RECOVERY OF BUTANOL FROM MODEL FERMENTATION BROTHS BY ADSORPTION ON ACTIVATED CARBON

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Key Words: adsorption, biobutanol, carbon F400, modeling

The interest for the fermentative production of butanol (as bio-fuel or chemical) has increased in the last years mainly due to the increasing of oil price, the depletion of fossil resources and the CO2 emissions. Bio-butanol is produced in ABE fermentation process. The butanol concentration in the broths at the end of the process is very low (10-20 g/L) because it causes the inhibition of the producing microorganism. From this fact, biobutanol needs to be continuously removed from the broth to avoid this inhibition process. In addition, an energy-efficient process must be developed to recover a product with a very low concentration that also presents an azeotrope with water mixtures.

In this contribution, a cyclic process is proposed which consists of an adsorption step in liquid phase using activated carbon F400® (Calgon Carbon®) followed by a desorption step with hot air. The desorbed products are recovered by condensation and decantation. The selectivity of the adsorbent in the adsorption step, the effect of desorption conditions on the regeneration time and the purity and recovery of the condensed products have been studied. A mathematical model based on fundamental equations has been developed to describe the full cyclic process.

![Figure 1 – Breakthrough curves.](image)

![Figure 2 – Desorption mass and temperature profiles.](image)

Using the experimental conditions showed in figure 1, the equilibrium adsorption capacity of butanol was 0.180 kg/kg\text{carbon} and 0.030 kg/kg\text{carbon} for the rest of organic compounds (mainly acetone and butyric acid). Acetone, ethanol and acetic acid are displaced by butyric acid and butanol (Figure 1).

The effect of temperature and air flow rate on the regeneration time has been studied. The experimental profiles of bed mass and temperature for two air flow rates are shown in Figure 2. A two steps regeneration process is proposed, the first step at low temperatures evaporated unbound butanol and the second one at high temperatures desorbed the bound butanol present in the micropores.

The column effluent from the two steps desorption process was condensed at -5 °C. During the first step a stream with a 16 % in weight of butanol was obtained which is separated by decantation in two phases (one with a 77 % in weight of butanol and other one with 7 % in weight of butanol). During the second step a stream with a 90 % in weight of butanol was produced. The streams with a high butanol concentration (77 and 90 % in weight) would be fed to a distillation unit in order to obtain pure butanol and the stream with a low butanol concentration (7 % in weight) would be send to a second adsorption column.

The mathematical model has been validated with the experimental data obtaining the adsorption and desorption kinetic parameters of the full cyclic process.