PREPARATION, CHARACTERISATION AND APPLICATION OF ACTIVATED CARBON FROM INDUSTRIAL BY-PRODUCT

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Introduction

Activated carbon is a processed carbonaceous material consisting of pores of various sizes and having large surface area (usually in range of 500 to 1500 m^2/g). It is an excellent adsorbent and is widely used in the purification of chemical products, pharmaceuticals, food industries, drinking water, controlling environmental pollution and recently in the manufacturing of electronic component. It can be prepared from various lignocellulosic materials. The focus of the study was to prepare activated carbon from the by-product of local agricultural industries. Two main industries were identified namely, oil palm and sago industries. Oil palm industry alone is producing millions of tonnes of mesocarp fibre, palm shells, empty fruit bunches and palm trunks annually. These by-products have been proven to be potential raw materials for the activated carbon. On the other hand local sago industry is generating thousands of tonnes of waste each year, which create environmental problems to the nearby rivers. In this abstract the preparation and characterisation of activated carbon from sago waste is presented.

Materials and Methods

Sago waste obtained from a local sago industry was initially dried under sunlight before being dried in an oven at 120 °C for a week. Elemental analysis of C, H and N was usually carried out on the raw material. This was followed by thermal analysis to determine its thermal stability. The preparation was carried out with and without chemical impregnation. About 10 g of the dried raw material was impregnated with different amount of $ZnCl_2$ (5 - 40 %). The impregnation was carried out at 70 °C with constant shaking until almost all the water had evaporated. Further drying was carried out in an oven at 120 °C for a week. The dried impregnated sample was heated at 400 – 800 °C in a quartz tube, which was inserted horizontally into a tubular furnace. The heating process was carried out for a total of 4 hours, with a constant flow of N_2 and CO_2 for 3 and 1 hour respectively. The resulting activated carbon was repeatedly washed in 1 M HCl or HNO_3 followed by distilled water to remove the $ZnCl_2$.

Results and Discussion

Elemental analysis of the raw material showed that the carbon content was about 39%. This is considered sufficiently high and suitable for the preparation of activated carbon. Apart from other major elements neutron activation analysis showed that sago waste also contained significant amount of trace elements such as Ca, P and Si. Thermal analysis indicated a change in weight at the temperature around 260-390 °C presumably due to carbonisation process. Removal of non-carbon elements as volatile matter occurred in this temperature range followed by formation of elementary graphitic crystallites (Wigmans, 1989). Thus the preparation of activated carbon may be carried out at temperature as low as 392 °C. The quality of the product was found to be related to the amount of the chemical impregnation of the raw material. The carbon content of unimpregnated sample prepared at 500 °C was around 63% and increased to 75% at 15% impregnation. The surface area increased with increasing amount of $ZnCl_2$ for every heating temperature up to 15% impregnation where a maximum was reached. Further increase in the impregnation has no effect on the surface area. This trend was similar to previous findings in the preparation of activated carbon from oil palm trunk (Hussein et. al. 1995) and oil palm shell (Hussein et. al. 1996) where the amount of $ZnCl_2$ adsorbed by the raw material reached a saturation at about 15% impregnation. The heating temperature of around 400 – 500 °C was found to give relatively high surface area. Pore formation was also found to be affected by the amount of $ZnCl_2$ impregnated in the precursor. The average pore size was in the micropore region at low level impregnation (less than 5%). As the level of impregnation increased the average pore size increased which might be due to the formation of more mesopores. The iodine adsorption analysis was also performed and was found to follow the same trend as the surface area. The iodine numbers were usually lower compared to the value of the surface area. This analysis was sometimes used as an alternative method to analyse the surface area when the N_2 adsorption method was not possible. Activated carbon from sago waste was found to be very effective in removing organic substance from water. The test was carried out using phenol.

Conclusions

Sago waste is a valuable raw material for the preparation of activated carbon. High quality activated carbon can be obtained from this source with surface area of over 1500 m^2/g. Optimum preparation condition was at 15 % impregnation of $ZnCl_2$ and combustion of 500 °C. The activated carbon obtained also has sufficiently high carbon content and effective in removing organics and colours from water.

References

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