ADSORPTION OF BUTANOL IN ACTIVATED CARBON FOR THE DEVELOPMENT OF MIXED MATRIX MEMBRANES

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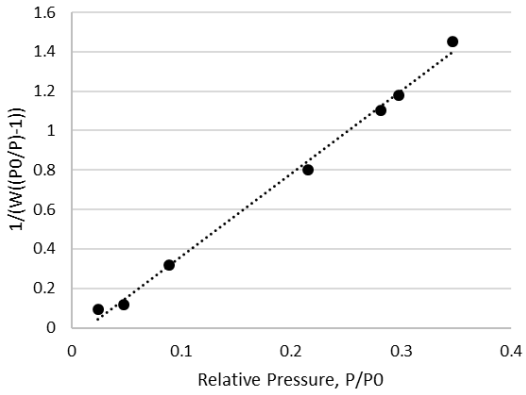
EXPANDED ABSTRACT

Currently, society has sought to meet the demand for energy and raw materials in all sectors of industry in a sustainable way. In this context, biofuels are a remarkable option. Amongst then, biobutanol, produced by fermentation, has stood out for his potential as biofuel and for being useful in many industrial applications. Biobutanol is produced through a process known as ABE fermentation, in which the final products are 1-butanol, acetone, and ethanol (HARVEY & MEYLEMANS, 2010). Pervaporation is a membrane separation technique for liquid solutions, and it is one of the most efficient methods used for the ABE system (ABDEHAGH *et al.*, 2014). In this work, the adsorption of butanol in activated carbon (AC), a well-known adsorbent, was studied to gain knowledge of the process and improve and optimize its application as a filler for developing mixed matrix membranes to separate butanol via pervaporation.

The AC was previously milled and passed through a 38 µm screen, then dried for 1 hour at 393 K. Its granulometry was analyzed by laser diffraction (Horiba LA-950) and the mean particle size was of 23.4 µm. The surface area, determined by nitrogen adsorption (Quantachrome, Nova 1000) using the BET isotherm model (Linearized, Figure 1) was 855 m^2/g, a value expected for activated carbons (ABDEHAGH *et al.*, 2013). The BET analysis pointed to a type I isotherm (N_2), seen in microporous solids with narrow pores (THOMMES, *et al.*, 2015). To evaluate the adsorption performance, an equilibrium experiment was carried out. 0.1 g of AC was added to various butanol aqueous solutions with different concentrations, and then placed in a shaker (IKA KS 4000i) for 24h at 150 rpm and temperature of 313K. The samples were filtered and analyzed by gas chromatography (FID, GC-17A, Shimadzu). The data was adjusted to several isotherm models to find the better fit. The plot of butanol adsorbed *versus* equilibrium concentration adjusted to Freundlich Isotherm is presented on Figure 2.

The R-squared value for the Freundlich isotherm was 0.90. Other isotherm adjustments did not fit the data and were omitted. For the Freundlich isotherm, usually means there is no monolayer formation, and the parameters “K” and “n” are related to adsorption capacity and intensity, respectively. In the data analyzed, the value of “n” was 1.19, considered low, since good adsorption is said to happen for values between 1 and 10 (IGWE and ABIA, 2007). The “shape” of the data also points to a weak adsorption, typical of a type III isotherm, according to IUPAC official reports (THOMMES, *et al.*, 2015). On the other hand, the raw value of butanol adsorbed registered was significant if compared to other works in literature, reaching 1 g/g at initial concentration of 10 g/L,



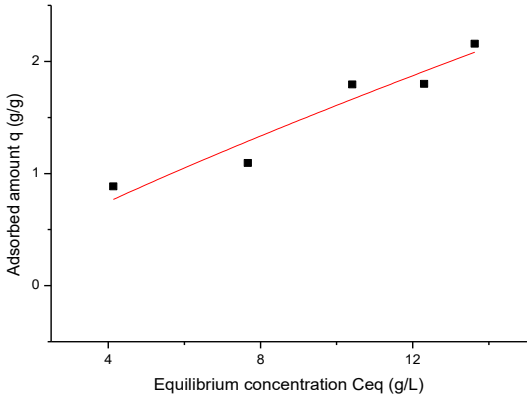


Figure 1 – Linearized BET model isotherm for N_2 in AC (R-squared of 0.99) (left).
Figure 2 – Adsorption of butanol on AC adjusted to Freundlich model at 313 K. (right).

compared to 0.3 g/g reported by Xue *et al*. (2014), and 0.26 g/g reported by Abdehagh *et al.*, (2013) at room temperature. It is important to notice that in these works the AC particle size is either bigger than the one tested (from 0.55 mm to 1.00 mm of mean diameter) or not informed.

The analysis showed that adsorption of butanol in AC roughly fitted the Freundlich isotherm, pointing to a weak type of adsorption, but in considerable amounts if comparable to other references in literature, making it a good candidate for loading MMMs to separate butanol from ABE solutions.

KEYWORDS: Adsorption; Biobutanol; Separation.

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