ScienSage

Journal of Advanced Scientific Research

Available online through http://www.sciensage.info

ISSN
0976-9595
Research Article

REMOVAL OF HEAVY METALS FROM INDUSTRIAL WASTE WATER BY ACID ACTIVATED CARBON PREPARED FROM TEAK WOOD BIOMASS

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ABSTRACT

The removal of heavy metals from the effluent is of special concern due to their prolonged existence. Removal of copper, cadmium, lead, and zinc from effluent by acid activated carbon prepared from Teak wood bio mass, has been studied. The prepared carbon was characterized by FT-IR spectroscopy and SEM. The effect of temperature and contact time on the removal of these heavy metals using the activated carbon was investigated. Batch experiments were conducted to test the ability of activated carbon for the removal of heavy metals. Maximum removal was observed at a temperature of 80 °C and at an optimum contact time of 60 min. This work, therefore, suggests that Teak wood bio mass (TPAC) is suitable for the removal of heavy metals on effluent.

Keywords: Acid activated carbon, Heavy metals, Adsorption, Pollution, Effluent.

1. INTRODUCTION

Heavy metal pollution affects the ecosystem [1]. The heavy metals like lead (Pb), zinc (Zn), copper (Cu), arsenic (As), cadmium (Cd) etc. originate from sources such as dyes, mordants, pigments and bleaching agents [2,3]. The absorption of heavy metals has shown adverse effects like kidneys damage, nervous disorder [4-6]. Heavy metals present in effluent should be removed before it discharging to the water bodies. Adsorption technique is used to remove heavy metals from effluent, adsorbents such as zeolites, silica gels, and commercial activated carbons (ACs) are the materials most commonly used in water treatment [7]. Commercial activated carbon has some drawbacks, not suitable for effluent treatment process because its adsorption capacity is low at lower concentration, very poor affinity towards divalent cations. In contrast, acid activated carbon has the efficiency to remove heavy metal ions completely in low concentration which indicates its stronger activity [8]. Phosphoric acid activation forming surface functional groups like phenols, alcohols or acids; thus produces activated carbon suitable for removing heavy metal ions. Thus, acid activated carbon derived from teak wood bio mass to be used in drinking water purification purposes in removing heavy metal ions.

2. MATERIAL AND METHODS

2.1. Activated carbon preparation

The collected Teak wood biomass waste biomass material was washed and air dried for 15-20 days, grounded and mixed with equal amount of phosphoric acid (H_3PO_4) and stirred for 30 min. The acid- plant material slurry was heated up to 120 °C for 90 min. After cooling, wet carbon material was dried at 110 °C and sieved into discrete particle size and stored. The adsorbent was designated as TPAC. A stock solution of dye with known concentration (1000 ppm) was prepared [9]. The prepared activated carbon further characterized by FTIR and SEM.

2.2. Effluent

The effluent was obtained from SIPCOT industrial estate, Cuddalore, Tamil Nadu which has several environmental pollutants.

2.3. Determination of metal concentration

The heavy metal concentration was determined according to a procedure of Karvelas et al., [10] using the atomic absorption spectrophotometer (AAS).

2.4. Physiochemical properties

Physicochemical properties viz. Iodine number, Bulk density, Moisture content, Total ash content, pH value, Water soluble and acid soluble matter were determined.

2.5. Batch adsorption experiments

2.5.1. Effect of contact time

A 50 mg of the activated carbon dissolved in 100 ml of wastewater each in five different 250 ml flask. The flasks were agitated for 20, 40, 60, 80, and 100 min, respectively, then filtered and the filtrates were analyzed by AAS.

2.5.2. Effect of temperature

A 50 mg of the activated carbon dissolved in 100 ml of wastewater each in five different 250 ml flask. The flasks were heated. This procedure was repeated at 20, 40, 60, 80, and 100 °C, respectively, the samples were filtered and the filtrates were analyzed.

3. RESULTS AND DISCUSSION

3.1. Characterization of the adsorbent

The physicochemical properties of the prepared activated carbon were determined by standard procedures. The physicochemical properties are listed in Table 1.

Table 1: TPAC Parameters

Parameter	TPAC
Iodine number	1021.0 mg/g.
Decolourising power	24.8 mg/g
Bulk density	0.642 g/cc
Moisture content	12.6%
Total ash	2.52%.
pH value	6.92
Water soluble matter	4.13%
Acid soluble matter	10.0%

3.2. FTIR analysis of activated carbon

The surface chemical characteristic of TPAC was determined by FTIR, and the spectrum is given in Fig. 1.

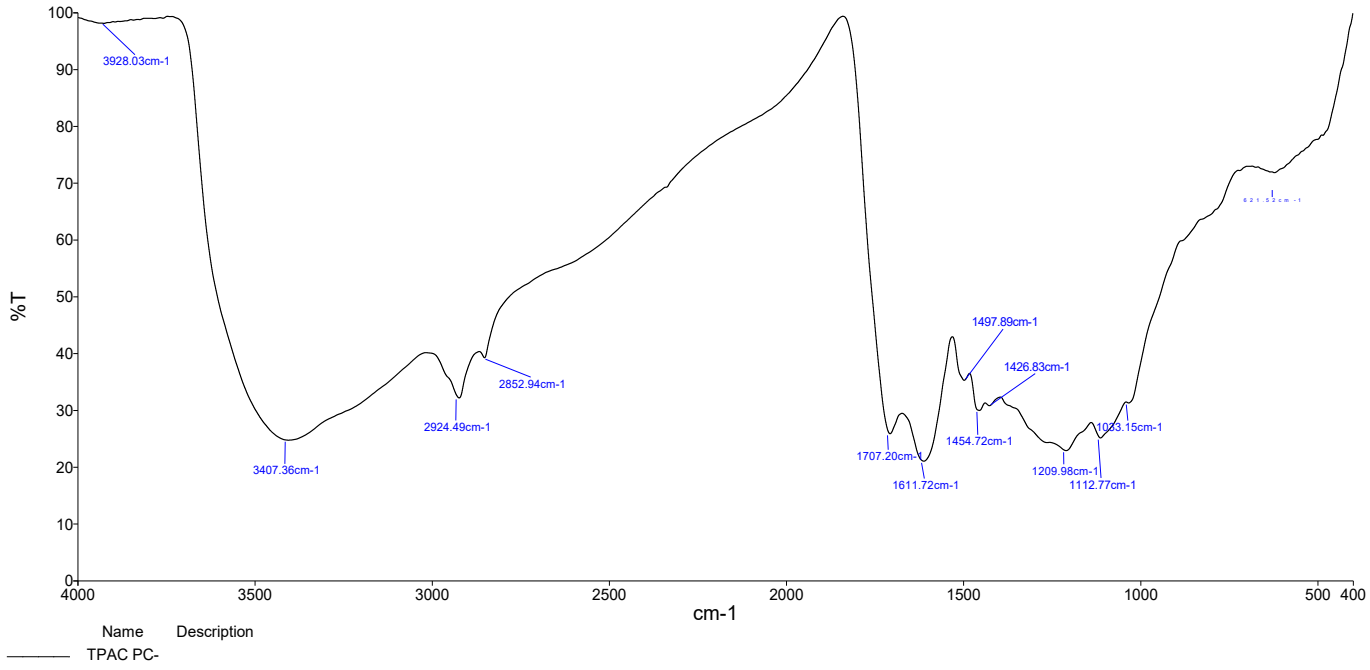

Fig.1: FTIR spectrum of pure activated carbon

The peak at 3407 cm^{-1} is due to the stretching vibration of O–H band. The peaks at 2924 cm^{-1}; stretching vibration of C-H, at 1707 cm^{-1}; acidic carbonyl C=O stretching, 1033-1209 cm^{-1}; C-O stretching in phenols, alcohols, acids, ethers and esters. These groups participate in heavy metal adsorption.

3.3. Scanning Electron Microscope analysis of activated carbon

The SEM micrograph of TPAC is shown in Fig. 2. It is seen that TPAC has a highly porous active centres in its structure.

Table 2 shows the effect of contact time on removal of

heavy metals; copper, cadmium, lead, and zinc. There are higher removal percentage for Cu (96.12±0. 14%), Cd (96.71±0.06 %), Pb (99.21±0.12%) and Zn (96.87±0.06%) obtained at 60 min, removal percentage decreased after 60 min. Previous study carried out by Abdulrazak et al. (2015) support the current study report [11].

Table 2: Effect of contact time on removal of heavy metals

Contact time (minutes)	Percentage removal of heavy metals (%)			
	Copper	Cadmium	Lead	Zinc
20	91.07±0.12	91.94±0.12	91.72±0.13	90.80±0.07
40	93.24±0.07	96.59±0.06	97.34±0.11	95.50±0.14
60	96.12 0.14	96.71±0.06	99.21±0.12	96.87±0.06
80	94.97±0.08	94.24±0.08	97.21±0.05	94.66±0.19
100	94.07±0.02	92.64±0.02	94.79±0.12	92.541±0.28

Expressed as mean ± standard deviation

Table 3: Effect of temperature on removal of heavy metals

Temperature (˚C)	Percentage removal of heavy metals (%)			
	Copper	Cadmium	Lead	Zinc
20	89.24±0.05	89.63±0.16	90.17±0.03	81.10±0.11
40	91.26±0.13	91.80±0.13	93.50±0.15	83.18±0.02
60	92.66±0.62	92.62±0.01	94.32±0.10	86.01±0.29
80	94.20±0.13	94.22±0.18	96.31±0.08	89.02±0.62
100	92.52±0.82	93.14±0.12	94.10±0.28	87.12±0.02

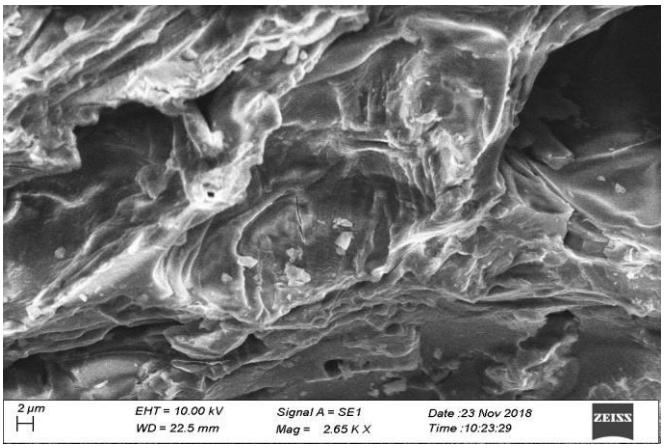

Fig.2: SEM image of TPAC

Table 3 shows the effect of temperature on removal of heavy metals: copper, cadmium, lead, and zinc. The highest removal of copper (94.20±0.13%), cadmium (94.22±0.18%), lead (96.31±0.08%) and zinc (89.02±0.62%) occurred at an optimum temperature of 80 ˚C after which the percentage removal decreases. Abdulrazak et al., [12] carried out heavy metal removal from wastewater using African palm fruit activated carbon, this study further shows that as the temperature of the experiment increases up until 80 °C; there is a clear increase in the percentage of heavy metals removed from the effluent waste water samples after which the percentage removal tends to decrease, which supports the current study. From Table 3, the highest removal of heavy metals happened at a temperature of 80 ˚C after which the percentage removal decreases. Results showed that low cost adsorbent (TPAC) can be used for the removal of heavy metals copper, cadmium, lead, and zinc. The contact time necessary for maximum adsorption was found to be 60 min and the optimum temperature heavy metal adsorption was 80˚C.

4. CONCLUSION

The activated carbon produced from Teak wood waste bio mass (TPAC), a low-cost product showing effective removal of heavy metals such as copper, cadmium, lead, and zinc from effluent waste water. The characterization of TPAC was done by FTIR. FTIR study revealed that several functional groups were existed on the surface of the adsorbent. SEM analysis proved the existence of pores or active centres on the surface of TPAC.

Conflict of interest

The authors wish to declare that there are no conflicts of interest associated with this research work and similarly there has been no financial support involved in this work that could affect its outcome.

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