An Application of Dean's Flow in Spiral Micro Channels for Particle Isolation

Nandigala, Vipul

Although simple at macro meter scales, the separation of particles inside of fluids has long been a difficult task at sizes under 200 micrometers. Various methods for such separation have been attempted but have suffered from low efficiency rates and high costs due to the viscous forces of fluids overpowering all other forces at these small scales. This paper proposes a practical solution to not only separate particles but also to isolate them individually with an efficiency rate of nearly eighty percent. By forcing fluids through spiral micro channels instead of the conventional linear channels, a prominent force called the Dean's force comes into effect. The Dean's flow, being a direct result of the inertial velocity difference caused by the curvature of the channel, creates two synchronous co-rotating vortices inside the channel. With the combination of these unique vortex flows and a "lift force" that has also been engineered, it is possible to force particles into an equilibrium point where they experience no net force. This allows particles to concentrate in a specific region of the channel in an orderly and high efficient fashion. After ordering, the fluid and suspended particles were then sliced into droplets by a transverse drop splitter. By equating the distance between particles to the frequency of droplet formation, a system was created that allowed each droplet to contain exactly one particle. Fine adjustments were constantly made to the fluid velocity, fluid viscosity, fluid density, particle density, particle size, channel dimensions, and channel shape in order to optimize the isolation process.

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