Abstract Submitted
for the DFD14 Meeting of
The American Physical Society

Experimental and numerical study of viscosity effects on the dynamics of the Benjamin bubble ALESSANDRO MARIOTTI, PAOLO ANDREUSSI, MARIA VITTORIA SALVETTI, DICI, University of Pisa — The "Benjamin bubble" is a gas bubble, which, due to gravity, forms and moves in a horizontal pipe, initially filled with stagnant liquid, once one end of the pipe is opened. In water this bubble moves with a constant velocity, which can be predicted by a non-viscous model. The Benjamin bubble velocity is also the base of state-of the-art predictions of the bubble drift velocity in the slug flow regime occurring e.g. in oil transport pipelines. Thus, it is interesting to investigate the dynamics of the Benjamin bubble in highly viscous oils. The findings of experiments and numerical simulations aimed at characterizing the effects of viscosity on the dynamics of the Benjamin bubble are presented. Experiments and simulations were carried out for a large range of fluid viscosities. The results show that two different flow regimes can be defined according to the Reynolds number. For high Reynolds, the bubble velocity and shape do not change in time, as for the classical Benjamin model. Conversely, for low Reynolds (heavy oils) the bubble velocity decreases along the pipe and the height of the bubble front is progressively reduced. We also show that the two different flow regimes are due to the critical or subcritical flow conditions of the liquid phase under the bubble.

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Date submitted: 29 Jul 2014 Electronic form version 1.4