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

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ABSTRACT

Coir is a natural vegetable fibre obtained from the coconut tree. The porous structure found in the lacuna region of this fibre offers an attractive preposition for producing activated carbon. In this research, bristle coir fibres were subjected to alkaline activation method. Then the fibres were fed into a tube furnace with a constant heating rate 10C^o min^{-1} until the temperature reaches at different temperatures selecting between 290C^o to 330C^o. At a selected temperature between 290C^o to 330C^o the samples were kept inside the tube furnace for 30min in a nitrogen flow. Subsequently they were cooled up to room temperature to determine the activity level of the fibres. Then KOH was used to treat the carbon fibre subjecting it to KOH's alkali activation, in order to determine the activity level of fibre. Through this experiment it was found that the weight losses increase gradually until about 330°C and then there is a rapid increment in weight loss after 330°C. The highest activity level was obtained at the temperature of 330°C. The method found to produce activated carbon from coir products after alkali activation is remarkable due to the low cost. It can be concluded that producing activated carbon from coir will make a tremendous impact towards the economic development of Sri Lanka.

Key words: Scouring, weight loss, activity levels

1. INTRODUCTION

Coir is a natural vegetable fibre obtained from the coconut tree. Coir fibre extracted from the coconuts grown in Sri Lanka generally contain lignin, cellulose, hemi cellulose, pectin, wax matters, and ash. Coir is a multi-cellular fibre that consists of phloem and parenchyma cells. Coir fibre also consists of a central portion, called lacuna [1]. The porous structure found in the lacuna region offers an attractive preposition for producing activated carbon.

The scouring process that is practiced in the textile industry involves use of alkaline chemicals or enzymes to remove the non-cellulosic impurities present in the natural fibre. 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. The main objective of scouring of coir fibre is to improve the porosity level by removing all type of hydrophobic matters present in the coir fibre, while having minimum damage to the coir fibre. In this research bristle coir fibres are subjected to alkaline and bio- scouring methods.

2. METHODOLOGY

The bristle coir fibres were scoured in solution of 0.15M of NaOH with added pectin of (2g) and Teepol (2g) 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.

Then the fibres were fed into a tube furnace with a constant (2.5 L min$^{-1)}$ nitrogen flow. The initial temperature was increased maintaining a heating rate 10C^{o}min^{-1} up to 290^{0}C to 370^{0}C . Then the temperature was varied between 290^{0}C to 370^{0}C for thirty minutes and then cooled up to the room temperature for each sample to determine the activity level of the fibres. Coir charcoal sample was activated by the following procedure. The samples were treated with 0.5M of KOH in order to determine the activity level of the fibre. Iodine number was determined according to the standard test method ASTM D 4607 for the above alkali activated samples.

3. RESULTS AND DISCUSSION

Figure 1 shows the weight loss in fibres at different temperatures. It is found that the weight losses increase gradually until about 330°C and it is clearly seen that there is a rapid increment in weight loss after the 330°C temperature. 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.

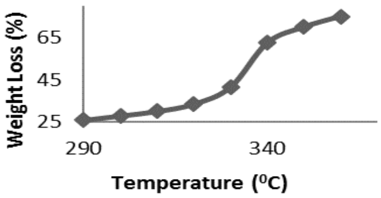

Figure 1: Weight loss vs. activity temperature

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 330°C. When further increment, pores may have got damaged and thus reducing the activity level of the fibre 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 activated carbon from coir for various purposes at low cost.

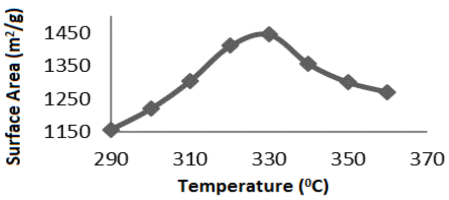

Figure 2: Surface area vs. activity temperature

Alkalis KOH and NaOH effectively activate charcoal at lower temperatures and shorter durations of treatment [5, 6, 7, 8]. Alkalis also enhance pyrolysis of bio-materials leading to formation of activated carbon. Although many studies have been conducted, as yet, the mechanism of alkali activation is not fully understood. Most experiments on alkali activation of carbon are conducted in the absence of oxygen, and observation of hydrogen liberation points to the conclusion that intercalation alkali metals in carbon phase contribute to the activation process [5, 6]. 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 in below (eq 1.2.3) or their variations, 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 eq .(1-3) are endogenic and the rate facilitated on heating 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 in activation compared to NaOH, producing material of higher surface area as shown in the Figure 3 SEM michrograph. It should be mentioned that the SEM michrographs for activated carbon using NaOH clearly show the micro-crystals of carbon suggesting that the pore sizes are larger than that of KOH activated carbon with nano-size pores.

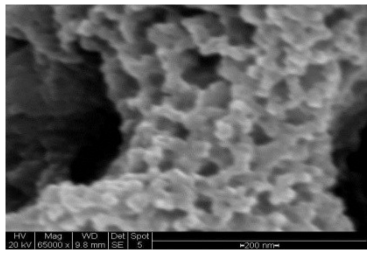

Figure 3: SEM michrograph of activated carbon of coir fibre

Compared to potassium, sodium poorly intercalates into graphite and this difference is believed be the cause of the difference in KOH and NaOH in activating charcoal. Again the hydrated sodium ion is larger than the hydrated potassium ion, enabling the latter ion to reach the pores of charcoal more easily than the former. In the present experiment KOH impregnated pure coconut charcoal was heated in an atmosphere containing oxygen and the reaction taking place is,

$$2KOH(aq) + C(s) + O_2(g) = K_2CO_3(s) + H_20(aq)$$

$$\Delta H = -586.8\ kJ/mol \qquad (4)$$

Possibly the highly exogenic reaction eq. (4) is catalysed by KOH itself. A great advantage of activating charcoal via eq. (4) is that the alkali impregnated charcoal can be heated in a closed container supplying small amount air to the steam atmosphere. From Le Chatelier's principle, it is clear that pressure favours forward reaction eq. (4). It is obvious that at higher pressures the activation occurs at lower temperatures.

4. CONCLUSIONS

The method found to produce activated carbon from coir products after alkali activation is remarkable due to low cost in comparison to the cost and the experimental procedure for presently available coconut shell charcoal activated carbon production. This finding of a low cost method of producing activated carbon, immensely contributes to the production of activated carbon from coir fibres in Sri Lanka, thus hugely enhancing the economic development of the coir industry of Sri Lanka.

5. REFERENCES

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