XX Fluid Mechanics Conference KKMP2012,
Gliwice, 17-20 September 2012

EFFECT OF THE HOLE ELONGATION ON PERFORATED PLATE PERMEABILITY

Tomasz Lewandowski[1], Piotr Doerffer[1]
[1]Institute of Fluid Flow Machinery, Polish Academy of Science;
Fiszera 14, 80-952, Gdańsk, Poland
tomasz.lewandowski@imp.gda.pl
doerffer@imp.gda.pl

Key words: perforated wall, L/D ratio, mass flow rate

Perforated walls find wide use as a method of the flow control and the effusive cooling. Some literature data on L/D (hole length-to-diameter ratio) effect on flow structure and mass flow rate may be found [1,2], but all those works concern holes of diameter at least one order of magnitude larger than our presented simulations. Due to the size of the analysed holes and it's cylindrical shape, the only method of analysing the flow through such holes is the numerical method. In the carried out simulations, the holes were of D = 0.6mm, 0.3mm and 0.125mm diameter and the perforation values were 4%, 5%, 8% and 10%. L/D changes between 0.01 to 8. Data bank of the flow through the cylindrical holes, has been produced.

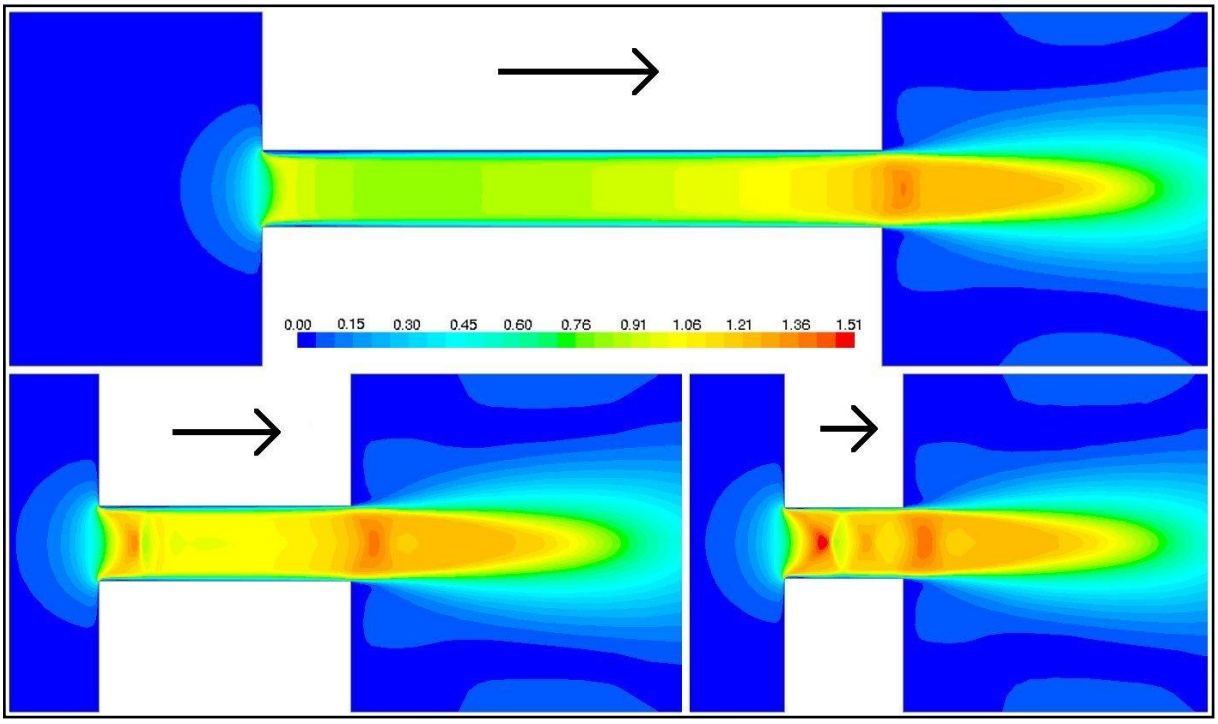

Figure 1. Contours of Mach number for three different values L/D ratio and diameter of the hole D = 0.3mm

Figure 1 presents how the length of the hole influences a change of flow structure, for a constant diameter of the hole and the same pressure drop. The hole elongation has a significant influence on the obtained mass flow rate. In addition, entrance effects appear to be important.

The influence of the hole elongation on the flow structure is a part of the work whose ultimate goal is to define a physical transpiration model of a flow through perforated plates. That new model may be used as the boundary condition for numerical simulations. Previous presentations concerning this subject were presented at National Conferences of Fluid Dynamics [3,4].

References

[1] Wilfert G., Wolff S., [2001], Influence of internal flow on film cooling effectiveness', Journal of Turbomachinery , Vol. 122, pp. 327-333

[2] Sang W.P., Joon S.L., [2001], Flow characteristics inside circular injection holes normally oriented to a crossflow: Part I - Flow visualizations and flow data in the symmetry plane ', Journal of Turbomachinery, Vol. 123, pp. 266-273

[3] Lewandowski T., Doerffer P., [2008], Defining the aerodynamical perforation of plates by means of numerical simulation', XVIII KKMP2008

[4] Lewandowski T., Doerffer P., [2010], Modelling of transpiration flow on the basis of numerical simulations', XIX KKMP2010