PRODUCTION OF POWDER ACTIVATED CARBON FROM PALMYRA FRUIT FIBRE AT LOW COST

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ABSTRACT

Activated carbon has been prepared by a one-step chemical activation with KOH at different pyrolysis levels to study the porosity development and its efficiency in Methylene Blue (MB) adsorption from aqueous solution Palmyra activated carbon. Activated carbon was prepared by one step pyrolysis by treating with 0.1M KOH of scoured Palmyra micro level particles at 410^0C- 430^0C heat rate of 10 cm^{-1} in the nitrogen atmosphere for 0.15h. Iodine number was determined to all carbon samples. The batch adsorption experiments were carried out at room temperature using stock solution of MB. Carbon particles were stirred with MB solution operating at a speed of 150 RPM for various time intervals. Initial and final concentrations of dye solution were measured by recording absorbance on a double beam UV-Spectrophotometer at 645 nm. The adsorption capacity of the carbon samples increased with increasing activation temperature widening the pores, thereby increasing the porosity accessible to MB. The high adsorption efficiency of MB for carbon was observed at 420^0C for 0.15h. This finding leads to production of activated carbon by a low cost method for value added eco-friendly applications.

***Key words*:** Palmyra, pyrolysis, adsorption.

1. INTRODUCTION

Palmyra fruit fibre is a natural lignocellulose fibre obtained from the Palmyra fruit. It grows abundantly in the Jaffna peninsula of the Sri Lanka. It generally contains lignin, cellulose, hemi cellulose, pectin, wax matters, and ash. The pore found in the internal structure offers an attractive preposition for producing activated carbon.

Scouring would enhance the absorbency of the fibre without appreciable loss in strength and would help in increasing the hydrophilic property of the fibre. This is achieved by uncovering the pores that are already present in the fibre by removing waxes and non cellulose materials in the primary wall [1-2]. The main objective of scouring of Palmyra fruit fibre is to improve the porosity level by removing all type of hydrophobic matters present in the Palmyra fruit fibre, while having minimum damage to the Palmyra fibre.

Higher internal surface areas and pore volumes of the activated carbon pore structures play an important role in various kind of liquid and gas phase applications [3]. More recently interests have been shown in the preparation of activated carbon using natural raw materials as precursor materials [4-6].

The present work reports on the production of activated carbon from natural vegetable fibre, namely Palmyra fruit fibre. In this research Palmyra fruit fibres are subjected to alkaline bio- scouring using KOH by one step pyrolysis and characterized for activity level and morphology. The batch contact time method used to measure the adsorption rate.

2. METHODOLOGY

2.1. Materials

Ripe Palmyra Fruits were collected from a coastal area in Kalpitiya in Sri Lanka. The average diameter and weight of fruit were 11 cm and 1kg respectively. Firstly the blackish husk of the fruit is removed. The seeds are separated from fibre and the fibres were boiled and finally dried in the muffle oven.

2.1.1. Methods

Activated carbon were prepared by one step pyrolysis by treating with 0.1M of Potassium Hydroxide (KOH) of raw Palmyra fibres particles at 420 0C heat rate of 10 0C min-1 in nitrogen pressurised atmosphere for 0.15h. Before heat treatment, raw fibres were scoured (alkaline-bio) thoroughly and washed ultrasonically with distilled water to remove excess chemical and dried at 80 0C in electrical muffle oven for 5h. After cooling fibre to room temperature raw fibres were grounded by using ball mill machine (Model: Fritsch supreme line Pulverisette 7). It ran at (250- 270) rpm for ten minutes with in one cycle to produce Palmyra micro level particles. Palmyra particles were leached with 0.5M KOH for 45 min, after which they were filtered and separated. In order to determine the activity level of the carbon, Iodine number was determined according to the standard test method ASTM D 4607 for the all chemical activated samples.

2.2. Preparation of Dye Solution

Methylene blue (MB) was obtained from analytical grade. Stock solutions of MB were prepared by dissolving accurately weighed sample of dye in deionized water to get a concentration of 1000 mg/l. Then the test solutions were prepared by dilution of MB stock solution as per the requirement.

2.2.1. Batch Adsorption Experiments

These experiments were carried out at room temperature of 30°C using stocks solution of Methylene blue 50ml. Carbon were stirred with MB solution operating at a speed of 150 RPM for various time intervals. Initial and final concentrations of dye solution were measured by recording absorbance on a double beam UV-Spectrophotometer (Shimadzu, 1800) at 645 nm (λ max. values for M.B. dye) respectively. In the entire batch experiment the extent of removal of the dye was measured in terms of the values of percentage removal of dye.

3. RESULTS

Figure 1 show scanning electronic microscope michrographs construction and destruction stages of pore structure of Palmyra fruit activated carbon with various temperature profiles. Figure 1 (ii) shows how Higher Nano range pore were developed at 420^0C.

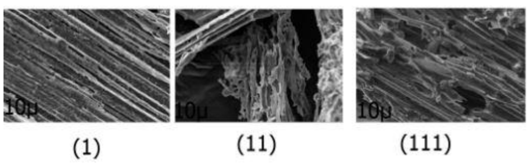

Figure 1: Pore structure of Palmyra powder activated at temperature of (i) 410^0C (ii) 420^0C (iii) 430^0C

Figure 2 shows the variation of surface area estimated from iodine number for the produced activated carbon with various temperature profiles after one step activation. The highest activity level was obtained at the temperature of 420°C. With further increment, pores may have got damaged and thus reducing the activity level of the Palmyra powder producing CO_2 and thus rapidly increasing the weight loss. It should be mentioned that the activation by maintaining slow heating rates facilitates to produce high quality and low cost activated carbon.

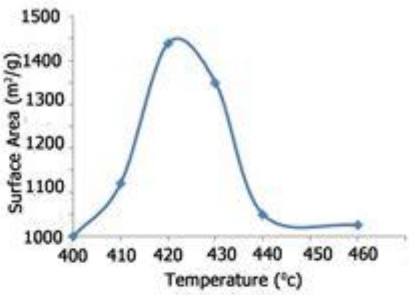

Figure 2: Surface area vs. activity temperature

The adsorption capacity of the prepared AC samples was studied by the uptake of MB, a cationic dye that has fairly large molecules. It is clear from Figure 3 that the carbon samples treated with a 0.1M solution of KOH adsorbed a very small amount of MB. For the carbons prepared by treating with KOH, the adsorption of MB increased with increasing pyrolysis temperature from 410°C to 430°C. It is clearly shown in scanning electron microscope micrographs in Figure 1. It is confirmed that chemical activation with KOH helps porosity in carbon. More carbon porosity created allows for more reach to the bulky molecules of MB, thereby raising its removal efficiency. Activation temperature and functional groups also give insight to the adsorption capacity of activated carbon. The adsorption capacity of the carbon samples increased with increasing activation temperature from 410°C to 430°C increasing the activation temperature widens the pores, thereby increasing the porosity accessible to MB. The high adsorption efficiency of MB for carbon produced at 420°C for 0.25h.

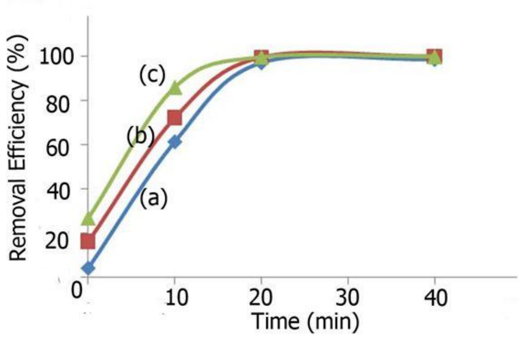

Figure 2: Removal Efficiency vs. time, activation temperature at (a) 410^{0}C (b) 420^{0}C (C) 430^{0}C

4. CONCLUSIONS

The method found to produce activated carbon from Palmyra products after alkali activation is remarkable due to low cost in comparison to the experimental procedure for presently available two step pyrolysis activated carbon production. This finding of a low cost method of producing activated carbon as value added product for eco-friendly applications.

5. REFERENCES

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