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INTRODUCTION OF THE ANALYTICAL TURBULENT VELOCITY PROFILE BETWEEN TWO PARALLEL PLATES

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Abstract: *A new analytical velocity profile between two parallel plates is introduced in this article. It is possible to use this velocity profile for both laminar and turbulent flow. All necessary parameters can be obtained from the unit flow rate and the pressure drop. We can also use this model in case when the material of the upper and lower wall is different.*

Keywords: ***velocity profile, laminar flow, turbulent flow, flow between parallel plates***

The new analytical velocity profile between two parallel plates has been presented in this paper. It is a case of flow governed by a pressure gradient. The situation is depicted in a fig. 1.

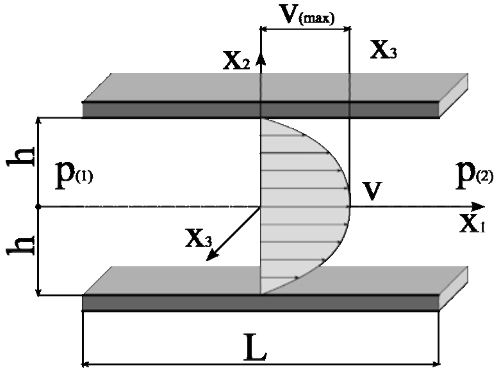

Fig. 1 Velocity profile between two parallel plates.

The new velocity profile is derived on the basis of the vorticity distribution over the space between two parallel plates. This velocity profile can be used for all, laminar, turbulent and the constant velocity profile. The derivation of this type of the velocity profile is based on the Biott-Savart law.

The velocity profile for the case of the symmetrical problem should be expressed by this formula

$$v_1 = \frac{(N+2)}{(N+1)} . \frac{Q}{2.h} . \left[1 - \left(\frac{|x_2|}{h} \right)^{N+1} \right] \text{ within the interval } x_2 = \langle -h, \quad h \rangle \tag{1}$$

$$N = \frac{h^2}{\mu . v_{(av)}} . \frac{(p_1 - p_2)}{L} - 2 \tag{2}$$

Where Q is an unit flow rate between the parallel plates, h is the half distance between these plates, μ is the dynamic viscosity, $v_{(av)}$ is the average velocity, all other parameters are clear from the fig.1.

This velocity profile can be, in formal way, compared with the power law velocity profiles introduced by Munson (2006) and Janalík (2008). More detailed comments are mentioned in the full length paper in CD. These velocity profiles are depicted in the fig. 2.

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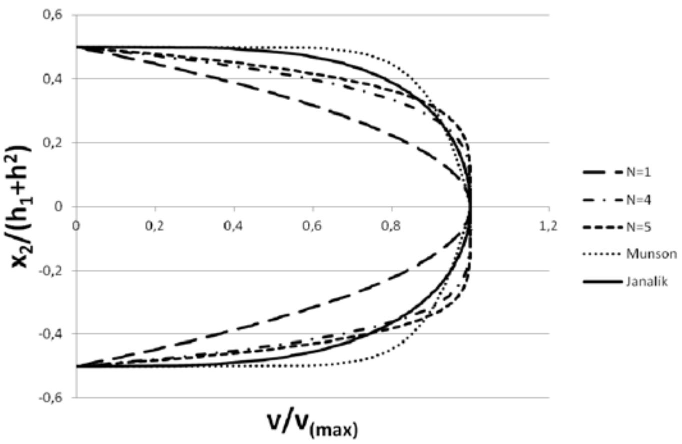

Fig. 2 New velocity profiles in comparison with power law velocity profiles.

It is also possible to compare the velocity profile near the wall with the logarithm wall law. This comparison is depicted in a fig. 3.

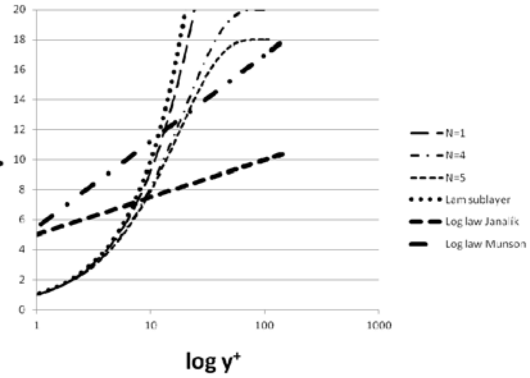

Fig. 3 The new velocity profiles comparison with log wall law.

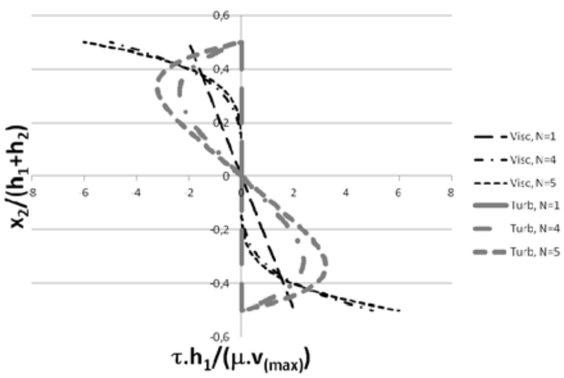

Fig. 4 The Reynolds and viscous shear stresses.

The viscous stress and the Reynolds stress for three different exponents N are depicted in the fig. 4. This cannot be compared with the power law velocity profiles because its shear stress at the wall is infinite.

The new velocity profile based on a vorticity distribution between two parallel plates has been presented in this paper. This new velocity profile is better than the power law velocity profiles because it has not infinite shear stress close the wall. It means that it is possible to express the Reynolds stresses and it is also possible to compare this profile with the logarithmic law near the wall. It is not possible to do this in case of the power law velocity profiles because they have infinite derivative near the wall. The new velocity profile has only one problem which can be removed. The problem is that this profile has zero value of the second derivative in the centre of the channel. It means that there is the infinite radius of the curvature in the centre line. It is also necessary to compare this velocity profile directly with the experimental velocity profiles. This work can help in the understanding or even in the modeling of a boundary shear layers in CFD software.

Acknowledgement

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