Numeric Analyses of an Electroosmotic Flow in Capillaries

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In the last decades, the topic of microfluidic Electroosmotic Pumps (EOP) gained the attention of scientists all over the world. One of the greatest advantages of the Electroosmotic Pumps is the fact, that there are no moving parts. EOPs generate a continuous, bi-directional, impulse-free stream of electrolyte fluids.

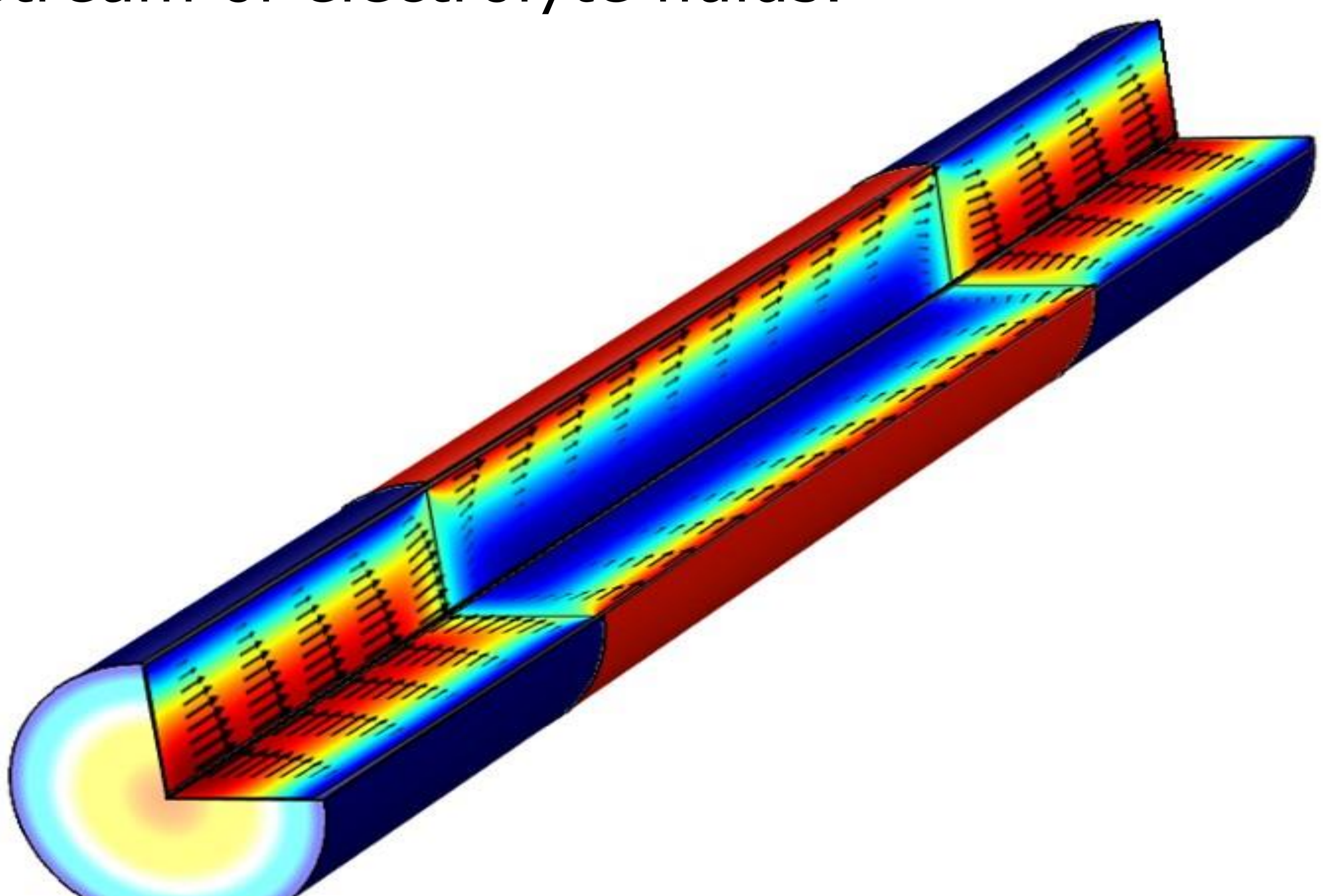


Figure 1. Flow in an EOP

An Electroosmotic Flow (EOF) is the flow in a capillary, which is induced by an electric field and a charged capillary wall. Creating a constant balance, the cations of the electrolyte move nearby the capillary wall.

This effect causes the forming of a double layer which produces a potential difference. The electric field pulls the cations of the diffuse double layer straight to the cathode. The impulse of the cations diffuses through the fluid. So the Electroosmotic Pump transports the electrolytes from the anode to the cathode.

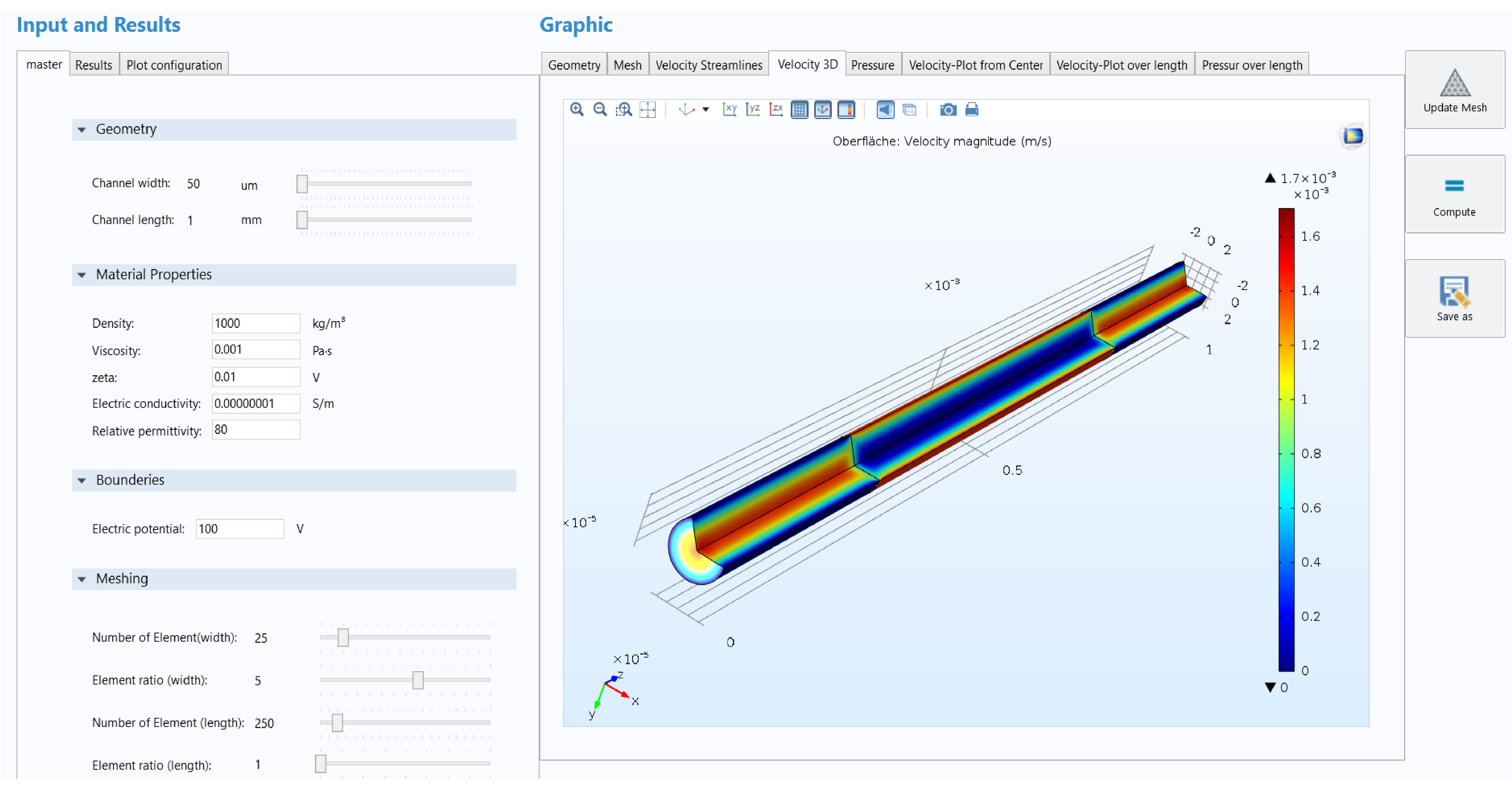


Figure 2. Application Overview

Different parameter studies were performed. This was done with the COMSOL Application Builder. The created App is shown in Fig. 2.

One of the results is, that a smaller capillary leads to higher pressure (Fig. 3).

High pressure differences cause a better efficiency rate of the flow (Fig. 4).

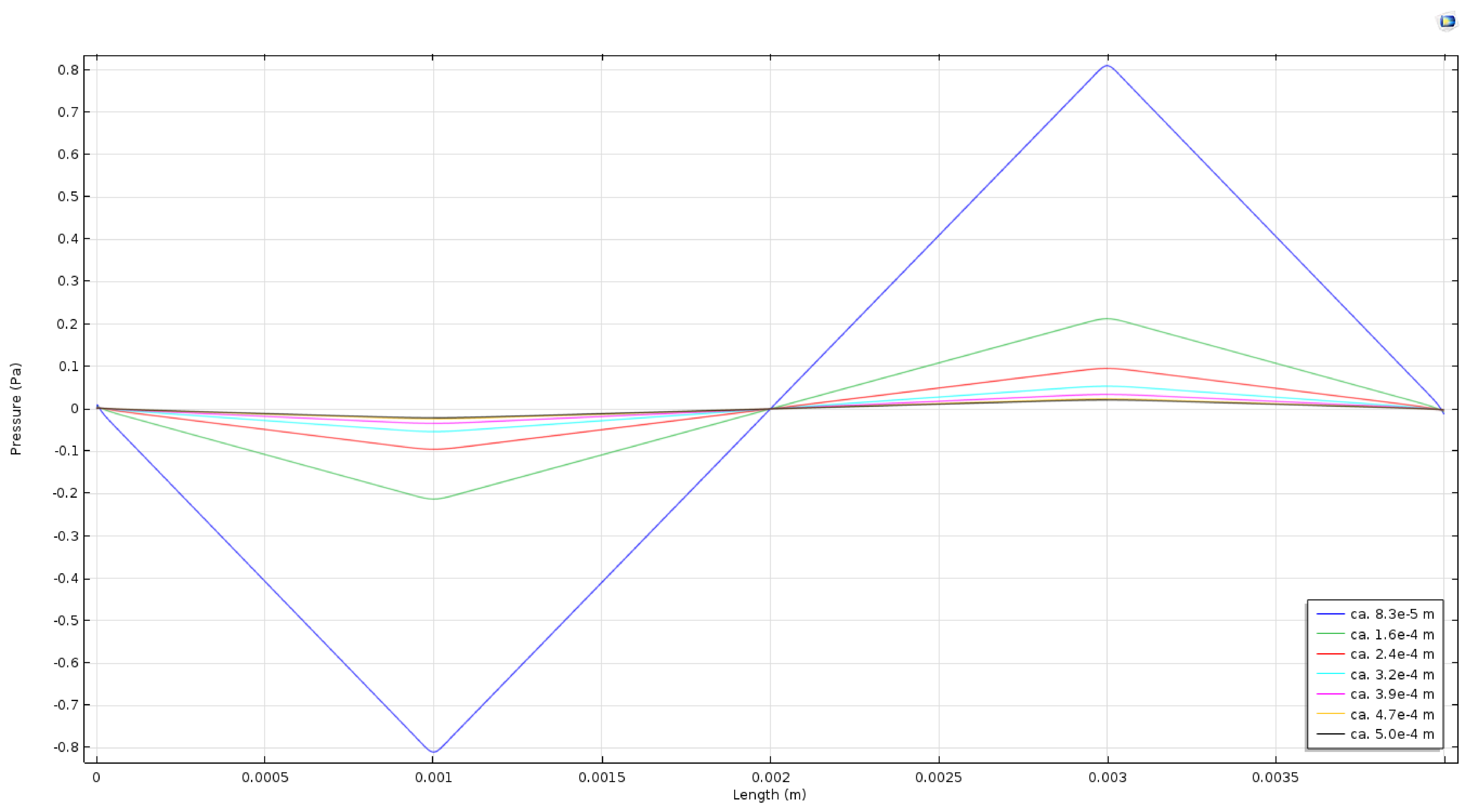
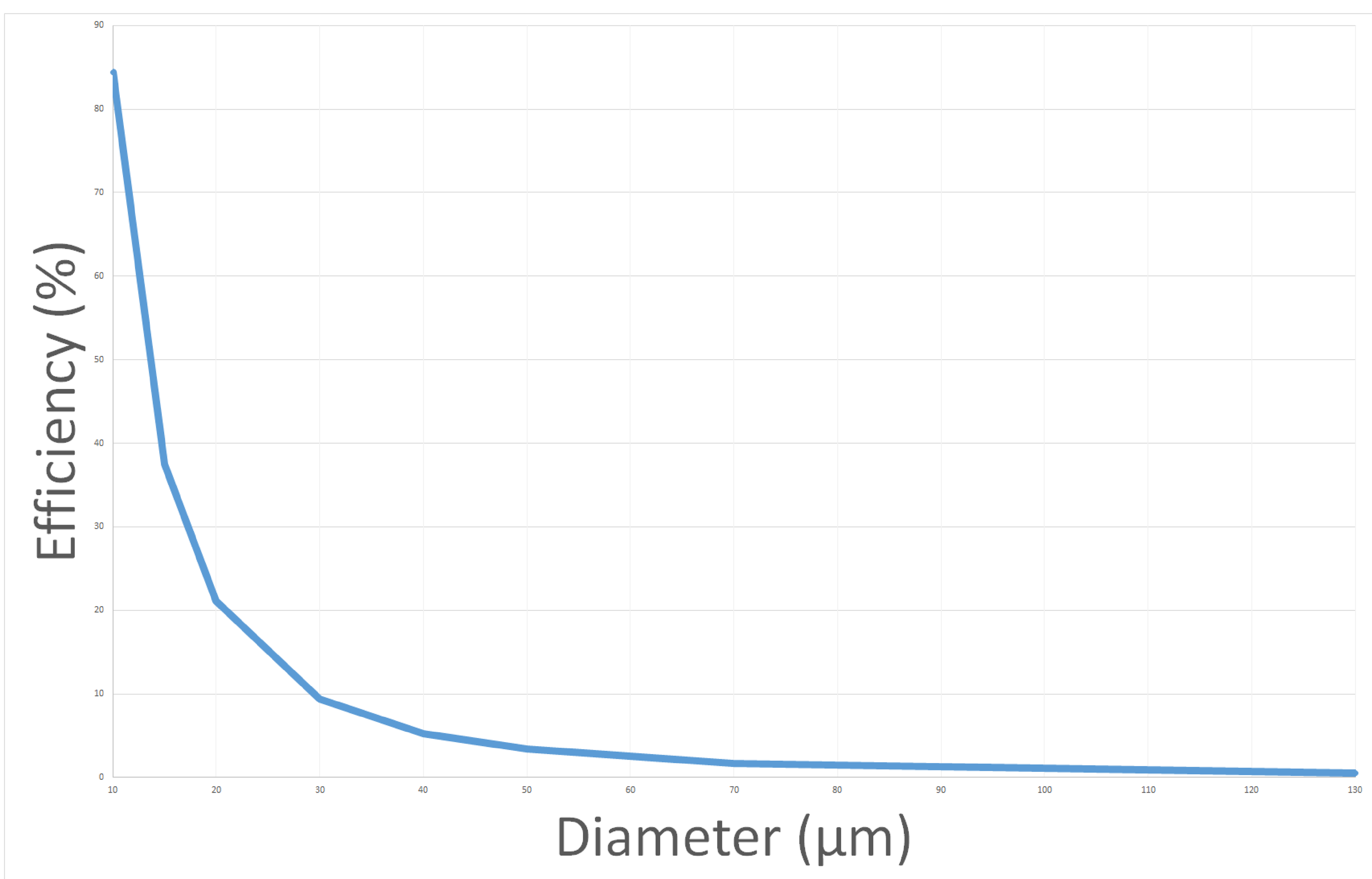


Figure 3: Diameter vs. Pressure



$$\eta = \frac{P_{out}}{P_{in}} = \frac{\int v\, ds \, * \, \Delta p}{\int J\, ds \, * \, U} = \frac{\dot{V} * \Delta p}{I * U}$$

Figure 4. Diameter vs. efficiency rate

The results show a non-linear influence of the geometry on the pressure. For an optimized efficiency the geometry configuration should be investigated further. The simplified model includes no losses. For a complete and correct model it is necessary to implement an equation for the fluid friction.

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