Paper 11.4

Characterisation of confinement and impingement effects on the near field of axisymmetric jets using LDA and PIV

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ABSTRACT

Laser Doppler Anemometry and Particle Image Velocimetry are applied to a domestic burner configuration to determine the effect of geometrical parameters and gas density on the flow field and on the entrainment process. The flow field is that of a confined jet impinging onto a plate. The main design parameters of the experimental devices may be adjusted to modify the confinement ratio and the distance from the outer section of the injector to the stagnation plate. The impinging distance is known to influence the structure of the flow field, mostly when the stagnation plate is in the near field region of the jet. Two density ratios were studied: an isodensity ($R_r = 1$) and a light jet ($R_r = 0.55$). The two nominal flow rates were investigated, associated with low Reynolds turbulent jets and laminar jets. A totally transparent new device was manufactured in quartz. This new device presents greater optical accesses for PIV measurements inside the burner. Several configurations were investigated for the different gases and impinging distances: free jets, confined jets, impinging jets, and confined impinging jets (whole burner configurations).

The results concentrate on the jet development and the dynamic field in the vicinity of the stagnation point. The structure of the flow field was investigated in terms of 2D dynamic fields, axial and radial profiles of velocity. A new derivation method for intercorrelation (Hart) is compared with classic FFT intercorrelation, bringing better resolution in the zones of highest velocity gradients. To guarantee high accuracy of the measurements for the whole flow field, two sets of experiments had to be conducted, with two different PIV pulse delay values: one to match the higher velocities encountered in the jet part and the other the lower velocities encountered in the entrainment part. The flow field consists in a combination of these two sets of experiments. The radial jets profiles allow to deduce the entrained air flow rate, against the distance of the stagnation plate as a function of the density ratio. The amount of air entrained by the jet is linked to the density ratio, the length of jet development and also to the pressure gradient due to the impact on the plate. An analysis of the mixture fraction distribution using planar LIF images is in progress