ABSTRACT

The suitability of the chemically activated carbon prepared by reacting *Syzygium jambolanum* nut with conc. sulphuric acid in the presence of ammonium persulphate followed by thermal activation in CO₂ atmosphere for the removal of toxic inorganics like mercury(II) and chromium(VI) has been systematically examined by both batch and column experiments. The carbon prepared was designated as chemically activated high temperature *Syzygium jambolanum* nut carbon (CHSJC).

Systematic studies on the removal of mercury(II) showed that the carbon was found suitable for the removal of Hg(II) in the pH range of 2.0 - 10.0. Hg(II) was removed as anionic complex HgCl₄²⁻ to prevent the reduction of Hg(II) to elemental state. Hg(II) was analysed using Direct Mercury Analyser (DMA). The optimum carbon dose needed was only 0.1 g and the optimum time needed was only 3 hours for quantitative removal of mercury in the batch mode. Though adsorption conformed to Freundlich, Langmuir and Temkin adsorption isotherms, the regression co-efficient (R²) value showed that the Freundlich adsorption isotherm model fitted well for Hg(II) adsorption. Kinetic studies showed that pseudo second order kinetics was more predominant than reversible first order and pseudo first order as the regression coefficient value of pseudo second order was one, but that of reversible first order and pseudo first order were nearer to one. Kinetic studies
also indicated that the removal of Hg(II) followed film diffusion process. $\Delta G^0$ value was calculated and the adsorption process was found to be spontaneous. The breakthrough capacity of the carbon was found to be 5.33 mg/g from the column studies.

Common anions like sulphate and bicarbonate had no effect on the removal of Hg(II) up to 1000 ppm. Chloride did not have any significant change on the uptake of Hg(II) up to 50 g/L. Mercury(II) could be recovered up to 99 % using 2 % Na$_2$S in 1 % NaOH. The exhausted carbon could be completely regenerated and put to repeated use after washing with 1 M HCl followed by distilled water. There was no change in the capacity of carbons up to 5 cycles of adsorption and desorption. The particle size degradation was found to be only around 1 % with the carbon.

Batch studies on removal of chromium(VI) by CHSJC showed that maximum removal occurred at pH of 2.0 as HCrO$_4^-$. Chromium(VI) was determined using spectrophotometry by 1,5-diphenyl carbazide method. The optimum carbon dose needed was only 0.1 g and the optimum time needed was only 4 hours for quantitative removal of chromium(VI) in the batch mode. Though adsorption conformed to Freundlich, Langmuir and Temkin adsorption isotherms, the regression co-efficient value showed that the Freundlich adsorption isotherm model fitted well for Cr(VI) adsorption. Kinetic studies showed that pseudo second order kinetics was more predominant than reversible first order and pseudo first order since the regression coefficient value of pseudo second order was closer to one than that of reversible first order and pseudo first order. Kinetic studies indicated
that the removal of Cr(VI) also followed film diffusion process. $\Delta G^0$ value showed that the adsorption process was spontaneous.

The breakthrough capacity of the carbon was found to be 20 mg/g from the column studies. Both sulphate and chloride had no effect on the removal of Cr(VI) up to 1000 ppm. Chromium(VI) could be recovered up to 85.1 % using 1 M NaOH and 10 % H$_2$O$_2$. The remaining chromium was desorbed as Cr(III) using 2 M HCl. The exhausted carbon could be completely regenerated and put to repeated use after washing with 2 M HCl followed by distilled water. There was no change in the capacity of carbons up to 5 cycles of adsorption and desorption. The particle size degradation was found to be only around 1 % with the carbon. Flow rate and bed height had influence on the removal of both the ions and the optimum flow rate was found to be 14 mL/min and the optimum bed height was 8.0 cm for maximum removal by CHSJC.

Synthetic chlor-alkali and electroplating wastewater were treated effectively by chemically activated high temperature Syzygium jambolanum nut carbon for the removal of Hg(II) and Cr(VI) respectively. The performance of the carbon was compared with the carbon derived from Syzygium jambolanum nut by the pyrolysis and thermal activation in CO$_2$ atmosphere, high temperature Syzygium jambolanum nut carbon (HSJC) and a commercial activated carbon (CAC) of M/s LOBA chemicals. CHSJC showed capacity considerably superior to other carbons HSJC and CAC for the removal of Hg(II) and Cr(VI). Scanning Electron Microscope (SEM) studies also confirmed the maximum adsorption of Hg(II) and Cr(VI) on the pores of
CHSJC. Fourier Transform Infra Red Spectroscopy (FT-IR) studies showed the various functional groups responsible for the metal uptake. Hence it could be concluded that chemically activated high temperature *Syzygium jambolanum* nut carbon (CHSJC) could be used as a new, viable and effective source for the treatment of wastewater containing Hg(II) and Cr(VI).