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On the Structure and Mixing of a Jet in Crossflow

Ph.D. Thesis

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Abstract

In the current thesis a comparison is made between the mixing and structure of two forms of transverse jet. The configurations investigated were the elevated jet and the flush-mounted jet. These cases shared identical flow conditions so that the difference lay in the presence or absence of a flat wall adjacent to the jet exit. Although the elevated case of the transverse jet occurs in many industrial applications it has received far less attention than the flush-mounted jet. In addition, a detailed comparison of the mixing and structures of the two flows had not been previously attempted. Volumetric flow measurement techniques and dye visualisation were used to investigate the differences between the two flow cases. The volume techniques allowed the mean three-dimensional concentration field and instantaneous flow structures to be captured and analysed on various planes within the flow.

The most significant finding from the study was that the elevated jet forms one of two distinct structures based on the velocity ratio and Reynolds number of the flow. At lower velocity ratios and Reynolds numbers the elevated jet structure is substantially different to a flush-mounted jet at the same flow conditions. As the Reynolds number or velocity ratio is increased the elevated jet undergoes a transition, and evolves into a flow that appears very similar to the flush-mounted jet at the same flow conditions. The difference in structure of the elevated jet affects both the characteristics of the jet (i.e. trajectory, lateral spreading) as well as the mixing. The interaction of the wall boundary layer circulation and the leading edge jet shear was also investigated, in addition to which the mechanism by which the jet shear layer roll-up occurs has been clarified.

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