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Spectral analysis to study the mixing layer in coaxial jets with different density

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The axis-symmetric mixing layer between two vertical flows of air in the transition zone to turbulence under the effects of buoyancy has been studied experimentally. The objective of this work is to determine the mechanisms that favour or disable the mixture between two currents of air by the study in the zone close to the exit from a pipe and its transition to the completely developed turbulence. It has been performed an experiment model that simulate as a warm gas come to the atmosphere from a chimney. The work have to parts in its performance, the first one it is studied the development of the mixing layer on natural flow conditions, i. e., with not external disturbances of any kind. In the second one part, by using the visualization technology, which allows to study a disturbed flow in order to know the dynamics of the coherent structures between both currents. It has been designed an experimental installation to allow quantitative tests with Laser Doppler Anemometry (LDA) and tests of visualization, for both isotherm flows as buoyancy flows. We have considered six different cases under instability. For each every case, the average axial speed has been measured at the centre of the flow at six dimensionless distances (z/D) downstream. We observed that for Ri larger or equal to 0.7 a strong convective acceleration exists in the primary flow from the exit plane of the pipe which leads a significant ingestion of air of the secondary flow. This is determinant in the development of the mixing layer into the study zone. For Ri = 1.53 average axial speed profiles have been obtained, showing a clearly parabolic behaviour, and so the mean velocity decreases quickly from the centre of the pipe as we move away in the transverse direction. The instability frequencies of the configuration have been determined by means of turbulent kinetic energy spectra, calculated for different positions in each profile and for different heights in the direction

of the flow. Just a clearly defined peak appears within the frequency interval between 10 and 30 Hz. In none of the cases the spectrum slope follows the ‘inertial subrange’ law of Kolmogorov, therefore confirming that there is no developed turbulence in the studied area. For Richardson numbers higher than 0.7, on the exit plane a frequency of 25 Hz appears, decreasing quickly as we move downstream until around 14 Hz. Nevertheless, the frequencies found for Ri <0.7 coincide with the results obtained for the homogeneous flow. Therefore, the value of Ri 0.7 marks the limit for different flow behaviour. In addition, although for a moderate intensity of the exciting signal the frequency of 14 and 25Hz provide a similar flow structure, it is stated that smaller disturbance intensity is needed for 14Hz, in order to cause a flow alteration to help the mixture between both currents. This fact confirms that the natural frequency of the analysed configuration is close to 14 Hz, because the strong convective acceleration of the flow lengthens the structures.