Lagrangian Models and Remapping Algorithms for 2D Multimaterial ALE Methods

Milan Kucharik[1], Richard Liska[2], Mikhail Shashkov[1], Pavel Vachal[2]
[1] *T-7, MS B284, Los Alamos National Laboratory, P.O. Box 1663, Los Alamos, NM 87545, U.S.A.*
[2] *Faculty of Nuclear Sciences and Physical Engineering, Czech Technical University in Prague, Břehová 7, Praha 1, 115 19, Czech Republic*

Most Arbitrary Lagrangian-Eulerian (ALE) methods for fluid dynamics consist of three stages: 1) Lagrangian solver updating the solution in the next time level; 2) mesh rezoning technique providing smoothed computational mesh; and 3) remapping algorithm interpolating fluid quantities from the Lagrangian to the rezoned computational meshes. For relevant results of numerical simulations, multimaterial model is often suitable which requires generalization of all used methods to the case of multimaterial fluid flow. In this talk, we will present 2D multimaterial versions of the Lagrangian and remapping stages needed for high-quality ALE method.

For the Lagrangian stage of the ALE algorithm, there exist plenty of models treating the multimatarial features of the fluid. Main differences among several of them (lying mostly in the new volume fractions estimate) will be described. We will emphasize several aspects of the multimaterial Lagrangian solver, such as incorporating of multimaterial artificial viscosity and tracking of pure material centroids. Also, basic comparison of mentioned models will be presented.

Generally, the remapping stage interpolates the fluid quantities from the Lagrangian computational mesh to the smoothed one. In the multimaterial case, the remapping stage must also provide volume fractions of each material in the cells of the rezoned mesh. Moreover, status of cells can change during the rezoning/remapping process, which must also be detected by the remapping algorithm. We will present here such an algorithm for remapping of a complete set of fluid quantities and volume fractions.

We will present several numerical examples to demonstrate properties of the described numerical methods. Effect of the particular interface reconstruction algorithm to the final solution will be presented. Finally, comparison of single/multi-material and pure Lagrangian/ALE simulations for well known fluid dynamics testing problems will be shown.