Effect of the Apex Angle of a Triangular-Shaped Vibrating Structure on Acoustic Streaming

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Acoustic streaming (AS) is generated by an acoustic field in a fluid and is capable of creating a specific flow pattern and a jet. We investigated the characteristics of AS produced by the vibration of triangles by using simulation and experiment. Thermoviscous equations and Navier-Stokes equations were employed for the numerical simulation, while the experiment was conducted using the PIV technique. From the simulation and experiment results, we found the alternation of the jet's direction. Specifically, the jet changes its direction from outward to inward as the apex angle becomes bigger, which wasn't predictable in the prior research. Moreover, the lateral jet is observed in the AS from a triangle with a large apex angle. In addition, the number of vortices as well as the streaming velocity were affected by the apex angle of the triangles. The mechanism for the jet's direction alternation and emergence of the lateral jet were investigated and explained using body force analysis. Specifically, body force due to acoustic field and viscous force were compared at various apex angles, showing an overriding of force as the apex angle approached its small and large limit. Furthermore, the relationship between the magnitude and direction of the AS and the geometry yields convenience in the modeling and development of microfluidic devices, where precision is crucial, providing an application in circulating, mixing, and trapping microparticles.

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