InPROMPT SFB/Transregio 63
8th INTERNATIONAL BERLIN WORKSHOP ON TRANSPORT PHENOMENA WITH MOVING BOUNDARIES
25/26 October 2018 Berlin, Magnus-Haus

Characteristics of a non-Newtonian free-falling film in inclined μ-channels

A.T. Koupa, G.G. Stergiou and A.A. Mouza*

Chemical Engineering Dept., Aristotle Univ. of Thessaloniki, Univ. Box 455, 54124 Thessaloniki, GREECE

*mouza@auth.gr

Abstract: Among the most important variables in the design of falling film microreactors (FFMRs) is the liquid film thickness as well as the gas/liquid interfacial area, which dictate the mass and heat transfer rates. In turn the extent of interfacial area depends of the geometrical characteristics of meniscus formed by the liquid film. In our previous studies [1,2] we employed Newtonian liquids and have experimentally investigated the effect of liquid phase parameters (i.e. physical properties and flow rate), along with the geometrical characteristics and inclination angle of the conduit on the geometry of the film. The purpose of the present study is to extend our previous one by employing non-Newtonian liquids.

Preliminary experiments were conducted in an open rectangular microchannel 1200 µm wide, 100 mm long and 25 deg inclination angle from the horizontal position. Two non-Newtonian (*shear thinning*) liquids were used, prepared by dissolving a small amount of xanthan gum either in water (*nW*) or in a 20% w/w aqueous glycerol solution (*nG20*). The spatial film thickness distribution was measured by the technique described in our previous study [1]. In this technique the fluorescent particles, which are used in μ-PIV for measuring the velocity field, are also used for identifying the area covered by the liquid phase. The film flow was also simulated using a Computational Fluid Dynamics (*CFD*) code in an effort to estimate the mean effective viscosity inside the free-flowing liquid film.

Fig.1 presents typical results that corelate the ratio (h/h_o) of the spatial film thickness (h) to the minimum film thickness (h_o) with the ratio (y/D) of the distance (y) from the wall to the channel width (D). It is obvious that the meniscus shape is practically the same regardless of the type of fluid or the flow rate. ***Fig. 2*** shows that the film characteristics measured when a non-Newtonian fluid is used are equivalent to those of a Newtonian liquid, which has a viscosity equal to the mean effective viscosity value estimated by the *CFD* simulation. More experiments are currently in progress to further elucidate the phenomenon.

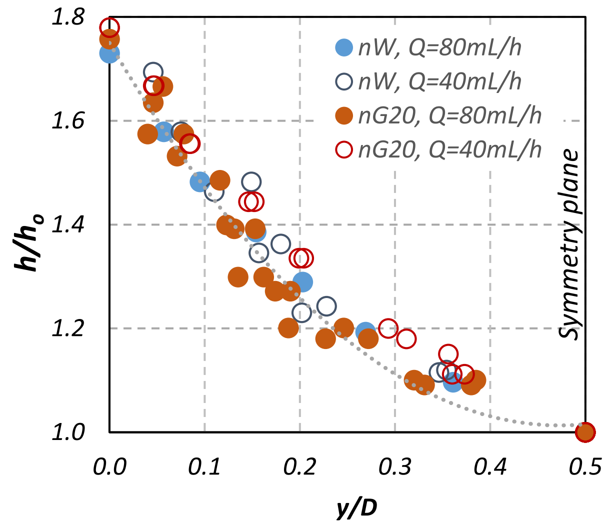

Fig. 1. Effect of type of liquid and flow rate on the shape of the meniscus.

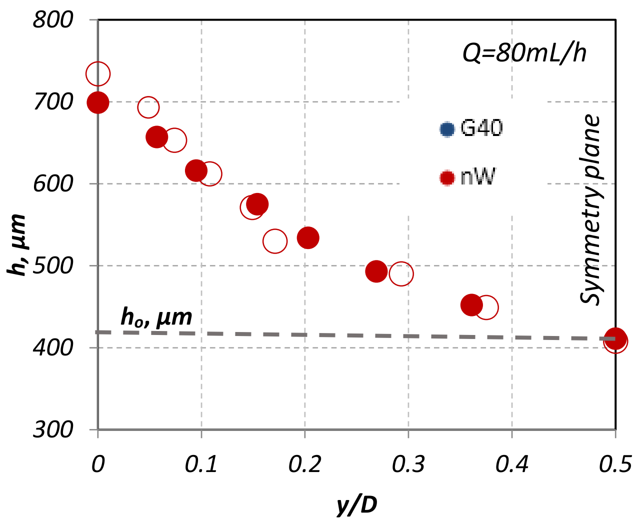

Fig. 2. Comparison of the meniscus between the non-Newtonian (*nW*) and its Newtonian counterpart (*G40*).

References

1. Anastasiou, A.D., Makatsoris,C., Gavriilidis, A., Mouza, A.A. 2013. *Exp Therm Fluid Sci*, **44**, 90-99.
2. Anastasiou, A.D., Gavriilidis, A., Mouza, A.A. 2013. *Chem Eng Sci*, **101**, 744-775.