Experimental Study on Development Length and Spatial Growth of Instabilities in Heavy Oil-Water Stratified Flow

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ABSTRACT

Liquid-liquid flows are present in a wide range of industrial processes. Although significant amount of work has been devoted to the understanding of gas-liquid systems, the same cannot be said about liquid-liquid flow. The interest in liquid-liquid flows has recently increased mainly due to the petroleum industry, where oil and water are often transported together for long distances. The hydrodynamic stability of two-phase parallel flow has been subject of intense research over the last decades ([1], [2] and [3]). The transition from annular or stratified flow to another flow patterns is related to a wide range of practical applications, for instance in the nuclear, refrigeration and oil industries. The purpose of this paper is the experimental study of the development length and spatial growth of instabilities in stratified heavy oil-water flow. The development length is studied based on the idea that the time-averaged pressure drop should be constant between two points in the pipe line after the flow is completely developed. Hence, the pressure drop is measured between subsequent pairs of pressure taps in a sequence. It is suggested that the development length is related to the Reynolds number of the effectively less viscous phase. The other part of the work is devoted to the study of spatial development of instabilities which may cause the liquid-liquid interface to break up some diameters from the entrance of the pipe line. It depends on the development of the interfacial wave properties in space, *i.e.*, along the pipeline. The two-phase flow is filmed at different pipe positions and the geometrical (amplitude and wavelength) and kinematic mean properties of the interfacial waves are recorded, until the stratified flow pattern breaks up into some different flow pattern. The holdup is measured by capacitive probes installed along the pipe line. All the data acquired will be useful as input parameters for simulations of the spatial transition of parallel flow patterns due to spatial growth of instabilities ([3] and [5]). The flow is modeled by the one-dimensional two-fluid model [4], coupled by the Young-Laplace law. The experiments were carried out in the hydrophilic-oilphobic glass test line of 26mm i.d. and 12m length of the multiphase flow loop of the Thermal-Fluids Engineering Laboratory of the Engineering School of Sao Carlos at the University of Sao Paulo (LETeF).

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