Mixing characteristics in the near-field of a swirling jet

R. Örlü*

Experiments on swirling jets use different swirl generating methods (e.g. vanes, rotating honeycomb, azimuthal injection of secondary flow) which leave traces in the flow and make it impossible – especially if the near-field is under examination – for accurate comparisons or general conclusions. The purpose of the present work is to analyse the effect of rotation on the near-field of a turbulent swirling jet with and without a passive scalar (in this case the temperature). Experiments have been conducted in a heated swirling jet emanating from a fully developed axially rotating and thermally insulated pipe flow as seen in figure 1(a). The pipe is 6 m long and has a diameter of 60 mm. The Reynolds number (based on pipe diameter and bulk velocity) is Re=24000 and a swirl number S (defined as pipe wall azimuthal velocity divided by the bulk velocity) of 0 and 0.5. The set-up gives well defined streamwise and azimuthal velocity distributions as well as temperature profiles. We have developed a special designed and built combined X-wire and cold-wire which makes it possible to simultaneously acquire the instantaneous axial and azimuthal velocity as well as the temperature.

In the experiment we investigated the effect of rotation on the spreading and the axial decay of a passive scalar, but also investigated the turbulent statistics, such as spectral analysis of the velocity (figure 1(b)), and the temperature, respectively. There are, to the author's knowledge, no previous works on heated turbulent swirling jets issuing from a fully developed rotating pipe flow, but results for the velocity field confirm preliminary studies in an isothermal swirling jet[1]. The temperature field characteristics for the non-swirling jet match results from heated round jets. The implemented measurement technique provides reliable data and confirms the assumption that the temperature acts as a passive scalar as is evident from figure 1(b). Besides the turbulent statistics, access to the axial and azimuthal heat fluxes contribute to the understanding of passive scalar transport as well as heat transfer processes.

*KTH Mechanics, SE-100 44 Stockholm, Sweden.
[1]Facciolo, *TeknL thesis, KTH Mechanics*, (2003).

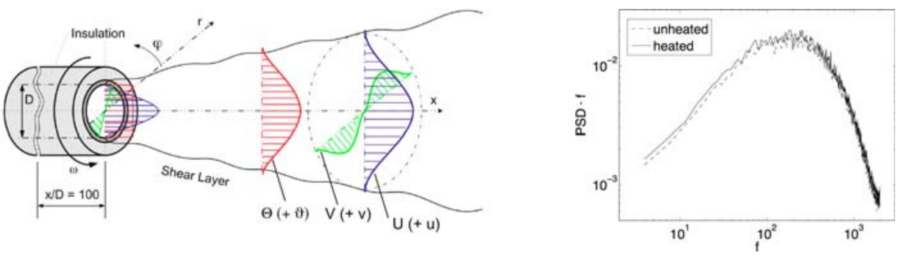

Figure 1: (a) Definition of physical quantities (b) Axial velocity spectrum for the unheated and heated jet at Re=24000 and S=0.5.