Some Measurements in Radial Free Jets

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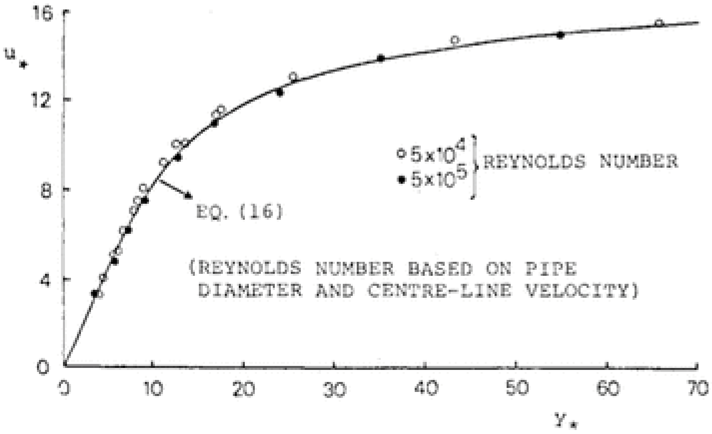

Fig. 1 Comparison of formula with pipe-flow data of Laufer in viscous sublayer and buffer zone.

the Stanford Conference. After integrating Eq. (9) and combining with Eqs. (13) and (14), a good deal of algebra yields the following closed-form expression for the velocity distribution over a smooth wall which is valid continuously from the wall up to the freestream:

$$u_* = 5.424\tan^{-1}\left[\frac{2y_* - 8.15}{16.7}\right] + \log_{10}\left[\frac{(y_* + 10.6)^{9.6}}{(y_*^2 - 8.15y_* + 86)^2}\right] - 3.52 + 2.44 \times \left\{\Pi\left[6\left(\frac{y}{\delta}\right)^2 - 4\left(\frac{y}{\delta}\right)^3\right] + \left[\left(\frac{y}{\delta}\right)^2\left(1 - \frac{y}{\delta}\right)\right]\right\} \quad (16)$$

where $u_* = u/u_0$ and $y_* = yu_0/\nu$.

Discussion

As far as the author is aware, there is no other explicit expression available for the smooth-wall velocity distribution which satisfies both the momentum and continuity equations near the wall while satisfying the four boundary conditions: $y=0$, $u=0$ and $du_*/dy_* = 1$; $y=\delta$, $u=U_\infty$ and $du/dy=0$. (For $y=\delta$, $y_* \to \infty$ is regarded as a limiting boundary condition.)

The description of the mean velocity distribution afforded by Eq. (16) is in excellent agreement with Laufer's[5] experimental data near the wall, as is shown in Fig. 1. Away from the wall, as $y \to \infty$, Eq. (16) approaches Eq. (15) asymptotically and so the logarithmic and outer regions are adequately described (see Ref. 7).

Conclusions

It has been shown how the cubic law for the variation in eddy kinematic viscosity very near the wall can be combined with the linear law in the logarithmic region by the use of a simple interpolation formula. This formula leads to an explicit closed-form expression for the velocity distribution over a smooth wall in a turbulent boundary layer which should prove useful in studies of heat and mass transfer and tur-

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Introduction

IN many fluid flow problems of practical importanc encounters free shear flows such as jets, wakes, and m layers. In the class of jet flows there is a flow configu known as a radial jet which has not yet received mu tention. Recently Witze and Dwyer[1] have investigate turbulent radial jets. In their investigation the radial jet been classified as "constrained radial jets" and "imp radial jets." In this investigation a distinct new catego radial jets has been introduced to distinguish it from the two categories. This is the ideal radial free jet. Essential similar to the impinged jet, but it has small sepa distance between the nozzles to avoid the initial devel regions of the axisymmetric jets. The constrained rad has been investigated by Heskestad,[2] and some measure on the ideal radial free jet have been reported by Patel et

From these investigations it is noted that the measure of the impinged radial jets reported so far are limited example, Witze and Dwyer selected nozzle spacings g than 20 times the nozzle diameter, thus limiting the fi investigation to $(r/s) < 0.5$. With such large sepa distances the impinged radial jets produced by them w fact a result of the two interacting axisymmetric turbule that had already undergone some development.