Discussion

Full-range pipe-flow equations

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The discussers appreciate the authors’ representation of the full-range pipe-flow equations. As stated by the authors these are valid for laminar, transitional and turbulent flows. However, the errors associated with the diameter equation [Eq. (20)] in the laminar flow close to \( R = 2000 \) seem higher than the reported values.

For laminar flow the pipe diameter was expressed by Eq. (17) and for full-range pipe-flow by Eq. (20). The results of these two equations should concur in the laminar flow region. Substituting Eq. (17) in Eq. (14), and solving for \( \nu_* \) yields

\[
\nu_* = \left( \frac{2}{\pi^3 R^4} \right)^{0.2}
\]

(27)

The percentage error between Eqs (20) and (17) for laminar flow, i.e. \( R \leq 2000 \) or \( \nu_* \geq 0.001322 \), is

\[
\text{Error(\%)} = 100 \times \left( 1 - \frac{0.66[(214.75\nu_*)^{0.25} + \epsilon_1^{0.25} + \nu_*]^{0.04}}{(128\nu_*/\pi)^{0.25}} \right)
\]

(28)

Figure 3 shows the results of Eq. (28) in terms of \( R \) and different \( \epsilon_* \) values, indicating that the errors associated with Eq. (20) for \( R = 2000 \) and \( \epsilon_* = 10^{-6} \) and \( \epsilon_* = 10^{-2} \) are about \(-6.2\) and \(-10.7\%\), respectively. Therefore, it seems that the proposed equation should be used with caution in the range \( 1500 \leq R \leq 2000 \).

Reply by the Authors

The Authors are grateful to Ali R. Vatankhah and Salah Kouchakzadeh for their Discussion. In order to model a pipe flow equation near the Reynolds number \( R = 2000 \), one has to use a transition function. The transition function for our friction factor Eq. (10) is \( f = (2500/R)^{\gamma} \), whereas the transition function for our the discharge equation [Eq. (25)] is \( Q = (415\tilde{\nu})^{\delta} \). These two functions model the peculiar shape of the curves in the vicinity of \( R = 2000 \). For example, in Fig. 2, there is a peculiar shape of the curve in the region \( 10^{-3} \leq \tilde{\nu} \leq 10^{-2} \).

For the diameter equation the transition function is complicated. Thus it was not attempted to include it, and errors were allowed in a narrow region of \( \nu_* \). Moreover if the diameter would be obtained accurately, the next larger diameter has to be selected from a list of commercially available pipe sizes (Swamee and Sharma, 2008).

Reference