A Study of high Reynolds number pipe flows with porous inserts

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Abstract This paper reports experiments and calculations for the flow at the inlet and exit of a ceramic foam located in a straight pipe and in a pipe with a 1:4 sudden expansion. For the latter, the foam, with thickness to diameter ratio between 0.15 and 0.60, was located at different distances from the sudden expansion wall. Three different pore sizes (10, 20 and 60 ppi) were investigated for pore Reynolds numbers in the range $20 \leq Re_p \leq 400$. LDA measurements include velocity profiles at the foam exit as function of the Reynolds number, foam thickness and inlet conditions, and confirm that the outlet multi-jet flow structure induced by the non-regular configuration of the porous matrix results in a strongly three-dimensional velocity field which dissipates as the fluid flows downstream. Numerical calculations were performed to assess the suitability of available models for turbulent flow within porous media. Two different turbulence models and a laminar model for flow within the porous medium were considered. The numerical and physical models used could not reproduce completely the foam influence on the separated turbulent flow region formed in-between the sudden pipe expansion and the foam inlet.

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