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Adsorption model development for mass transport characteristics of MFEP structure by physisorption method

Guomin Xu[1,3], Wenjian Guan[1,3], David Blersch[2], and Suan Shi[2]*

1. Chemical Engineering Department, Auburn University, AL 36849

2. Department of Biosystems Engineering, Auburn University, AL 36849

3. These authors contributed equally to this work.

* Corresponding author. E-mail: suanshi@auburn.edu

Abstract

A novel heterogeneous contacting structure, microfibrous entrapped particles (MFEP) structure, was developed to intensify chemical processes including heterogeneous catalytic reactions and the gas-solid adsorption process. MFEP is characterized by its extremely high heat and mass transfer efficiency, which is critical for thermal and/or mass transfer limited reactions. To investigate the mass transport characteristics of MFEP, a physisorption (hexane adsorption onto activated carbon) was used as a probe process. A theoretical adsorption model was developed based on the linear driving force approximation and constant pattern behavior. Mass transfer mechanisms including external diffusion, intraparticle molecular diffusion, Knudsen diffusion, and surface diffusion, were considered in the model. This model was then used to analyze the experimental breakthrough data and calculate the mass transfer coefficient. The experimental results showed that for MFEP with a particle diameter of approximately 200 μm, the volumetric mass transfer coefficient is more than 10 times higher than that of a packed bed. Combining the experimental results and theoretical analysis, it was also found that in the particle diameter range of 2000 to 100 μm, the system's mass transfer resistance is primarily the result of both the external and internal mass transfer resistances. This leads to the conclusion that decreasing the particles size can effectively increase the mass transfer rate. However, when the