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Theoretical Study of Moving Magnetic Beads on an Inclined Plane and its Application in the Ratchet Separation Technique

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Abstract

For first time, motion of a magnetic bead ascending an inclined surface is investigated. The translational and rotational velocities of magnetic beads traveling on an inclined plane in the creeping flow regime are studied. The governing equations considering lift force and magnetic torque are obtained. Rolling and slipping cases are studied in detail. It is shown that the lift force effect is critical for large values of sedimentation Reynolds number (Res) and negligible for small values of Res. This method is applicable for neutrally buoyant and heavy magnetic bead motion. Practical application of this study is implemented in the ratchet configuration for separation of magnetic beads with different sizes. This is applicable for novel applications such as drug delivery, magnetic tweezers, and magnetic actuated stiffness testing systems which require accurate magnetic bead sizes for accurate function.

Keywords: Magnetic bead; Ratchet separation technique; Creeping flow; Reynolds number; Sedimentation