Electronic Supplementary Material (ESI) for Soft Matter.

Supporting Material for Clog mitigation in a microfluidic array via pulsatile flows

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Particle size distribution

The colloidal suspension used in this study consist in carboxylate-modified latex beads purchased from Invitrogen. Each suspension is filtered through an 8 μm track-etched membrane filter (Whatman Nuclepore) directly before experiments. This eliminates particles and aggregates which would immediately clog the array through sieving. The particle size distribution is shown in figure 1.

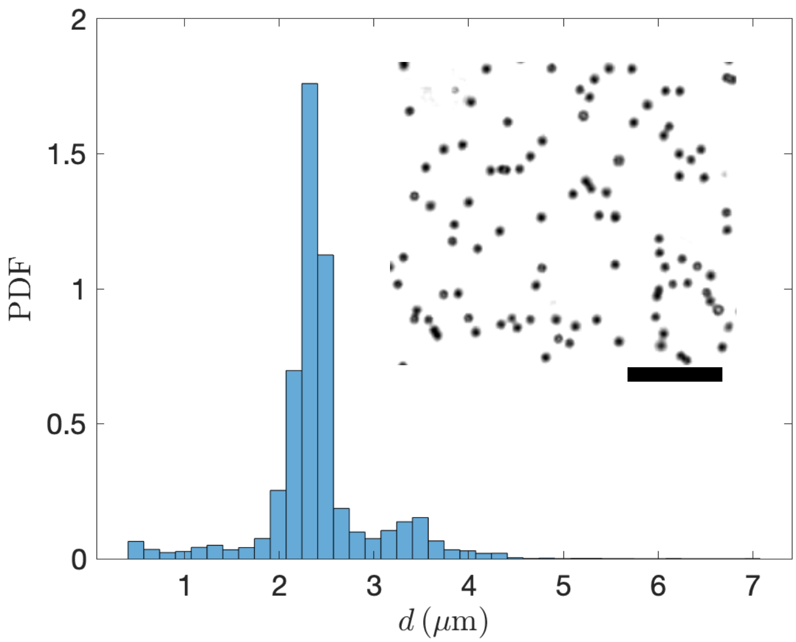

Figure 1: Size distribution of the colloidal particles after filtration. The mean diameter of the particles is 2.4±0.56 μm Inset: Picture of the particles. Scale bar is 20 μm.

Frequency and amplitude limits for this system

The pressure-driven flow is generated using an Elveflow OB1 system and the flow rate is measured using a microfluidic Coriolis flow sensor (Elveflow). We tested the system frequency limitation, *i.e.*, the maximum frequency at which the flow rate still follows the time-varying pressure. An example of these tests is shown in figure 2. At $f = 0.1$ Hz, the normalized flow rate follows the normalized pressure, with a small phase shift. At higher frequencies, the maximum flow rate is not achieved, and the phase shift increases. At 2 Hz, the flow response is nearly steady. Therefore, 0.1 Hz was chosen as the upper frequency limit for this system.

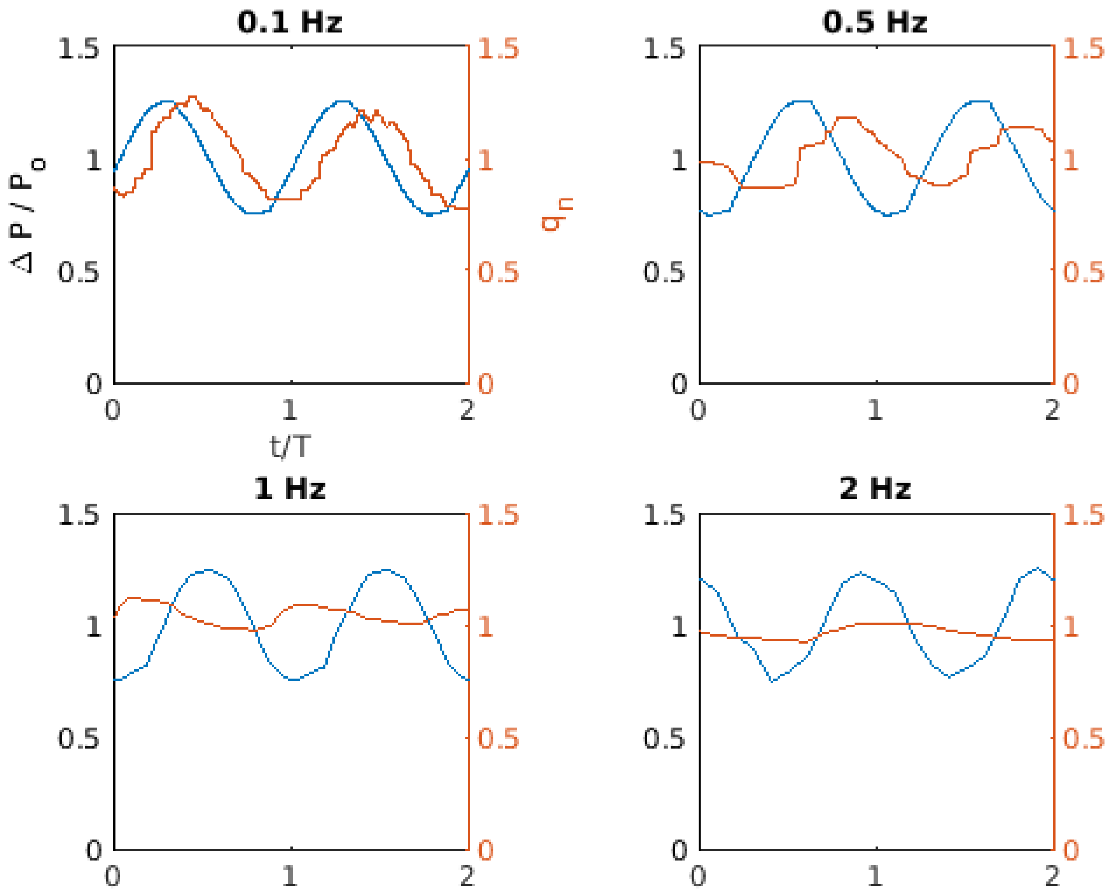

Figure 2: Characterization of the system frequency limitations. Time-variation of the normalized imposed pressure (left-axis and blue curve) and normalized measured flow rate (right axis, orange curve). The experiments are performed here with $\delta P = 0.25 P_0$ and varying pulsatile frequency.

PDMS microfluidic devices are known to deform if the pressure imposed is too large [1, 2]. We therefore measured the evolution of the flow rate for increasing pressure. In our system, when slowly increasing the pressure with a linear ramp, the pressure-flow relationship diverges from linear around 500 mbar, as shown in figure 3. The departure from a linear relationship is due to deformation of the PDMS device, which reduces the hydraulic resistance of the system. To minimize the effects of deformation, the maximum pressure used across all experiments does not exceed $\Delta P = 337.5$ mbar.

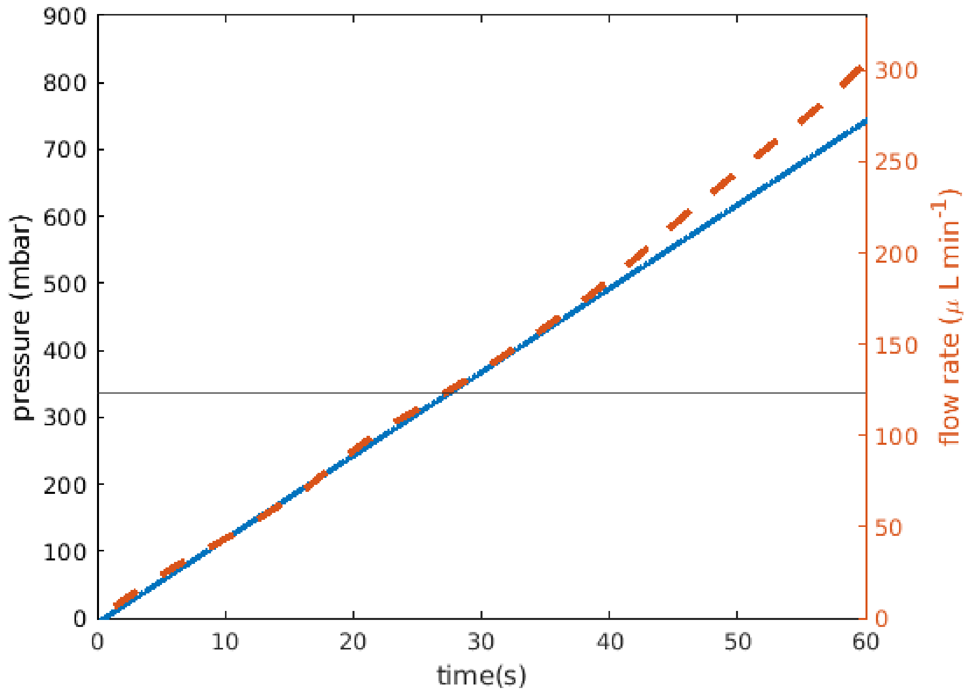

Figure 3: Linear ramp of imposed pressure (left axis, blue curve) and corresponding measured flow rate (right axis, orange dashed curve). The horizontal line indicates $\Delta P = 337.5$ mbar beyond which the deformation of the PDMS microfluidic devices modifies the linear relationship between the imposed pressure and the flow rate.

Movies of the experiments.

- Movie corresponding to Figure 9(a), accelerated 64 times.
- Movie corresponding to Figure 9(b), the acceleration of the movie is indicated in the video.
- Movie corresponding to Figure 9(c), accelerated 32 times.
- Movie corresponding to Figure 10(a), the acceleration of the movie is indicated in the video.
- Movie corresponding to Figure 10(b).

References

[1] Thomas Gervais, Jamil El-Ali, Axel Günther, and Klavs F Jensen. Flow-induced deformation of shallow microfluidic channels. *Lab on a Chip*, 6(4):500–507, 2006.

[2] Brian S Hardy, Kawika Uechi, Janet Zhen, and H Pirouz Kavehpour. The deformation of flexible pdms microchannels under a pressure driven flow. *Lab on a Chip*, 9(7):935–938, 2009.