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NUMERICAL MODELLING OF HIGHLY COMPLEX FLOWS

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This paper presents a computational study of a single jet impinging on a flat plate through the influence of a low velocity crossflow. The purpose of this study is to quantify the relative influence of numerical and modeling sources of errors of a computational method based on the solution of the time-averaged Navier-Stokes equations and the standard "k-ε" turbulence model.

The accuracy of the discretization of the convection terms is quantified for first and second order numerical schemes. Additionally, the ability of the model calculations to simulate both the mean and the turbulence fields is examined, particularly in the high curvature zone near the stagnation point. The magnitude of each term of the momentum and turbulent kinetic energy is analyzed and detail. The computed results are compared with experimental data for the case of a single jet impinging on a flat plate located at 5 jet diameters from the jet exit and a velocity ratio between the jet and the crossflow of 30.

The shear layer surrounding the impinging jets and the impingement zone are characterized by intense velocity fluctuations with maximum values coincident with the highest mean velocity gradients. The distribution of the shear stress is consistent with that of the shear strain in the sense of a gradient diffusion hypothesis with exception of the impingement zone, which is dominated by strong stabilizing curvature effects. The use of high order methods to describe the convection terms improves considerably the numerical simulation of the flowfield. In the impingement zone, however, the shear stress is not predicted correctly and this is independent of numerical influences. The corresponding effect on the simulation of the mean velocity field is not significant, because the flow is dominated by strong pressure gradients.