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USE OF SURFACE VIBRATION FOR RESISTANCE REDUCTION IN PARALLEL MOVEMENT OF PLATES

Nafisha Nubayaatt Haq[1*] and J.M. Floryan [2]
[1,2]Department of Mechanical & Materials Engineering, The University of Western Ontario,
London, Ontario, Canada, N6A 5B9
*nhaq6@uwo.ca

ABSTRACT

The effects of plate vibrations on the external force required to maintain relative movement of parallel plates has been explored using a two-dimensional model problem. Surface roughness increases the overall resistance that this force needs to overcome. Wall vibrations are introduced to investigate if the driving force can be reduced. The main motivation behind this research is the determination of strategies which could be used for lowering of this resistance and, thus, lowering the energy cost associated with transportation. Vibrations in the form of travelling waves induced along the lower plate lead to progressive area of contractions and expansions which propagate in the streamwise direction creating peristaltic pumping effect. The main objective of this work is to quantify potential for reduction of the driving force due to utilization of this effect. The flow problem represents an unsteady moving boundary problem due to the plate movements. Use of the Galilean transformation reduces this problem to a fixed boundary problem with an irregular boundary shape dictated by the wave form, which is solved with spectral accuracy using the Immersed Boundary Conditions method. This is a gridless algorithm which provides means for analysis of a wide range of wave shapes with a significant reduction of manual labor required by typical grid-based algorithms. Its efficient implementation relying on specialized linear solvers provides basis for fast and accurate analysis of multiple geometries using desktop computers and can lead to shape optimization. As energy needs to be expanded for creation of vibrations, concept considered in this work can be viewed as an alternative propulsion method where the classical propulsion is assisted by boundary vibrations.