507g Adsorption Separation of Ethanol from Water for Bio-Ethanol Production

Rudy Jones, F. Handan Tezel, Jules Thibault, Rania El-Hawary, and Jeffrey S. Tolan

Bio-ethanol is the ethanol produced from agricultural waste through fermentation. It is a renewable source of energy and is added into the gasoline up to 10 % to be used in automobile engines. In the fermentor, if ethanol concentration is higher than 8 %, fermentation ceases. Therefore, ethanol needs to be separated from the fermentation broth. In this study, experiments have been conducted to examine the liquid phase adsorption of ethanol from ethanol-water solutions. Various adsorbents were tested for their ability to selectively extract ethanol from this system. Experiments were performed to study the kinetic and equilibrium characteristics of the adsorbents in the ethanol-water solution. When activated carbon cloth was used as the adsorbent, it showed an extremely high capacity for ethanol. However, the kinetics were extremely slow and likely hinder its usefulness in the industrial setting for the desired separation. Particle size was found to be a very influential factor in the kinetics. The large particle cloths and pellet adsorbents had sluggish kinetics when compared to their powdered counterparts. The effect of temperature was also studied for the high silica ZSM-5 adsorbent (HiSiv 3000). Isotherms were determined at 26 and 57oC. The results indicate that as the temperature is increased, the capacity of the adsorbent is decreased. Surface area per unit mass appeared to influence the equilibrium capacity, as well. The activated carbon cloth and the activated carbon meso-beads (M-30) had extremely high surface areas (approximately 2500 to 3000 m2/g) and showed higher than usual equilibrium capacities compared to the adsorbents with less surface area. For the silica based adsorbents some analysis was conducted to determine the effect of the silicon to aluminum ratio.