ABSTRACT

Study of Adsorption of Methanol in an Activated Carbon and Carbon Nanotube Matrix for use in a Solar Based Refrigeration Cycle

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This thesis seeks to investigate the adsorption capabilities of activated carbon and carbon nanotubes. The adsorption of methanol on both of these substances was tested for their application in a solar based refrigeration cycle. Research on carbon nanotubes and their growth has been carried out for applications in the semiconductor industry. Enough focus has not been given to the use of nanotubes for refrigeration purposes.

Adsorption refrigerators have been designed with the energy source being Solar Energy. Various adsorbent/adsorbate pairs have been tested in literature. The present work focuses on carbon nanotubes because theoretically, nanotubes should be able to adsorb better than activated carbon due to their high surface to volume ratios and hence a higher number of adsorption sites available for methanol to adsorb.

The amount of adsorption of methanol on nanotubes depends on whether the end caps of the nanotubes are open or closed and also on the hydrophilic nature of the nanotubes. Nanotubes with ends closed are supposed to adsorb less than the nanotubes with their ends opened. The ends of carbon nanotubes can be blocked because of iron
and other impurities. Nanotubes are annealed under high vacuum to open the end caps, in this project. The hydrophobic nature of the nanotubes is corrected by treating them with concentrated nitric acid. The acid treated nanotubes are used to obtain adsorption data at different temperatures. The hydrophobic nature of the nanotubes is corrected by treating them with concentrated nitric acid. The acid treated nanotubes are used to obtain adsorption data at different temperatures.

The adsorption of methanol on activated carbon is measured. It is then compared with the adsorption of methanol on as-prepared carbon nanotubes. Adsorption tests are run for carbon nanotubes which are treated by high temperature annealing under vacuum. Carbon nanotubes of various diameter ranges are annealed and the adsorption of methanol before and after annealing is measured. Also, adsorption tests are run with carbon nanotubes which are treated with concentrated nitric acid. Experiments are carried out at three different system temperatures. Electron microscopy is used to validate that annealing the nanotubes at high temperature under vacuum opens the end caps of the nanotubes.

Finally, a matrix of nanotubes and carbon powder is prepared with different concentrations. The mixture is tested for adsorption of methanol and the results are compared with the previous experiments. Kinetics of the adsorption tests are calculated using the adsorption isotherms of the reactions.