A 3-D Numerical Study of Fluid Flow and Heat Transfer of Multiple Laminar Jets in Crossflow

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Abstract:
In this study, a three dimensional computer code based on the so called SIMPLE algorithm (which stands for Semi-Implicit Method for Pressure-Linked Equations) developed by McGill University-Montréal-Canada is used for the numerical solution of a laminar fluid flow and heat transfer of impinging four jets in the presence of crossflow with constant temperature boundary condition on the impingement surface. The governing equations solved by the computer code are the continuity equation, three components of the momentum equation and the energy equation. The finite volume method is adopted for the discretisation of the governing equation. In the computer program, the finite difference equations are solved via the primitive pressure-velocity approach where the hybrid difference scheme, which is a combination of the central and upwind differences, is used to represent the convective and diffusive fluxes over the control volume surfaces. The results obtained show that in general, for multiple jets, the induced and imposed crossflow have significant effects on both the flow and temperature fields near the impingement surface. A strong crossflow deflects the jet and prevents it from impinging on the surface resulting in lower heat transfer rates and hence lower temperatures difference.The results also show that reducing the jet separation distances causes an increase of the temperature of the flow, and hence better cooling of impingement surface.