AN IMPLICIT SECOND-ORDER REGION COUPLING METHOD FOR DISCONTINUOUS VALUES AND TRANSPORT COEFFICIENTS

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Numerous technical applications involves multiple materials as for instance in Fluid–Structure Interaction (FSI), Conjugate Heat Transfer (CHT), and Multi-Phase Flows (MPF). Simulating those systems requires the solution of equation systems with transmission conditions at the material interfaces, i.e., the domain-wise solutions in the materials are inter-dependent and necessitate a global coupling technique. For FSI and CHT, such coupling techniques form an integral part of the most simulation tools and much research has been done on different coupling types [1]. However, those methods cannot simply be transferred to MPF and and interfacial mass transfer. In contrast to the temperature or the velocity, the concentration is in general not continuous at the interface. This is a serious problem, since many of the developed coupling techniques (both explicit and implicit), are not readily generalized to discontinuous values [2].

The implicit region coupling method as currently implemented in OpenFOAM is based on an adaption of the heat conductivity (or diffusivity) of the material interface [3]. As it has been developed for CHT applications, it is applicable to the transport of a continuous quantity. In this presentation we show how the diffusivity approach can be extended to support jumps of the value (e.g., the concentration). However, a generalization necessarily renders the transport equation non-linear and requires an iterative solution, which not only increases the computational costs but also suffers from instabilities. As a remedy, we introduce an alternative region coupling method based on higher-order interpolations of values and derivatives at the interface. The interpolation-based approached is unconditionally stable and second-order accurate, even in the case of discontinuous values and transport coefficients.

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