Título A bounded upwind-downwind semi-discrete scheme for finite volume methods for phase separation problems

Tipo de Producto Publicación científica

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Código del Proyecto y Título del Proyecto

P14T03 - Modelos Multicomponente Para El Análisis, Optimización Y Diseño De Equipos Y Procesos Industriales: Separadores De Fases

Responsable del Proyecto

Larreteguy, Axel

Línea

Fluidodinámica Computacional (CFD)

Área Temática

Modelado y Simulación Computacional (MYS)

Fecha

2017

INTEC
Instituto de Tecnología

UADE
FUNDACIÓN UADE

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Abstract

Phase separation processes play a key role in many industrial applications. For instance, the oil industry is full of examples of surface installations devoted to separate water from oil just after the extracted mixture leaves the well. Phase separation problems pose many challenges to numerical schemes due to the presence of shock and rarefaction waves, typical of hyperbolic problems. Moreover, the transported variables, usually the fractions of each of the phases present in the mixture, have the additional important feature of being bounded, for only fractions between 0 and 1 have physical meaning. The numerical schemes should be able to deal with this restriction, avoiding unrealistic, non-physical fraction values. A novel semi-discrete scheme for the disperse phase equation of the standard drift-flux model as implemented in a finite volume formulation is presented. The scheme results from combining an upwind interpolation based on the drift direction for the transported variable of the drift-flux term, a seldom used downwind interpolation based on the same direction for evaluating the drift velocity, and an upwind interpolation based on the mixture velocity for the transported variable of the convective term. The scheme is mathematically proven to ensure boundedness of the solution, and is simpler than existing successful but more elaborate approaches, although generally not that accurate. The scheme is tested in one-dimensional and multidimensional separation problems, whose results confirm the good behavior predicted by the mathematical analysis.

Keywords

Downwind; Drift-flux; Bounded scheme; Finite volume; Separation process

Publicación completa en:
https://www.sciencedirect.com/science/article/abs/pii/S0307904X17303207