Junggul Lee
Konkuk University
e-mail: jack9872@konkuk.ac.kr
Eunok Jung
Konkuk University
e-mail: junge@konkuk.ac.kr
Do-Wan Kim
Inha University
e-mail: dokim@inha.ac.kr

An Open Tank System of Valveless Pumping

We present a mathematical model of flows driven by periodic pumping without valves (valveless pumping) in an open tank system. The model consists of a cylindrical elastic closed tube with two open tanks under gravity. The two dimensional elastic tube is constructed based on the immersed boundary method and the tank model is governed by a system of ordinary differential equations based on the law of conservation of energy. We have observed the difference of fluid heights in the tanks by the periodic compress-and-release action that is applied to an asymmetric region of the elastic tube. As the previous research on the open systems of valveless pumping, we have also observed that the direction and magnitude of a net flow in our open tank system are determined sensitively by the driving frequency and the compression duration. We are able to explain the occurrence of local maximum or minimum mean flows (difference of tank heights) due to the resonances of the system.

References

[1] Y. Kim, W. Lee, and E. Jung, *An immersed boundary heart model coupled with a multicompartment lumped model of the circulatory system* SIAM J. Sci. Comput. **32** 1809–1831.
[2] C. S. Peskin and B. F. Printz *Improved volume conservation in the computation of flows with immersed elastic boundaries* J. Comput. Phys. **105** 33–46.
[3] E. Jung and C.S. Peskin *Two-dimensional simulations of valveless pumping using the immersed boundary method* SIAM J. Sci. Comput. **23** 19-–45.
[4] K. M. Arthurs, L. C. Moore, C. S. Peskin, E. B. Pitman and H. E. Layton *Modeling arteriolar flow and mass transport using the immersed boundary method* J. Comput. Phys. *147* 402–440.
[5] R. P. Beyer *A computational model of the cochlea using the immersed boundary method* J. Comput. Phys. *98* 145—162.
[6] D. M. McQueen, C. S. Peskin, and E. L. Yellin *Fluid dynamics of the mitral valve: Physiological aspects of a mathematical model* Amer. J. Physiol. **242** H1095—H1110.
[7] G. Liebau *Die Bedeutung der Tragheitskrafte für die Dynamik des Blutkreislaufs* Zs. Kreislaufforschung **46** 428—438.
[8] J. S. Hansen and J. T. Ottesen *Molecular dynamics simulations of oscillatory flows in microfluidic channels* Microfluid. Nanofluid. **2** 301-–307.