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An extended Disontinuous Galerkin method for two-phase flows and moving contact lines

M. Smuda[1,2,*], F. Kummer[2] and M. Oberlack[1,2]

[1] Chair of Fluid Dynamics, TU Darmstadt, Otto-Berndt-Straße 2, 64287 Darmstadt, Germany, ∗smuda@fdy.tu-darmstadt.de, www.fdy.tu-darmstadt.de

[2] Graduate School CE, TU Darmstadt, Dolivostr. 15, 64293 Darmstadt, Germany, ∗smuda@gsc.tu-darmstadt.de, www.graduate-school-ce.de

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We are going to present a high-order numerical method based on a Discontinuous Galerkin (DG) discretization for transient, incompressible two-phase flow problems. Such flows exhibit kinks in the velocity field and jumps in the pressure field, due to discontinuous fluid properties (density and viscosity) at the interface. The presented DG method adapts the approximation space to the position of the interface and provides separate degrees of freedom for each fluid phase in cells, which are cut by the interface. Thus the extended DG (XDG) approach allows a sharp and sub-cell accurate approximation of those kinks and jumps. The interface is described by the zero-isocontour of a level-set function [1].

An important property of a DG method is the approximation by local basis functions. This gives rise to an easy handling of the discretization under local mesh refinement. Considering transient flow problems with moving interfaces, such a refinement should adjust to the current flow situation. We are going to present a mesh refinement technique, which adapts locally to the interface and furthermore, in regions with a strong curvature.

Looking at industrial relevant applications, we don't restrict to flow configurations with closed interfaces, but allow the formation and movement of a so-called contact line. At this point both fluid phases meet at a solid wall. However, imposing the standard no-slip boundary condition leads to a singularity in the stresses at the contact line. In order to cope with this singularity, we introduced a slip boundary condition into our XDG discretization based on dissipative effective forces, similiar to [2] for extended finite element methods.

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