Operator-split finite element method for high-dimensional population balance equations

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Simulations of population balance systems can be used to study the behavior of crystallization, polymerization, pharmaceutical productions, dispersed phase, etc. A population balance system (PBS) consists of the time-dependent Navier-Stokes equations to describe the flow field, a couple of nonlinear convection-diffusion-reaction equations for describing chemical reactions, transport of temperature and concentrations, and a population balance equation (PBE). The PBE depends not only the time and physical space but also the properties of the particles. Thus, the PBE is posed on high-dimensional domain than other equations in the PBS.

In this talk, we present the recently developed operator-split finite element method for high-dimensional PBE. In the operator-split finite element method, we first split the single high-dimensional PBE into a collection of low-dimensional equations using an operator-splitting method. Then, we solve each low-dimensional equation separately. In addition, the splitting facilitates to use different finite element discretizations such as the standard Galerkin and SUPG for different low-dimensional equations. The stability and convergence analysis of the operator-split finite element discretization of the PBE will be presented. Further, a new algorithm based on the nodal points of the finite elements to implement the operator-split finite element method will also be presented.

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