Modeling liquid coating flows – recent progress and many challenges

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There has been tremendous progress in modeling problems with free and moving boundary problems both in terms of the computational approaches to solve the large nonlinear equations sets coming from the domain discretization methods. Free surfaces are one of the signatures of coating problems with the important effects of surface tension and the fluid-solid contact line boundary condition. Examples of moving interfaces include the dynamics of surfaces under flow perturbations, multiple coating materials, and phase change due to solidification. These types of problems can also have a free or moving surface that is either a continuous surface or moving surfaces and domains in which the position is defined by the fluid properties and the flow geometry. Mathematical approaches that have been used to capture these free and moving boundaries include front capturing and front tracking methods such as: spines, volume of fluid methods, fictitious species, and level set methods. These techniques are used in combination with finite element methods, boundary fitted finite volumes and, now less often, boundary element methods. Recent work has addressed the challenging problem of multi-scale, multi-surface problems such as those found in flow problems with interacting particles in dispersions, which include features such as multiple length scales, many surfaces, and flow subdomains that can form and disappear.

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