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Activated carbon from scrap tires for water purification

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Activated carbon from scrap tires for water purification

S. Bilal Butt, Mansoor Innayat, M. Riaz and Asif Mahmood, Pakistan

THE SCRAP TIRES are generated worldwide in billion of kg each year (William et al 1990). It has been proposed to convert this waste material into value added product e.g. reclaim rubber and suitable adsorbents (Brady et al. 1995). The latter can be compounded with virgin rubber to produce low value rubber. However, it has small economic potential. Tire material is a rich source of carbon. Its typical composition is 62 per cent natural rubber/poly styrene-butadiene, 31 per cent carbon black (to reinforce rubber) and other materials like extender oil, sulphur, ZnO and stearic acid (Akbar et al. 1993). The hydrocarbons base of scrap tires make it a potential source of liquid fuel, fuel gases and valuable product like activated carbon. A typical pyrolysis process produces 30-50 per cent char along with other valuable products. The char contains 78 per cent of the original sulphur and rest of the sulphur is present in liquid and gas by products. The char could be used as a reinforcing filler, in making printing inks and vulcanizaters. However, it can also be converted into an environmentally friendly product, activated carbon, which has got vital applications in water treatment industry.

In industrial waste and municipal water treatment plants, activated carbon is considered to be the heart of the treatment process particularly for mop water stream treatment. Municipal water is treated with active carbon to remove odour and improve taste, which may arise from industrial pollution, from decay of vegetations or from algae. Among the industrial pollutants, substituted phenols, polyaromatic hydrocarbons (PAHs) are included in the list of priority pollutants. Above mentioned contaminants are discharged by the processing of coal, gas generators and by dyes industry into the water streams. The extensive network of tannery industry in Pakistan is also using chlorophenols (PCP) in bulk, thus contaminating the water streams. Granular activated carbon is used to remove odour and excess chlorine, which is used for water sanitation. The utility of activated carbon regarding the removal of synthetic organic compounds (SOCs) from domestic water has been discussed in environmental protection agency (EPA, 1989), USA. It has declared activated carbon a base line technology against which all the other technologies must be measured for the removal of synthetic organic compounds.

The char generated by pyrolysis of scrap tire can be converted into activated carbon either using chemical or physical activation. In the present method generated char is given varying quantity of steam and then char is activated at 800-1000°C. The quality of product is characterized by

measuring the surface area and microporosity. Further, its application to remove some of the PAHs are discussed.

Method

The scrap tire was cut into 2-3 cm pieces and thoroughly washed with clean water. The desired temperature of furnace was attained and reaction vessel containing 2kg tire shreddings was placed in furnace for charring. The char was further activated with steam. The chemical analysis of char was carried out by ICP-AES (ARL-3580) and atomic absorption spectroscopy (Hitachi Z- 8000). The surface area measurement and characterization of microporosity of activated carbon was accomplished by Autopore II 9220 V 2.04.

Results and discussion

The main objective of present work was to utilize the developed activated carbon for the removal of organic pollutants from the drinking water. Therefore, it became essential first to know about the levels of various toxic elements already present in the char. In this reference the analytical results are given in Table 1. It indicates that the material is almost free of toxic metals. Also, most of the zinc is removed and its concentration can further be reduced by giving acid treatment if desired.

Measurements of surface area and microporosity

The efficiency of activated carbon depends upon its surface area and porosity. The latter can be divided on the basis of diameter into micropore ($d < 2\text{nm}$), mesopore ($2\text{nm} < d < 50\text{nm}$) and macropore ($d > 50\text{nm}$). In the present investigation mercury intrusion has been used to measure porosity of the developed activated carbon. Before measuring the surface area and porosity the samples were dried over night at 110 °C. Fig. 1-2 depict the commulative pore area vs. diameter plots for char and activated carbon. The char surface area is lower than the activated carbon. The surface area of activated carbon is not as desired and it needs further improvements regarding the activation step. The data collected for different samples and char are given in Table 2. The pore diameter of the activated carbon is in the vicinity of 10 nm.

Water purification: removal of pollutants

The activated carbon was investigated for the removal of polyaromatic hydrocarbons. For preliminary studies

naphthalen and anthracene were selected. Activated carbon columns (i.d. 5mm) of variable height were prepared and solution containing 50 ppb anthracene and 1000 ppb naphthalene was passed through these columns of activated carbon. The column of 1 gram activated carbon was found best regarding the retention of these pollutants. The collected volumes were scanned using photometer. The fractions containing eluted naphthalene and anthracene were analyzed by HPLC as shown in Fig.3. Based on these analyses it was concluded that column bed of 1 gram activated carbon has retained 99 per cent naphthalene and 98 per cent anthracene. These data indicated that a waste product could be converted in to a value-added product.

Conclusion

The activated carbon produced has lower surface area. However, it exhibited a potential to remove trace level impurities present in groundwater and slightly polluted surface water. Further work is in progress to improve the surface area and microporosity of activated carbon for its improved performance in other areas of interest.

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SHAHID BILAL BUTT, Nuclear Chemistry Division, Pakistan Institute of Nuclear Science and Technology.

MANSOOR INNAYAT, Pakistan Institute of Engineering and Applied Sciences.

MOHAMMED RIAZ, Nuclear Chemistry Division, Pakistan Institute of Nuclear Science and Technology.

ASIF MAHMOOD, Nuclear Chemistry Division, Pakistan Institute of Nuclear Science and Technology.

Table 1. Analysis of various toxic metals (ppm) in activated carbon from scrap tire

Table 2. Pyrolysis conditions and characterization of char and activated carbon from scrap tire

