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ON THE APPLICATION OF ENRICHED TWO-FLUID FLOW SOLVER FOR THE SIMULATION OF CASTING PROBLEMS

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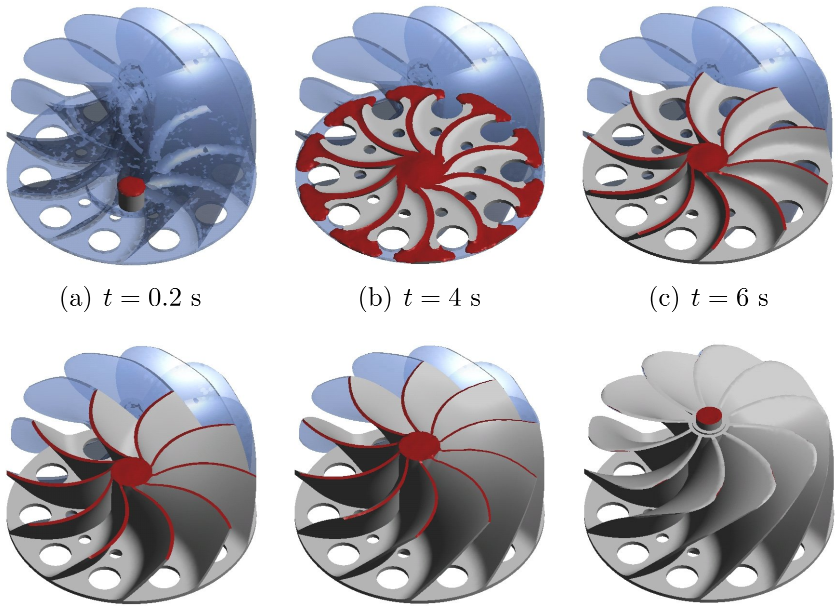
Multi-fluid flow simulation with large deformations at the interface has to deal with two main challenges. The fist one is accurately follow or capture the interface between the phases and the second one is treating jumps in the material properties at the interface that result in kink or jumps in the unknown fields. Two types of methods are generally distinguished for resolving the interface between the two phases: *interface tracking* in which the mesh explicitly represents the interface and follows its movements [1] and *interface capturing* in which the interface is described implicitly as the zero level-set of an auxiliary function [2] defined on the fixed mesh. The interface-capturing method is more convenient in case that large topological changes occur at the interface. Level set method [3], as the most popular interface-capturing technique, can deal with the large deformations of the interface. Its main deficiency is the gain/loss of the material at sharp interfaces during the convection and the reinitialization steps. To overcome this problem of mass conservation, various solutions have been proposed like; particle level set, volume of fluid, geometric conservative redistance and discontinuous Galerkin level set method.

On the other hand, for applications like mold filling that one of the fluids has large density, aluminum or steel, and the other one small density, air, instabilities appear at the interface that can totally destroy the solution accuracy. The main reason for such behavior is the poor quality of the linear elements to capture kink or jumps in the pressure-velocity pair. Various *enrichment* techniques [4] are provided to improve the approximation properties at the elements cut by the interface.

We propose a new set of local enrichment functions to capture jumps and kinks in the pressure field caused by jump in material properties at the elements cut by the interface.

They are presented in the variational multiscale stabilized framework and have the nice property of being condensed at the element level. This fluid solver is then loosely coupled with an improved level-set technique that account for the mass preserving issue to model the mold filling process. Figure 1 shows various instances during the filling of a turbine blade. The simulation is then followed by a post-filling analysis that accounts for the solidification and shrinkage.



(a) $t = 0.2$ s (b) $t = 4$ s (c) $t = 6$ s

(d) $t = 9$ s (e) $t = 12$ s (f) $t = 15$ s

Figure 1: Filling of a turbine blade. Red color shows the aluminum-air interface at different instances. The inlet velocity is 0.3 m/s and the blade is filled from the bottom.

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