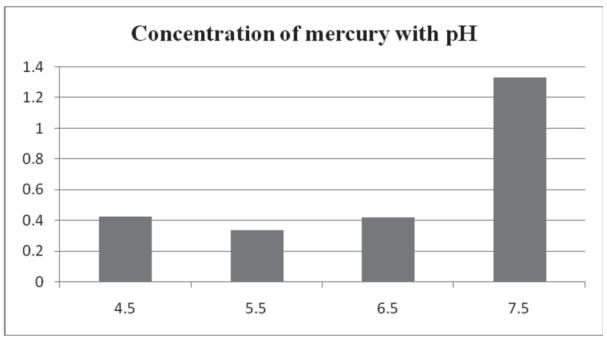

Fig. 5. Change of concentration of Mercury with pH

0.005 mg/L at pH value of 6.5.

CONCLUSION

Based on the results of this study following conclusions could be drawn:

1. The present analysis is done to study the suitability of Indigenous adsorbent of Wheat husk for the removal of heavy metal such as arsenic, Cadmium, Copper, Mercury, Lead and Zinc from Textile Effluent.
2. Wheat husk was found to be more effective on the heavy metals and showed a great affinity towards removal of Chromium and Mercury.
4. The maximum removal of mercury was found to be in the pH range of 4.5 to 5.5 and also same trend was followed for chromium.
5. Wheat Husk are the agro waste products which are readily available and usage of these adsorbents can bring a revolutionary effect in removing heavy metals with less expense.

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