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Simulation of source-sink flows in a rotating fluid annulus

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The source-sink flow between porous walls of a rapidly rotating annular container has been simulated using the Nuclear Electric finite element code FEAT. In this system Stewartson boundary-layers form on surfaces parallel to the rotation axis when the Rossby number is small enough to neglect inertial effects. At larger Rossby numbers analytical studies (Hide 1968 and Bennetts & Hocking 1973) indicate that the Stewartson layers are modified by inertial effects, becoming thicker at the source wall and thinner on the sink wall. The source layer solution has been supported by laboratory measurements (Hide 1968). Limited numerical simulations (Bennetts & Jackson 1974) allowed comparison between the analytic and numerical solutions at one rotation rate. The current simulations have extended the work to include extensive comparisons with the analytical studies and measurements. Additionally, the effects of changes in rotation rate (from 0.5 - 1.5 rad.sec^{-1}) and geometry have been simulated and compared with the analytical solutions. The results confirm the general form of the theoretical work, although Hide's (1968) solution gives better agreement with the simulations than Bennetts and Hocking's (1973). A further finding is that even at the smallest Rossby numbers covered, the source layer remains thicker than the sink layer, a result not predicted by the analytical solutions.

(200 words)

References

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