Simulation and Parametric Study of a PDMS Based Valveless Micropump Using FSI Approach

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Introduction: Simulation and parametric study of a PDMS valveless micropump using Fluid-Structure Interaction (FSI) approach is presented. The simulation for the valveless micropump are carried out in COMSOL Multiphysics. To improve the flow rate of the valveless micropump, some important diffuser/nozzle parameters, such as the diffuser length, the diffuser angle, and the neck width, should be optimized.

Results:

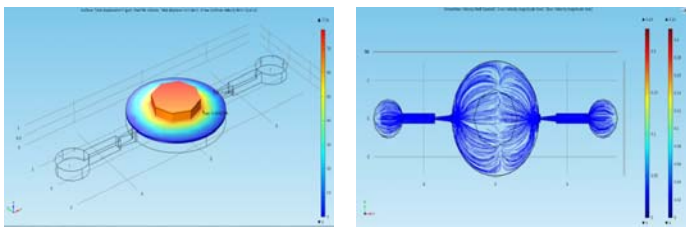

Figure 1. (a) Total Displacement of Diaphragm (b) Streamline velocity contours inside the chamber of micropump

Optimization of Divergence Angle and Diffuser Length

It is observed that the net flow rate is maximum at divergence angle 10°. At smaller values of divergence angle, the rectification efficiency is low and thus the net flow rate increases with increase in divergence angle. It was also observed that net flow rate is higher at 1.1 mm diffuser length and lower at 1.5 mm.

The flow rate becomes maximum for the neck width of 100 µm and minimum for the neck width of 150 µm. At lower value of neck width, the net flow rate is found to be less which may be due to 'clogging effect'. A higher value of neck width provides lower flow rectification and thus the net flow rate decreases.

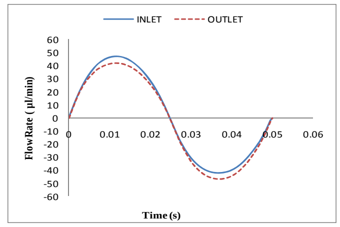

Figure 2. Flow low rate through the inlet and outlet a function of time

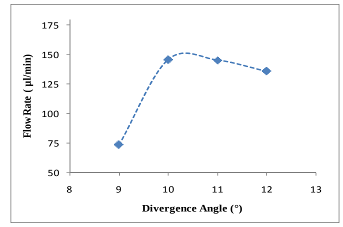

Figure 3. Net flow rate vs. divergence angle

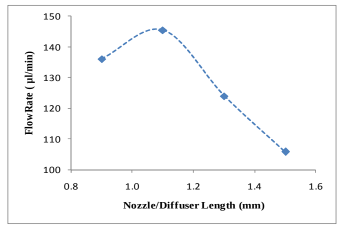

Figure 4. Net flow rate vs. nozzle/diffuser length

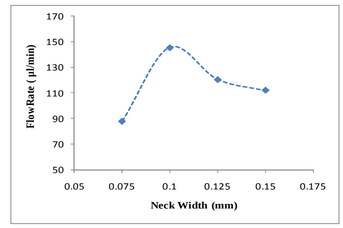

Figure 5. Net flow rate vs. neck width.

Conclusions:

The net flow rate is maximum at divergence angle 10° . At smaller values of divergence angle, the rectification efficiency is low and thus the net flow rate increases with increase in divergence angle. Also at higher values divergence angles, the net flow rate decreases due to possibility of flow separation. Thus the net flow rate is higher at 1.1 mm diffuser length and lower at 1.5 mm.

References:

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Excerpt from the Proceedings of the 2015 COMSOL Conference in Pune