Hydrodynamic free shear layers in a rotating saturated porous medium

Gudluru Ramadevi and Satyanarayana Badeti

ABSTRACT

The hydrodynamic free shear layers which occur in a linear, steady axisymmetric flow of a homogeneous fluid in a rotating porous medium confined between differentially rotating parallel plates are investigated using a combination of integral transforms and boundary layer techniques. The results are agreed with those of an earlier paper by Vempaty and Sundaram [1], where in the hydrodynamics in a closed, confined, rotating porous medium are investigated. As the rotational Darcy number $\frac{1}{N} = \frac{\mu}{\kappa\rho\Omega}$ increases beyond $\mathrm{O}(\mathrm{E}^{1/2})$, where $E = \frac{\mu}{\rho L^2 \Omega}$ is the Ekman number, the flow structure is significantly altered from the pure hydrodynamic case. The interior region is characterised by an azimuthal velocity which is less than O(1). As a result, it becomes a z-dependent structure. The outer Stewartson layer $(NE)^{1/2}$ becomes weak and $E^{1/3}$ layer alone supports the mass flux. For $E^{1/3} << \frac{1}{N} << o(1)$, the $E^{1/3}$ layer becomes inviscid $\frac{1}{N}$ layer to carry the mass flux. All these results are reminiscent of the hydromagnetic flow in a rotating system with magnetic field perpendicular to the vertical shear layer and rotating vector [2].

REFERENCES

1. S. Vempaty and V. Sundaram, Linear hydrodynamic flow in a rotating saturated porous medium, Proc. Ind. Acad. Sci. (Math Sci.) 101, 127–141 (1991).
2. Rainer Hollerbach (1996) Magnetohydrodynamic shear layers in a rapidly rotating plane layer, Geophysical & Astrophysical Fluid Dynamics, 82:3-4, 237-253.