Supplementary Material (ESI) for Lab on a Chip

In the incompressible and compressible cases we have the following pressure distributions, respectively

$$p_{incompressible} = p_i + (p_e - p_i)X/L$$
$$p_{compressible} = [p_i^2 + (p_e^2 - p_i^2)X/L]^{1/2} \qquad (*)$$

where L is the channel length, p_i the higher pressure at the entrance, and p_e the lower pressure at the exit (atmospheric). The above expressions (*) are plotted in Fig. I (where y stands for p and x for X/L). There are definitely deviations from linearity due to air compressibility, however, in this pressure range these deviations are not large.

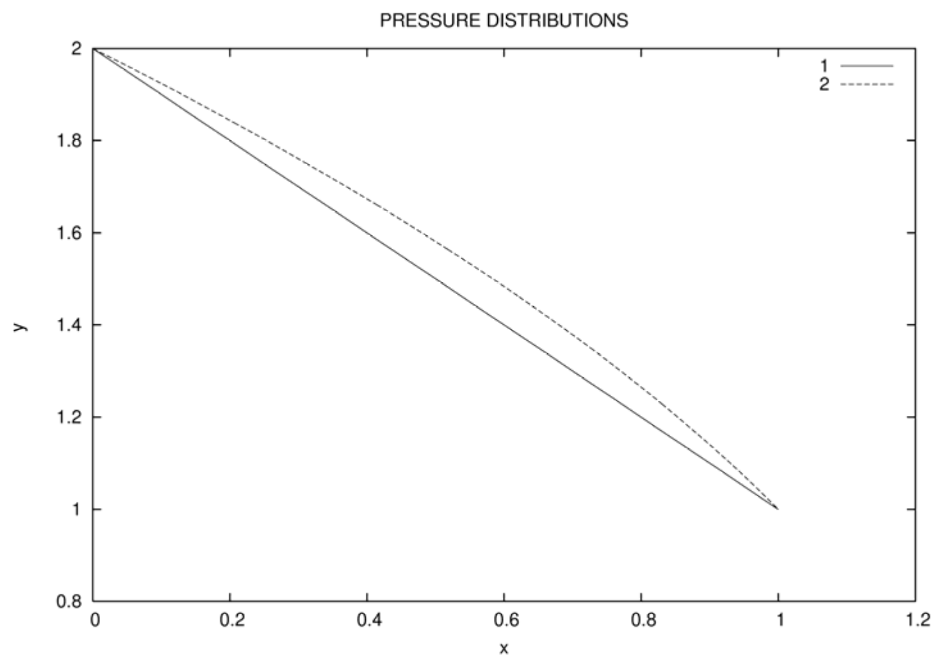

Fig. I: Pressure distribution p versus dimensionless axial coordinate (X/L). For this graph, we took a pressure drop $\Delta p = p_i - p_e = 1$ bar. The solid line (curve 1) depicts the linear distribution $p_{incompressible}$ in expression (*), while the dashed line (curve 2) shows the nonlinear distribution $p_{compressible}$ in (*).

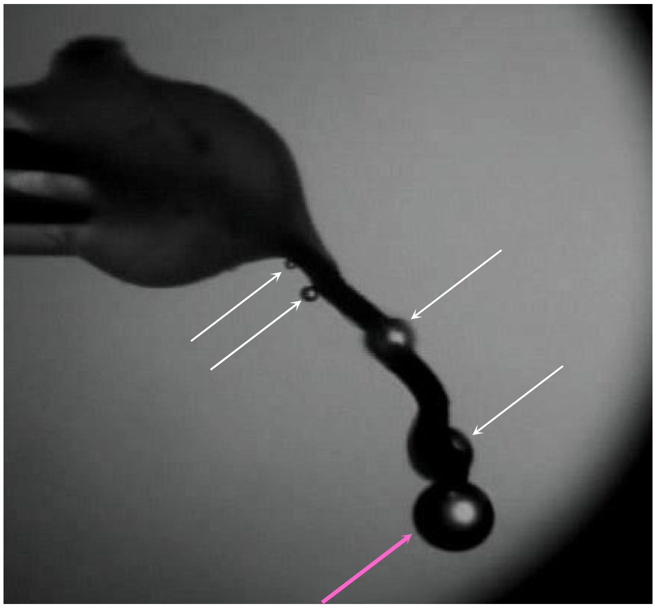

Fig. II: Optical microscope image showing the presence of multiple bubbles at different lateral locations of the tube bundle. The colored arrow shows the tip bubble, while the white arrows mark other secondary bubbles, whose contribution to the overall flow rate was not quantifiable. Such secondary air bubbles emerged only at high pressures (above 2 bar). These bubbles resulted in an underestimate of Q at high pressures.