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Mass transfer enhancement of hollow fiber membrane deoxygenation by Dean vortices

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Mass transfer of membrane deoxygenation

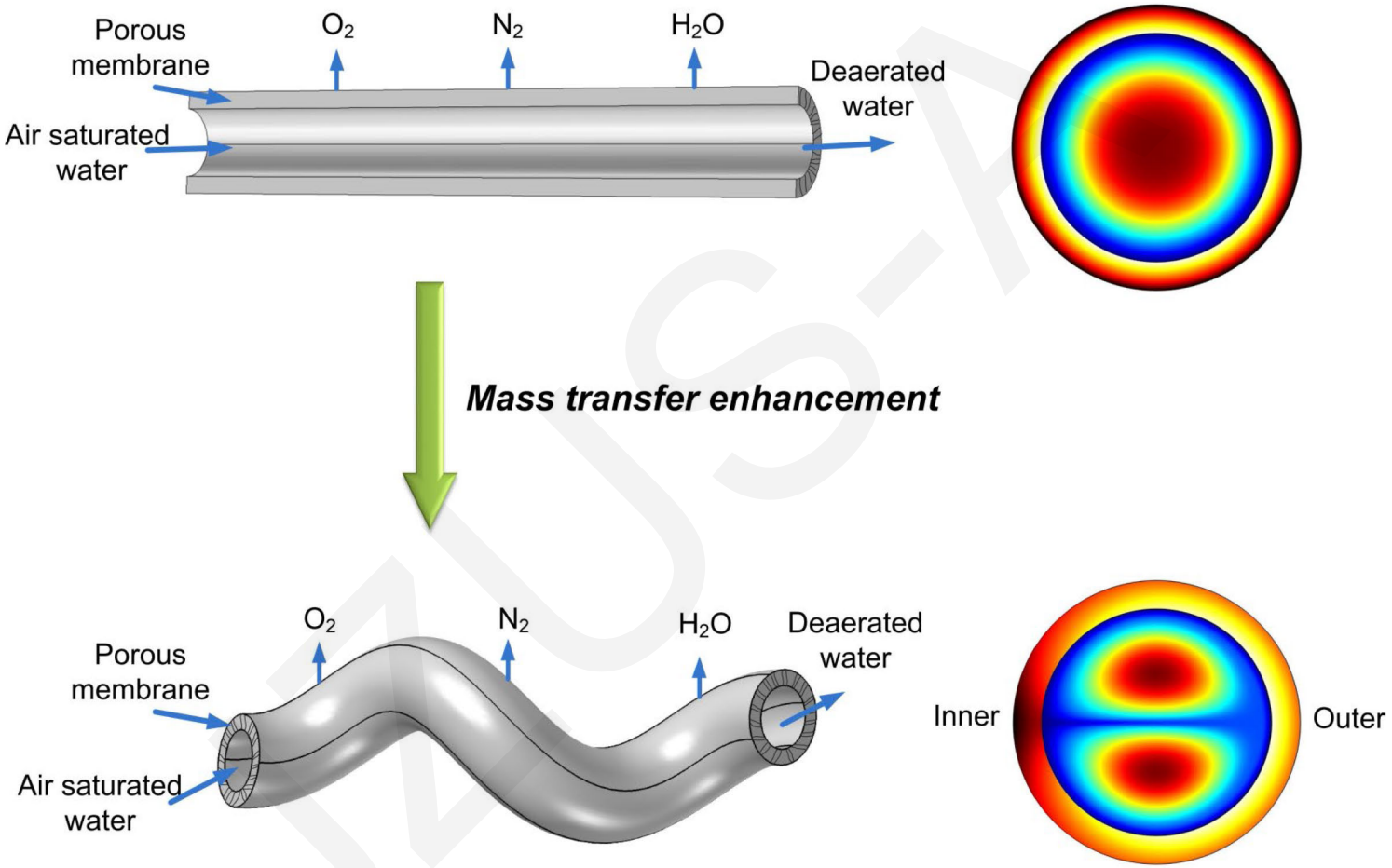


Fig. 1. Mechanism of mass transfer of membrane deoxygenation in linear and helical hollow fiber membrane.

Experimental set-up

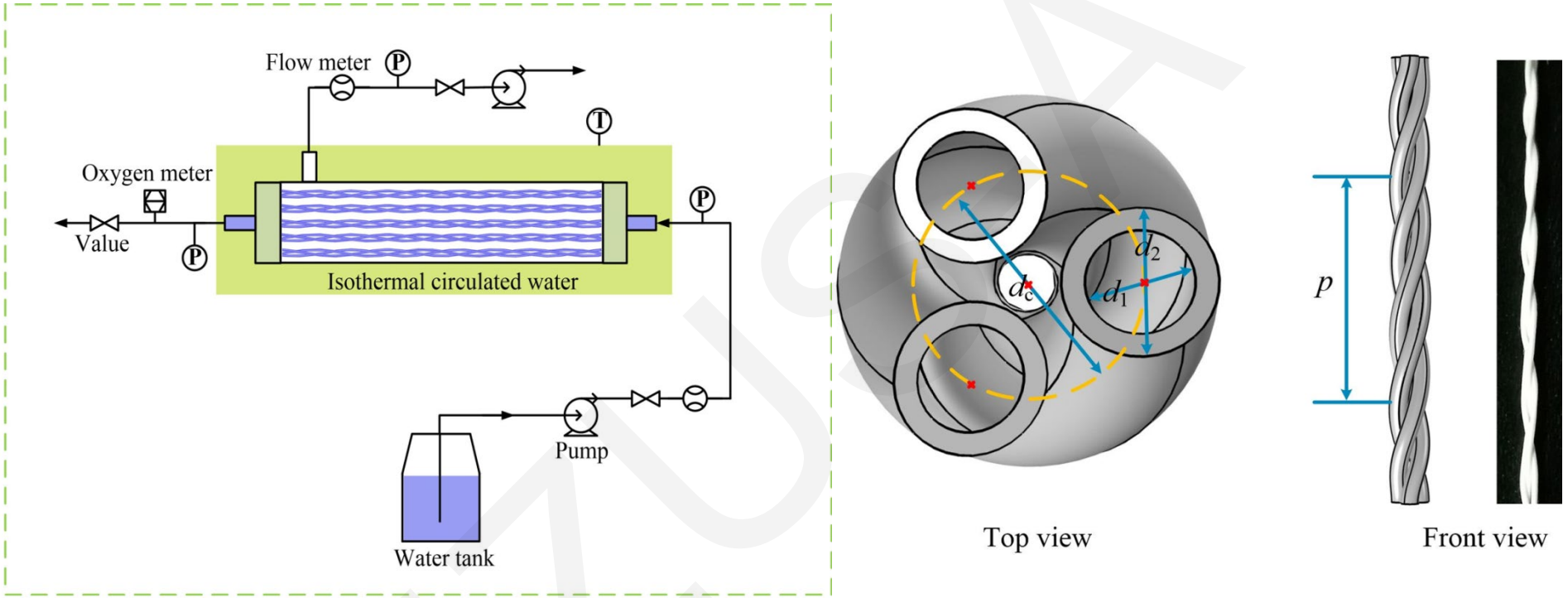
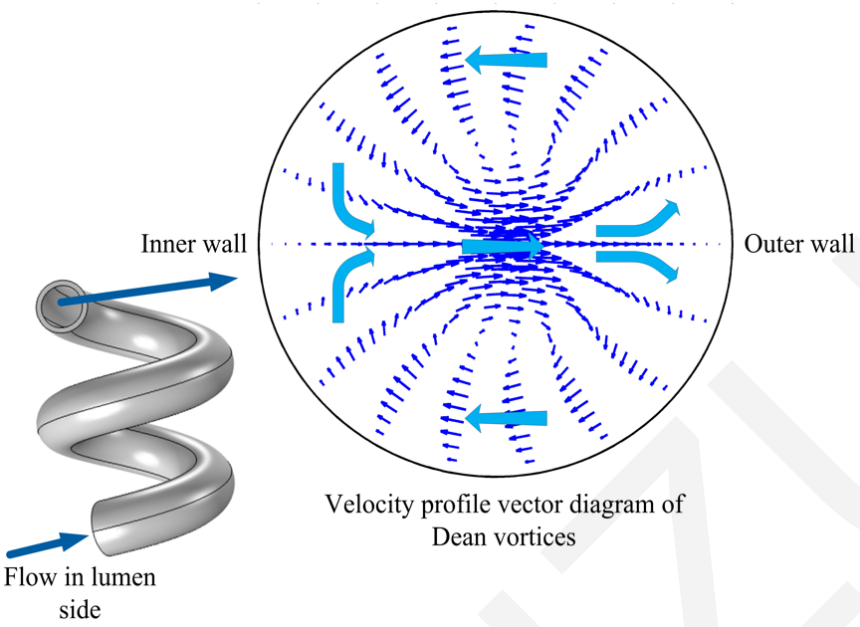


Fig. 2. Experimental set-up and geometrical structure of helical hollow fiber membrane.

Modeling of membrane deoxygenation



a. Lumen side

Mass continuity equation in a 3-D orthogonal helix coordinate system + a third-order perturbation solution Dean vortices

b. Porous membrane

Modified dusty gas model equation

c. Boundary conditions

Mass conservation + flux conservation

Concentration profiles of oxygen

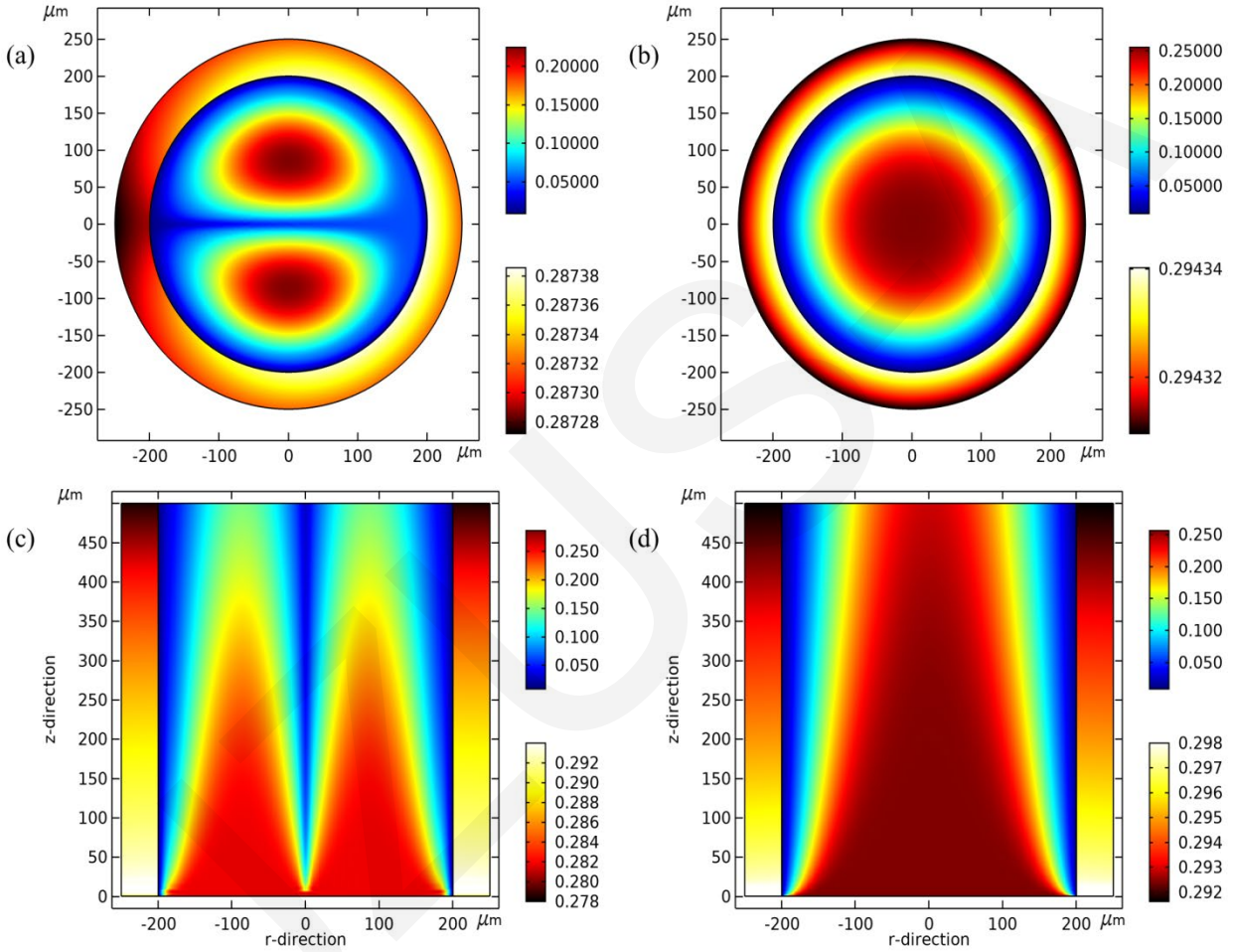


Fig. 3. Concentration profiles of oxygen on the cross-section and along the axis direction of the hollow fiber membranes.

Conclusions

1. A new model to describe membrane deoxygenation mass transfer was derived.

2. Simulation showed Dean vortices induce transverse fluid disturbance in the fiber, significantly promoting lumen side mass transfer.

3. The key parameters influencing the strength of Dean vortices are the Reynolds number of the lumen side and the curvature of HHFM.

4. Operating and membrane structure parameters were optimized for HHFM deoxygenation design.