

# *Diffusion of Heat and Circulation in Potential Flow Convection*

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*Communicated by G. TEMPLE*

**Summary.** A study is made of the diffusion of a scalar quantity, such as heat or circulation, in a standardized convection field which describes a potential flow past any two-dimensional, finite or semi-infinite body. The problem is of some interest in that it provides the start of an iterative description of the vorticity field in the outer region of a real incompressible viscous flow.

The potential flow field outside the streamline which divides at the body is first mapped onto a stagnation point flow in a half-plane. The temperature field of a unit point source of heat arbitrarily placed in this potential flow is then found by means of a double Fourier transform. Properties of the incomplete Bessel functions which arise in this solution are investigated and series representations of the source field are obtained in terms of a suitable collection of multipole fields. Separable solutions in cartesian coordinates provide a representation in terms of fields produced by a complete set of source or dipole distributions along a line parallel to the real axis. These separable solutions permit the construction of the vorticity field outside of the dividing streamline, if the vorticity distribution on it is known downstream of its point of attachment.

**1. Introduction.** It has been known since at least the days of Helmholtz that the two-dimensional motion of an incompressible viscous fluid can be described kinematically entirely in terms of volume conservation and the diffusion and convection of circulation. In the absence of non-conservative forces, the circulation is produced entirely by surface tractions at the boundaries of the fluid. The difficulty in the analysis of course has been the self-convection of the diffused circulation.

When the diffusing quantity is heat rather than circulation, the non-linearity can be formally removed from the diffusion-convection equation for the temperature, if the velocity is regarded as prescribed. Even so, surprisingly little is known about diffusion in convection fields which are not irrotational. For steady, forced, irrotational flow past a heated, two-dimensional, body,