Efficient Numerical Solution of Multicomponent Fluid Flows and Its Application in Computer Simulation of Float Glass Process

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Abstract

The float glass process (Pilkington process) is the standard industrial scale process for manufacturing flat glass, see [1]. It is a practical example of a multicomponent system composed of molten glass, molten tin and nitrogen. As a mathematical model describing the flow of such immiscible chemically noninteracting substances we use a Cahn-Hilliard-Navier-Stokes type model, see [2], which conceptually belongs to the class of so-called diffuse interface models. The main challenge in the computations is the very fine spatial resolution required for capturing the dynamics of the interface between the components. This places high demands on hardware as well as on numerical methods.

Several numerical approaches to the problem have been suggested, but only few of them have been tested beyond academic examples. Building on the FEniCS Project, see [3], we have redesigned and implemented some of the most promising methods. The most challenging part of the solution process is the efficient resolution of the incompressible Navier-Stokes system with variable density and viscosity. To this end we use Krylov subspace solvers with a field split based preconditioner, see [4], implemented using subroutines provided by PETSc and petsc4py. We will discuss the efficiency of the proposed methods in the large scale computing setting.

References

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