Prediction of the liquid film characteristics in open inclined microchannels.

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Falling film microreactors (*FFMR*) are important gas-liquid microdevices, in which extended specific surfaces (up to 20,000 m^2/m^3) can be obtained while the formed liquid film remains stable over a wide range of gas and liquid flow rates ***[1]***. The advantages offered by these devices, i.e. enhanced heat and mass transfer capabilities, attracted the interest of many researchers and as a result various papers concerning the design and operation of *FFMRs* have been published during the last decade.

In the majority of these works i.e. ***[2]*** the film thickness was estimated by well-known macroscale correlations of the. However, it has been proven that these correlations are not valid in the microscale ***[3]***. Thus, there is a need to formulate new correlations, which are valid in the microscale and can be used for the design of *FFMR*s.

Important parameters for designing *FFMR*s are the thickness (H) of the liquid film and the shape of the interface, which determines the gas-liquid interfacial area. In a previous work ***[4]*** we have proposed correlations for estimating the film thickness (H) (***eq.1***) and for calculating the shape of the interface (***eq.2***).

$$H/W_o = C\cdot(Re^a Ca^b Fr^d)^f \qquad (1)$$

where *Re, Fr* and *Ca* are the *Reynolds, Froude* and *Capillary* number respectively, while *a, b, C, d* and *f* are equation constants.

$$Y/(H_f - H) = K + A(W/W_O) + B(W/W_O)^2 \qquad (2)$$

Equation (***2***) express the local height of the meniscus (***Y***) as a function of the distance from the wall (**W**). The parameters H, H_f and W_o are defined in ***Figure 1***, whereas the constants ***A, B, K*** are simple functions of the geometrical characteristics of the microchannel and the liquid film, i.e. H_f, H and *Wo* ***[4]***.

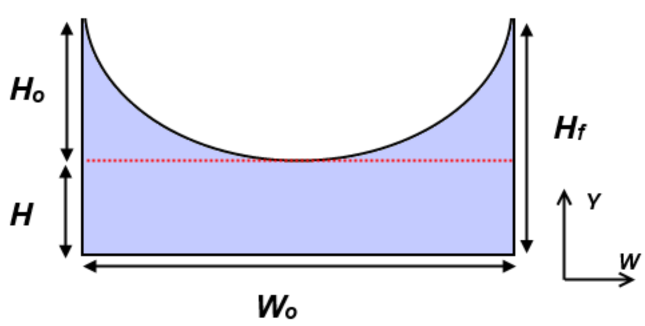

Figure 1: Geometrical characteristics of the liquid film.

The aforementioned correlations are based on data originated from *PMMA* μ-channels with various widths using various fluids. The aim of the present work is to check their validity using other microchannel materials.

Initial experiments are conducted in three microchannels with widths (W_o) *1200, 600* and *300* μm engraved on brass. Pure water as well as aqueous solutions of glycerol and butanol are used. During the experiments the geometrical characteristics of the liquid film are determined by a μ-*PIV* system using a previously published technique ***[3]***. By comparing these results with data ***[4]*** concerning a test section made of *PMMA*, it is found that ***eq. 1*** can predict well the film thickness, provided that the constant **C** is properly adjusted (***Figure 2***). More experiments are currently in progress using more microchannel materials in order to check the validity of these correlations.

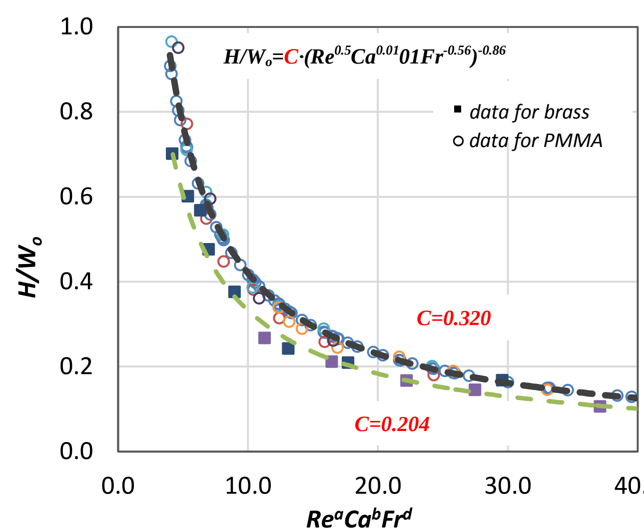

Figure 2: Comparison between film thickness data for microchannels made of *PMMA* and brass.

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