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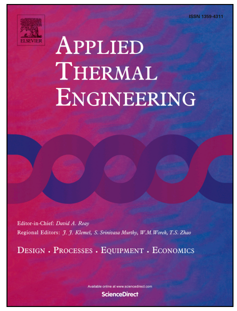

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E.R. Dario, L. Tadrist, J.L.G. Oliveira, J.C. Passos

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MEASURING MALDISTRIBUTION OF TWO-PHASE FLOWS IN MULTI-PARALLEL MICROCHANNELS

E. R. Dario,[1,a)], L. Tadrist[2,b)], J. L. G. Oliveira,[3,c)] J. C. Passos[1,d)]

[1]*Department of Mechanical Engineering, LEPTEN/ Boiling, Federal University of Santa Catarina, Florianópolis, SC, 88040-900, Brazil*
[2]*Aix-Marseille Université, Laboratoire I.U.S.T.I. - UMR CNRS 7343, Technopôle Château-Gombert, 5, rue Enrico Fermi, 13453 Marseille, France*
[3]*Mobility Department, Federal University of Santa Catarina, Joinville/SC, 89218-000, Brazil*

Liquid flow distributions were measured in nine parallel microchannels with inner diameters of 0.8 mm connected to a common header, fed by air-water flows through a single tube. Flow maldistribution in the microchannels was analyzed considering the combined effects of the two-phase flow characteristics (flow pattern, gas quality, mass fluxes and superficial velocities), microchannel-header arrangements (horizontal or vertical), and microchannel flow and header feeding orientations (horizontal, vertical upward or vertical downward). The header was loaded with two-phase mass fluxes of 72, 144 and 216 kg/m^2.s and the gas quality ranged from 0 to 0.75. An increase in the flow rate homogeneity was noted for the arrangement horizontal header and horizontal microchannels, when the header was loaded parallel to the microchannels or perpendicularly from the header bottom. Highly heterogeneous flow distributions occurred for the arrangement vertical header and horizontal microchannels. Preferential liquid feeding occurred in the microchannels far from the inlet feeding tube for inlet flows with high gas quality (over 10 %) and high gas superficial velocity (over 20 m/s) and with the inlet tube parallel to the microchannels. Preferential liquid feeding occurred in the microchannels close to the inlet feeding tube for inlet flows with a horizontal header and upward flows through the microchannels. The results and conclusions of this study represent an important contribution to this field, which could enhance the design of evaporators and condensers in compact heat exchangers.

Keywords: maldistribution, parallel microchannels, air-water, preferential feeding.

1. Introduction

Compact heat exchangers are advantageous in cases of space restriction and also offer a reduced cost of materials and fluids, weight reduction and a decrease in the operational costs. These advantages frequently compensate the initial investment in more recent heat transfer technologies. The compactness of these heat exchangers is related to a reduction in the hydraulic diameter and pipe length, and to an increase in the heat transfer area for the same available volume. This latter characteristic often leads to the occurrence of parallel flows in micro-sized conduits, where surface tension effects are of relevance. The presence of compact heat exchangers is becoming common in residences and automobiles; see Jacobi *et al*. [1], for example.

A reduction in the hydraulic diameter is also associated with an increase in the number of parallel channels required to maintaining the pressure drop at tolerable levels. The pressure drop must be kept at a minimum so as to increase the coefficient of performance (COP) of the heat exchanger. An increase in the number of channels requires a homogeneous flow distribution, which is often considered necessary in order to promote an increase in the heat exchanger efficiency; see Hrnjak [2] and Mohammadi and Malayeri [3], for example. In contrast to the common assumption of flow homogeneity among parallel channels, flow maldistribution regularly occurs, reducing the heat transfer effectiveness; see Baek *et al*. [4]. A thorough review of maldistribution is compiled herein, elucidating its effect on heat exchangers.

Several features can interfere with the two-phase flow distribution in heat exchangers, as described by Mueller [5] and Mueller and Chiou [6]. These authors showed that maldistribution can be caused by geometric factors (*e.g.* the header geometry, the coupling arrangement between the header and channels, and the position

[a)] Electronic mail: evandro.dario@luzerna.ifc.edu.br

[b)] Electronic mail: lounes.tadrist@polytech.univ-mrs.fr

[c)] Electronic mail: jorge.goes@ufsc.br

[d)] Electronic mail (corresponding author): julio.passos@ufsc.br