Abstract Submitted
for the DFD15 Meeting of
The American Physical Society

Oscillatory flow past a slip cylindrical inclusion embedded in a Brinkman medium D. PALANIAPPAN, Department of Mathematics & Statistics, Texas A&M University - Corpus Christi — Transient flow past a circular cylinder embedded in a porous medium is studied based on Brinkman model with Navier slip conditions. Closed form analytic solution for the stream-function describing slow oscillatory flow around a solid cylindrical inclusion is obtained in the limit of low-Reynolds-number. The key parameters such as the frequency of oscillation λ, the permeability constant δ, and the slip coefficient ξ dictate the flow fields and physical quantities in the entire flow domain. Asymptotic steady-state analysis when $\delta \to 0$ reveals the paradoxical behavior detected by Stokes. Local streamlines for small times demonstrate interesting flow patterns. Rapid transitions including flow separations and eddies are observed far away from the solid inclusion. Analytic expressions for the wall shear stress and the force acting on the cylinder are computed and compared with existing results. It is noted that the slip parameter in the range $0 \leq \xi \leq 0.5$ has a significant effect in reducing the stress and force. In the limit of large permeability, Darcy (potential) flow is recovered outside a boundary layer. The results are of some interest in predicting maximum wall stress and pressure drop associated with biological models in fibrous media.

D. Palaniappan
Texas A&M University - Corpus Christi

Date submitted: 31 Jul 2015 Electronic form version 1.4