Introduction: The MEMS based positive displacement Insulin Micro-Pump has a Piezoelectric Actuator on top of a Diaphragm membrane made from Silicone glass. Induced vibrations from PZT actuator create positive/negative volume in the pump’s main chamber, which pull fluid from Inlet gate and push it toward outlet gate with the action of check valves.

Computational Methods: Three COMSOL modules; Structural Mechanic, Piezoelectric Device and Fluid-Structure Interaction were used to study the 2-D/3-D models of Micro-Pump. Moving fluid-mesh follows solid deformation. The fluid flow is described by the Navier-Stokes equations with laminar incompressible Newtonian flow and free boundaries at the inlet and outlet:

$$\frac{\partial \mathbf{u}}{\partial t} + \mathbf{u} \cdot \nabla \mathbf{u} = -\nabla p + \nabla \cdot \mu (\nabla \mathbf{u} + (\nabla \mathbf{u})^T)$$

$$\nabla \cdot \mathbf{u} = 0$$

Figure 2 represents a 2-D layout of the Micro-Pump.

Results: The Micro-Pump COMSOL model used to study the behavior of this pump for different input voltages (10 to 110 volt) with different input exciting frequencies (1 to 3 Hz). Figures 3 to 6 show some of the performance outputs @ V=110 Volt and Frequency = 1 Hz.

Conclusions: A parametric computational model of MEMS based Insulin Micro-Pump was developed, using COMSOL Multiphysics. It was used to study the pump performance under different inputs. The design seems acceptable for application of Insulin injection. Micro-Pump performs correctly from the Min to Max spectrum of pressure and flow rates.

References: