PRODUCTION OF HIGH QUALITY GRANULAR ACTIVATED CARBON FROM COIR AT LOW COST FOR ELECTRONICS DEVICES

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INTRODUCTION

The activated charcoal of choice for a diverse variety of applications is derived from lingo cellulosic materials. Currently Activated carbon is even more extensively used as a sorbent of molecular and ionic species in the liquid phase (Madhava, 2004). Commercial water treatment processes and domestic water filters make use of Activated carbon, as it effectively sorbs a large number of hazardous inorganic and organic compounds (Harris, 1999), (Marsh, and Rodriguez-Reinoso, 2006). The other area of manufacturing industry and research where Activated carbon plays an important role is electrochemical double layer capacitors (EDLCs) frequently referred to as super capacitors or ultra-capacitors (*Viswanathan. et al, 2009).* Here again Activated carbon is generally superior to other forms with respect to capacitance as well as charge discharge characteristics. Consequently, commercial super capacitor manufactures prefer Activated carbon for the electrode fabrication.
Coir is bio mass separated from coconut husk during extraction of coconut fruit, due to porous structural organic nature that generally contain in lignin, cellulose, hemi cellulose, pectin, wax matters and ash: which would be ideal to prepare activate carbon.

Scouring would enhance the absorbency of the powder without appreciable loss in strength and help to increase the hydrophilic property of the powder. The main objective of scouring of coir fibre powder is to improve the porosity level by removing all types of hydrophobic matters present in the coir fibre powder, while causing minimum damage to the coir fibre powder.

The present work reports on the production of activated carbon from natural vegetable fibre, namely Bristol coir fibre. These raw materials abundant in Sri lanka, have a low ash content and low cost in comparison with man-made fibres. In this research bristle coir fibres powder is subjected to alkaline bio- scouring. Using KOH by one step pyrolysis and characterized for activity level and morphology.

METHODOLOGY

Materials

The bristle coir fibres were scoured in solution of 0.15 M of NaOH with added pectin of 2 g and Teepol (2 g) dissolved in 800 ml of water. The temperature was maintained at 45 ^{0}C. The liquor ratio was maintained at 1:50 and the pH level at 9.2. Thirty minutes after the scouring treatment the fibre were washed with distilled water and dried at 100 ^{0}C for three hours and were stored in desiccators. A sample of a scoured bristle coir fiber weighing 10 g was subjected to Ball Milling (Model: Fritsch supreme line Pulverisette 7). It ran at 600 rpm for 10 minutes to produce micro level coir particles.

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Methods

Then 0.1 M of Potassium Hydroxide (KOH) was used to treat the coir particles for activation. After this the coir particles were fed into a tube furnace with a constant heating rate of 20 $^{o}Cmin^{-1}$ until the temperature reached range of values between 380 ^{0}C to 450 ^{0}C. At a selected temperature between 380 ^{0}C to 450 ^{0}C the samples were kept inside the tube furnace for 15 minutes in a nitrogen flow.

After activation, the mixture was removed from the furnace and was allowed to cool to room temperature. In order to determine the activity level of the coir carbon, iodine number was determined according to the standard test method ASTM D 4607.

RESULTSANDDISCUSSION

Figure 1 shows the weight loss in Granular Activated Carbon (GAC) at different temperatures. It is found that the weight losses increase steadily until 400 °C and it is clearly seen that there is a rapid increment in weight loss after the 400 °C. This may be due to the formation of ash producing CO_2 reducing the carbon amount.

The amount of iodine absorbed in milligrams per gram of carbon at a residual iodine concentration of 0.02 M is known as the iodine number.

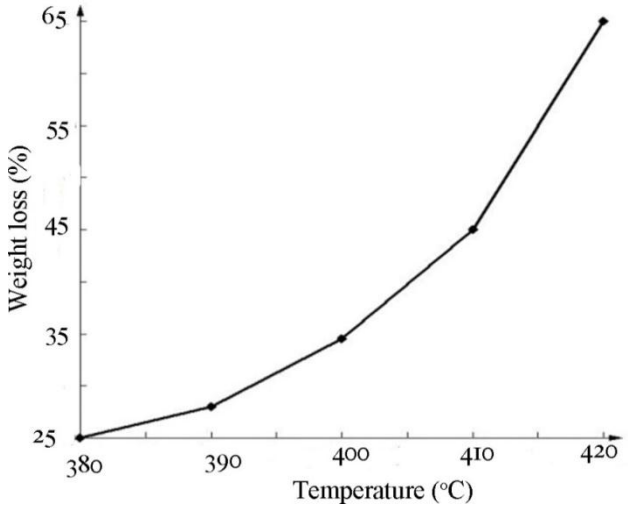

Figure 1. Weight loss vs. activity temperature

Figure 2 shows the variation of surface area estimated from iodine number for the produced activated carbon with various temperature profiles after alkali activation. The highest activity level was obtained at the temperature of 400 °C. When further increment, pores may have got damaged and thus reducing the activity level of the GAC producing CO_2 rapidly increasing the weight loss. It should be mentioned that the activation by maintaining slow heating rates facilitates to produce high quality activated carbon from coir for various purposes at low cost.

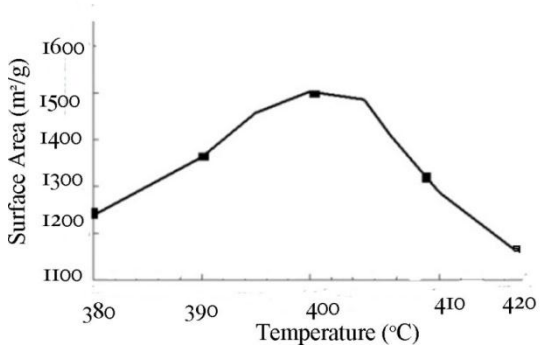

Figure 2. Surface area vs. activity temperature

Most experiments on alkali activation of carbon are conducted in the absence of oxygen, and observations of hydrogen liberation conclude that intercalation of alkali metals in carbon phase contributes to the activation process (Marsh,and Rodriguez- Reinoso, 2006). In the absence of oxygen, carbon and KOH could react to yield K, H_2, CO, CO_2, and K_2CO_3 via the reactions given below or, other reactions generating the same products.

$$2KOH\ (aq) + C\ (s) = 2K(s) + CO_2\ (g) + H_2\ (g) \qquad (1)$$

$$2KOH\ (aq) + 2C(s) = 2K\ (s) + 2CO\ (g) + H_2\ (g) \qquad (2)$$

$$2KOH(aq) + C(s) + H_2(g) = K_2CO_3(s) + 2H_2\ (g) \qquad (3)$$

Reactions given above are endogenic and the rate facilitates if the gaseous products are removed from the reaction phase (i.e., heating in a current of N_2). Under identical conditions, KOH is more effective, to produce material of higher surface area as shown in the SEM michrograph in figure 3. It should be mentioned that the SEM michrographs for activated carbon using KOH clearly show the micro-crystals of GAC.

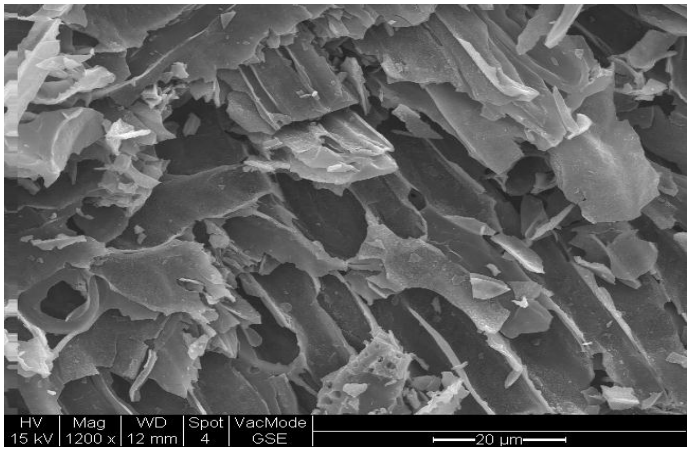

Figure 3. SEM michrograph of activated carbon of coir fibre powder

Pores in activated charcoal are generally classified on basis of pore diameter *d* as micro ($d < 2$ nm), meso (5 nm $< d <$ 50 nm) and macro ($d >$ 50 nm). Pore distribution in coconut charcoal is populated more densely in the micro and meso regions. Macro pores of average diameter ~ 1.3 μm are clearly seen in the SEM picture of the GAC sample. Pores smaller than ~ 20 nm are not clearly distinguishable in the SEM pictures and the larger fraction porosity originates from such pores.

CONCLUSIONS/RECOMMENDATIONS

The method found to produce activated carbon from coir fibre after alkali activation is significant due to low cost in comparison to the presently available two step activated carbon production. This finding of low cost method to produce activated carbon, that increases the pore size distribution will be favorable for super capacitor, solar cell application's, and hugely subsidizes to the production of activated carbon from coir fibres in Sri Lanka,

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