Abstract Submitted
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Relaxation of turbulent pipe flow following an axisymmetric square bar roughness element[1] LIUYANG DING, ALEXANDER SMITS, Princeton University — The relaxation of turbulent pipe flow following an axisymmetric square bar was studied. The upstream flow was fully developed with a bulk Reynolds number of 156,000. Three bar heights were investigated: $h/D = 0.02$, 0.05, and 0.1 (D is the pipe diameter). PIV data were collected at multiple downstream stations, with the farthest one at approximately $50D$ downstream. It was found that the downstream pipe flow evolved in three phases. Immediately following the square bar is the development of the shear layer, where the turbulence intensity scales linearly with Re_h (Reynolds number based on the bar height). The length of the first phase is a linear function of h, although the peak turbulence intensity occurs around $x/x_R = 1$ (x is the downstream distance and x_R is the flow reattachment length). The second phase features the convection of turbulence towards the pipe centerline, in which the triple correlation in the Reynolds stress transport equation plays a central role. Scaling laws in the second phase are given by ratios h/D and x_R/D. The last phase is the long-lasting non-monotonic recovery to equilibrium, in which damped harmonic oscillation is observed. A predictive model derived from RANS equations are examined against the recovery behavior.

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