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Adsorptive separation of meta-xylene from C₈ aromatics

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A B S T R A C T

Industrial adsorptive separation process for liquids is most successful when the involved species have very close boiling points, making distillation expensive or are thermally sensitive at convenient distillation temperatures. The adsorption process was studied for separating meta-xylene from a feed mixture containing all C₈ aromatics on binder-free X and Y zeolites in the liquid phase. Zeolitic adsorbents with different SiO₂/Al₂O₃ were synthesized by the hydrothermal method and ion-exchanged with alkaline metal cations like lithium, sodium and potassium. The adsorption process was carried out in a breakthrough system at temperature of 110–160 °C and pressure of 6–8 atm. The influence of adsorbent moisture content on the separation process was studied. The optimization of adsorption process was also investigated by the changing operation conditions. The isotherms for each isomer of C₈ aromatics and the desorbent possess the adsorption characteristics of Langmuir type. The selectivity factor of meta-xylene and the saturation adsorption capacities of adsorbates were determined. It was observed that the selectivity of meta-xylene increased by sodium ion-exchanging of cationic sites in Y zeolite and the selectivity factor of meta-xylene/para-xylene, meta-xylene/ortho-xylene and meta-xylene/ethylbenzene in the optimum conditions was determined to be 2.62, 2.83 and 5.93, respectively.

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1. Introduction

The growth in demand of meta-xylene (MX) is closely linked to the demand growth of para-xylene (PX), as it is used as a co-monomer in the production of polyethylene terephthalate (PET) based packaging resins with very low oxygen permeability. MX is first oxidized to isophthalic acid (IPA) prior to copolymerization with terephthalic acid (PTA) and ethylene glycol to produce the enhanced gas barrier resins. Significant progress is being made in using MX as the primary monomer in other resins with low oxygen permeability such as meta-xylenediamine (MXDA) (Harada, 1988; Toft and Postoaça, 2002). Industrial production of MX was first accomplished by Mitsubishi Gas Chemical in the early 1980s using an HF/BF₃ ionic liquid (Kulprathipanja, 2010a,b,c,d,e). Other methods like fractionation (Berger et al., 1972), crystallization (Mohameed et al., 2007) and also extractive distillation have been proposed to recover MX from C₈ aromatic isomers (MX, PX, ortho-xylene (OX), ethylbenzene (EB)). Fractionation method is used to

separate two or more solutes, by making use of their difference in solubility. Mikitenko and MacPherson (2000) reported a process for separating PX containing at least two crystallization stages at high temperature. The crystallization process consisted of two major events, nucleation and crystal growth. It was concluded that ultimate recovery of pure MX was around 99%. Hotier et al. (2008) reported a process for producing high purity MX, containing simulated moving adsorption and crystallization. In this system adsorption unit with 15 beds of adsorbent coupled with a crystallization zone which produced MX with a purity of 99.7%. Extractive distillation is defined as distillation in the presence of a miscible, high boiling, relatively non-volatile component, the solvent, that forms no azeotrope with the other components in the mixture. In the process for separation of MX from a mixture containing MX and OX by extractive distillation MX was recovered in a rectification column in the presence of about one part of extractive agent. Final mixture included a vapor composition of 57.6% MX and 42.4% OX (Berg and Yeh, 1987). It has been also suggested

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