Reply:

In this letter, we respond to the points raised by Bizmark and Ioannidis in their letter commenting on our article "Modeling of CO_2 mass transport across a hollow fiber membrane reactor filled with immobilized enzyme".[1] We appreciate the detailed attention that Bizmark and Ioannidis have paid to our work and their comments on the mass-transfer model. Below is our response to their comments.

Bizmark and Ioannidis point out that Eq. 5 is inconsistent with the laminar flow assumption, which mandates a parabolic velocity distribution for steady flow of a Newtonian fluid. This problem has been pointed out by the reviewer and is as follows, "The mathematical model section describes an assumption of fully developed laminar flow in the feed fiber, however, plug flow is supposedly presumed in the governing equation where v_o is constant. If laminar flow is assumed v should be a function of r". We have made a response to the comment of the reviewer, and are as follows, "First, the Reynolds number of CO_2 in the feed gas phase is less than 2,300, which belongs to the laminar flow. Second, in comparison to diffusion velocity in the membrane bores (Diffusion coefficient of CO_2 in the membrane is 4.42×10^7 m^2/s), the diffusion velocity of CO_2 in air (Diffusion coefficient of CO_2 in air is 1.39×10^5 m^2/s) is very fast. Finally, the diameter of hollow fiber membranes is small enough. Therefore, CO_2 velocity and concentration in the radial direction have changed very little. So, v_o in the governing equation could be considered constant, which is just a simplification for the solution of the Eq. 1."

Modeling study on CO_2 separation by facilitated transport membranes immobilized with amine solutions and carbonic anhydrase have been reported.[2–5] Differently, in this study, a nanocomposite hydrogel was used to immobilize CA enzyme. It is well known that it is very difficult to obtain the diffusion coefficient of CO_2 in the hydrogel. In order to simplify the issue, the CO_2 resistance in the hydrogel is proposed according to the experimental results. In addition, the effects of CO_2 concentration, CA concentration, and flow rate of feed gas on CO_2 removal performance were studied and the model solution agrees with the experimental data with a maximum deviation of up to 18.7%, a normal error.

Literature Cited

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