6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11-15 June 2018, Glasgow, UK

Effect of the liquid viscosity, wall wetting and mass flow rate on the flow through a horizontal U-bend subjected to an upwards flowing air/water-mixture

Laurent De Moerloose [1,*], Jan Vierendeels[1,2] and Joris Degroote[1,2]

[1] Department of Flow, Heat and Combustion Mechanics, Sint-Pietersnieuwstraat 41-B4, 9000 Ghent, Belgium.
[2] Flanders Make, Belgium
[*] Corresponding author. E-mail: Laurent.DeMoerloose@UGent.be

Keywords: *two-phase flow, computational fluid dynamics, U-bend*

Long, slender pipes in steam generators and condensers are typically connected with a U-bend. In this paper, a U-bend is considered with horizontal straight pipes subjected to an initially stratified water/air flow which moves upwards against gravity. The tube is assumed to be rigid. The flow is analyzed with a Reynolds-Averaged Navier-Stokes Volume-Of-Fluid approach. For low mass flow rates, separate gas bubbles form on the top side of the return pipe because the gravity forces are stronger than the inertia forces. The liquid layer builds up until a cross-section of the pipe in front of the bend is entirely filled with water, leading to liquid slug formation. The slug formation causes an impact on the bend wall. The transient force on the tube allows to determine precisely the moments of slug initiation and thus to quantify the slug frequency. The effect of a number of parameters on the flow profile is investigated. Firstly, the liquid viscosity makes the water-air interface in front of the bend more unstable, but does not affect the slug initiation point. Secondly, varying the wettability of the wall mainly affects the gas bubble shape in the return bend. Thirdly, the inlet conditions significantly affect the force on the wall. Finally, for higher mass flow rates, inertia forces become stronger than the gravity forces and the liquid layer remains on the outside wall of the bend, even in the return pipe. This leads to a nearly steady-state condition in the U-bend without any slug formation.