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Editors:
H.I. Andersson P.-Å. Krogstad

Department of Energy and Process Engineering,
The Norwegian University of Science and Technology
Trondheim, Norway.

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Characteristics of the turbulent fluctuating motion in swirling flow

R. Oerlue[1], J. Micheel[2], V. Vasanta Ram[3]
[1-3]Institute of Thermo- and Fluid Dynamics,
Ruhr University Bochum, D-44780 Bochum, Germany

The purpose of the present work is to analyse experimental data in a pipe flow with swirl from a point of view that attempts to illuminate the nature of anisotropy. Experiments have been conducted in a refractive-index matched facility in which swirl was generated by a rotating tube bundle and measurements were done by 3-D laser-Doppler velocimetry. The flow parameters for our present experiments were: Reynolds number of 1.17×10^5 in a range of swirl numbers 0.5 to 2.0, and a Reynolds number of 2.24×10^5 in a swirl number range of 0.75 to 1.8.

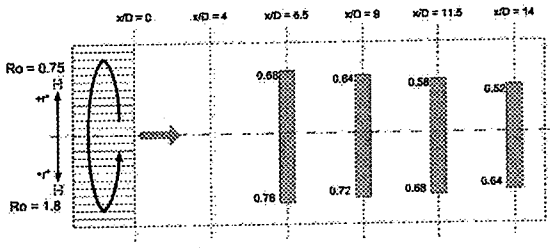

Figure 1: "Laminarisate" core region for a Reynolds number of 2.24×10^5

So far as the mean velocity is concerned, analysis of the data of our present experiments essentially substantiate the finding reported earlier, that the azimuthal motion in the core is virtually unaffected by the Reynolds shear stresses. This property manifests itself through the moment of the azimuthal velocity remaining constant on streamsurfaces.

The size of the core in which the Reynolds shear stress is ineffective and the radial distribution of the azimuthal velocity is solid-body like, is generally larger at larger swirl numbers (Fig. 1).

The quantities responsible for production of the turbulent kinetic energy; of components of the Reynolds normal and shear stresses; and the triple correlations entering their budgets have been evaluated from the measured data.

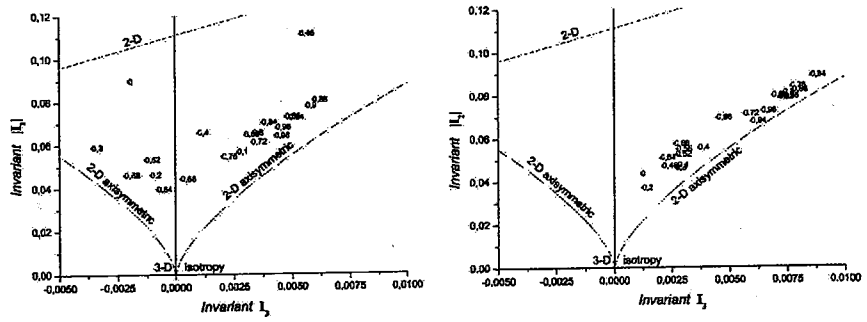

Figure 2: Lumley triangle for a swirl number of 0.75 and a Reynolds number of 2.24×10^5 at 4 and 14 pipe diameters downstream of the swirl generator

Furthermore the Lumley triangle was prepared from the measured data. As shown in Fig. 2 a clear tendency toward the two dimensional axisymmetry can be recognized with an increasing swirl number.