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Cross-stream migration of non-spherical particles in a general second-order fluid flows[1] SHIYAN WANG, CHENG-WEI TAI, VIVEK NARSIMHAN, Purdue University — We have developed a theory to investigate the cross-stream migration of ellipsoids in a weakly viscoelastic fluid under various pressure-driven flow profiles (circular tube flows and slit flows). The viscoelastic fluid we investigate is a general second-order fluid characterized by Weissenberg number Wi= $\psi 1\ \gamma/\mu$ and constant $\alpha = \psi 2/\psi 1$, where the first and second normal stress coefficients are $\psi 1$ and $\psi 2$, γ is the characteristic shear rate of the flow, and μ is the total viscosity. Considering the limit of weakly viscoelastic flow (Wi$\ll$1), we use perturbation theory and the reciprocal theorem to derive both the polymeric force and torque on a particle to O(Wi). Our theory is valid for an ellipsoid in any quadratic flow field, and have validated the theory for three cases: (a) sedimentation of a general ellipsoid in a second order fluid, (b) particle migration of a sphere in a pressure driven flow, and (c) particle migration of an ellipsoid in a pressure driven flow under the co-rotational limit (α = -1/2). After verification, we use our theory to compute how the first and second normal stresses affect the motion of a particle to towards the center of pressure driven flows, and discuss the orientation dynamics. Scaling results are presented for the particle migration speed.

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