Vorticity-Vector Potential Formulation of 3D Navier-Stokes Equation : Analysis of the Convective-Diffusive Transport Process in a Microfluidic T-Sensor

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The objective of this work is to provide an alternative computational tool for analysis of the convective-diffusive transport process of fluid flow and solute concentration in a microfluidic T-sensor. We adopt the vorticity-vector potential formulation, which considers the stream function in the 2D case and the scalar and vector potential in the 3D cases to accurately estimate flow properties. Due to the high Peclet number condition in the T-sensor, the concentration distribution is seriously affected by flow conditions. Both 2D and 3D simulations are performed and results are analyzed. When the flow conditions at the two inlets are non-symmetric, the transport processes become more complex: the diffusion becomes dominant and the concentration iso-surfaces are severely distorted (mainly) near the lower velocity inlet side. Through this work, we reveal that the asymmetric inlet condition locally enhances the role of the secondary diffusion, particularly near the lateral wall of the T-junction position.