STUDY OF GEOMETRICAL SINGULARITIES IN LIQUID AND GAS-LIQUID FLOW

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As with most problems in engineering, the interest in two-phase flow is due to its extreme importance in various industrial applications, like reactors (chemical and nuclear), where very often we can find flows in several phases. These reactors have security and control valves that may be seen as singularities for the flow. These devices may create sufficient local pressure loss and increase of vapour content (bubbles) so that the resulting flow behaviour can be difficult to be predicted in the designed process.

In this project, single and two-phase flows are investigated in a convergence and divergence singularity located in a pipe. The goal of this study is to analyse the resulting pressure drop due to these singularities in function of the mass flux. Experimental study is conducted on the VKI facility LUCY II which includes a test section fully instrumented by pressure taps related to transducers. Special care is taken to measure locally the pressure on four azimuthal positions as shown in view of Figure 1. Fluids used are water and air at atmospheric conditions and variables studied include liquid and gas flow rate, volume fraction of the gas and distance from the singularity. Also, Computational Fluid Dynamics (CFD) calculations using commercial package FLUENT are performed to reproduce the experimental results.

Numerical simulations and handbook solution predict satisfactory the static pressure change in the convergent restriction in single phase, while in the divergence some differences have been found. The two-phase flow results show that there is a strong effect of the air at low volumetric qualities at the divergence singularity while at convergence this effect is only observed at high air flow rate. Comparison between experimental results, numerical simulations, handbook solution and literature data (Figure 2), lead to conclude that in smooth convergence singularity the dimensionless static pressure change can be predicted by a corrected version of the correlation proposed by Janssen (1966).

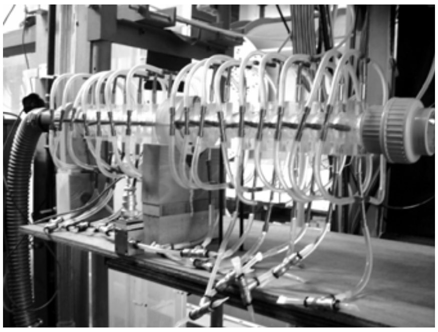

Figure 1: Test section

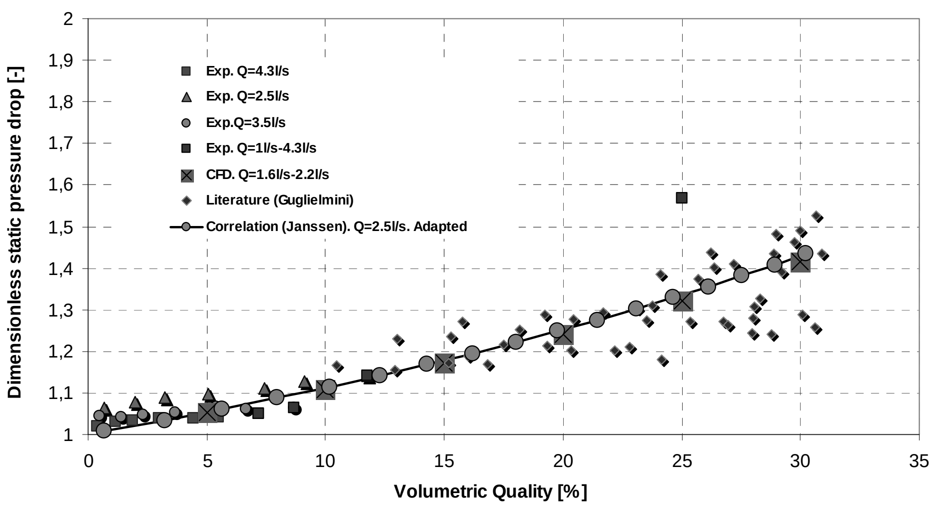

Figure 2: Evolution of the dimensionless static pressure versus the volumetric quality of air. Convergence restriction.