

Electronic Supporting Information

Design and characterization of a flow reaction calorimeter based on FlowPlate® Lab and Peltier elements

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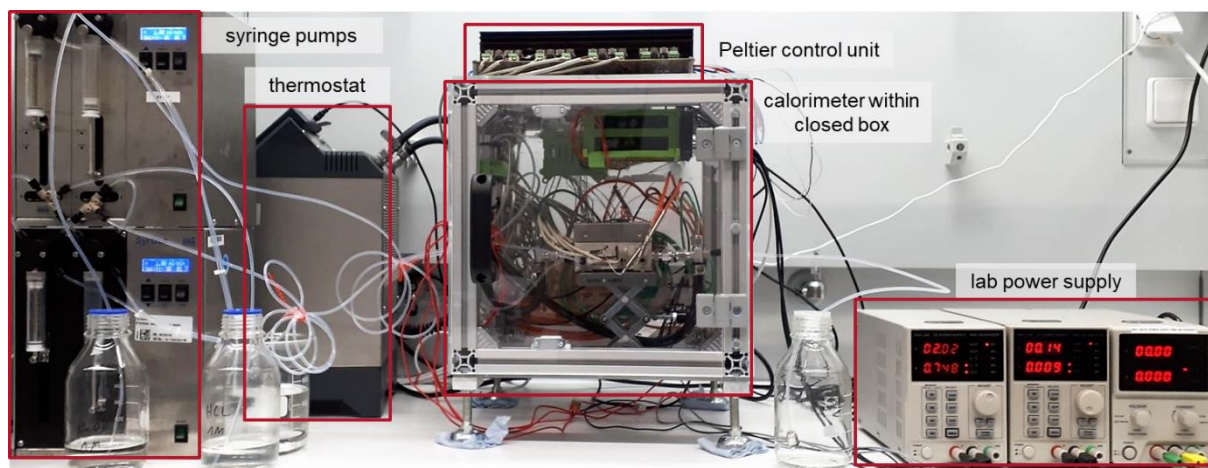


Figure S1 Picture of the experimental setup used for calorimetric measurements.

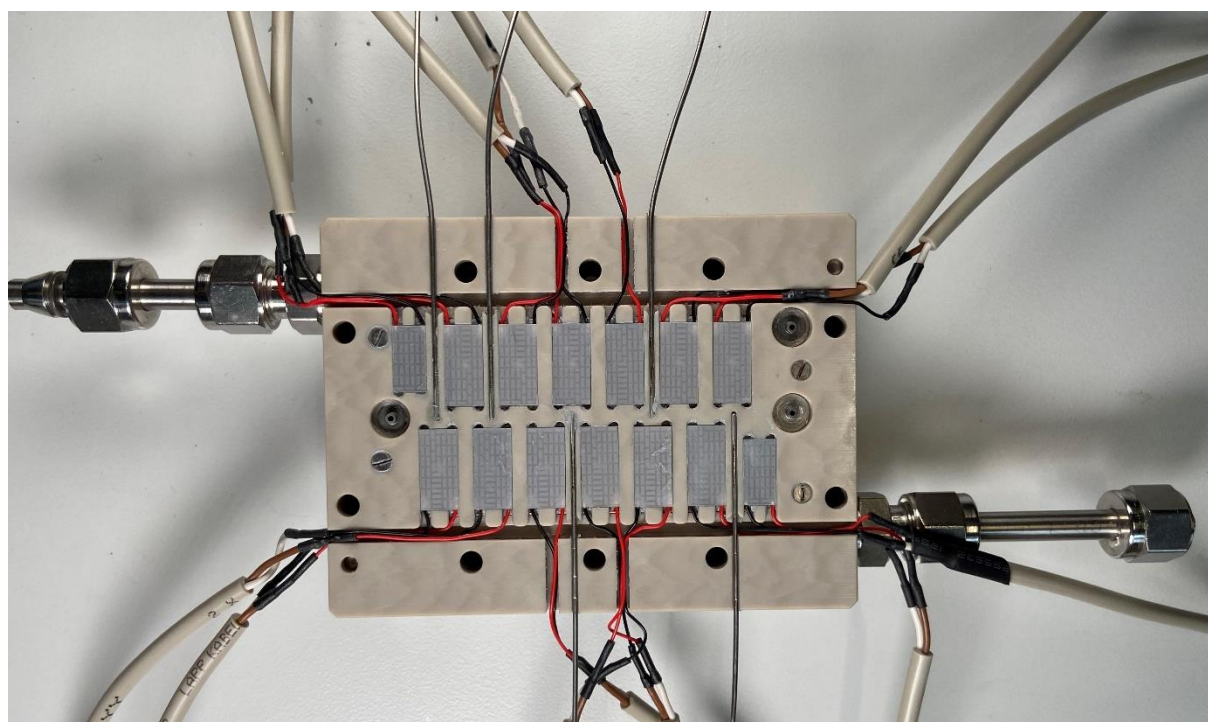


Figure S2 Picture of the Peltier carrier with Peltier elements and temperature sensors

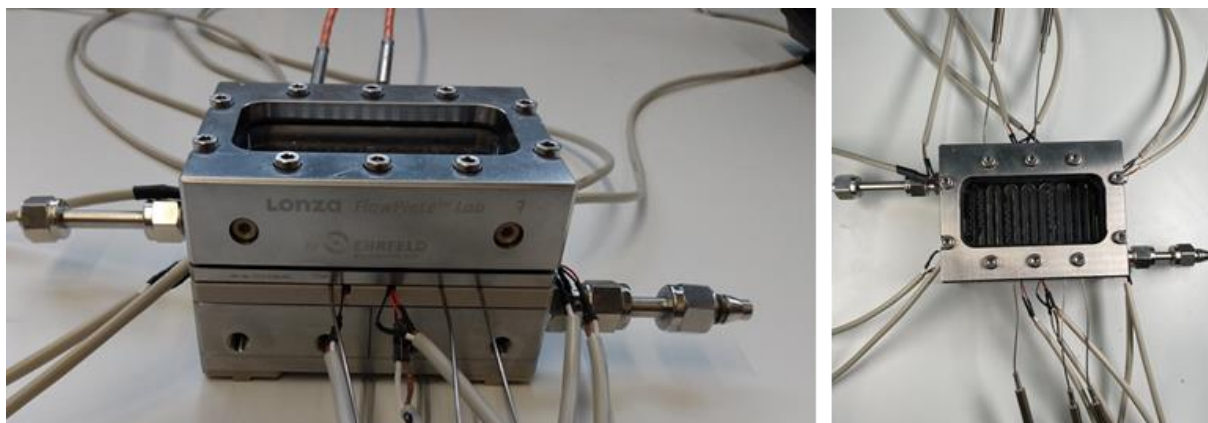


Figure S3 Left: side view on reaction calorimeter based on commercial stainless steel microreactor. Right: top view on reaction calorimeter based on commercial stainless steel microreactor.

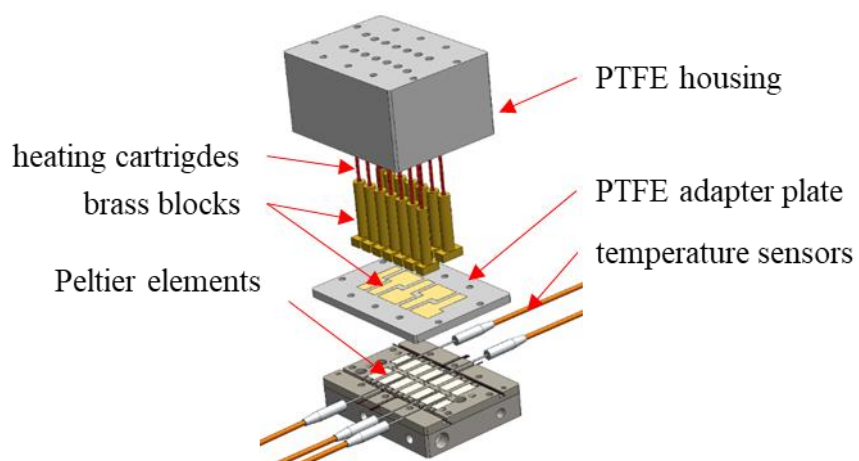


Figure S4 Explosion view of the modified calibration setup for calibration of the PES for isothermal operation mode.

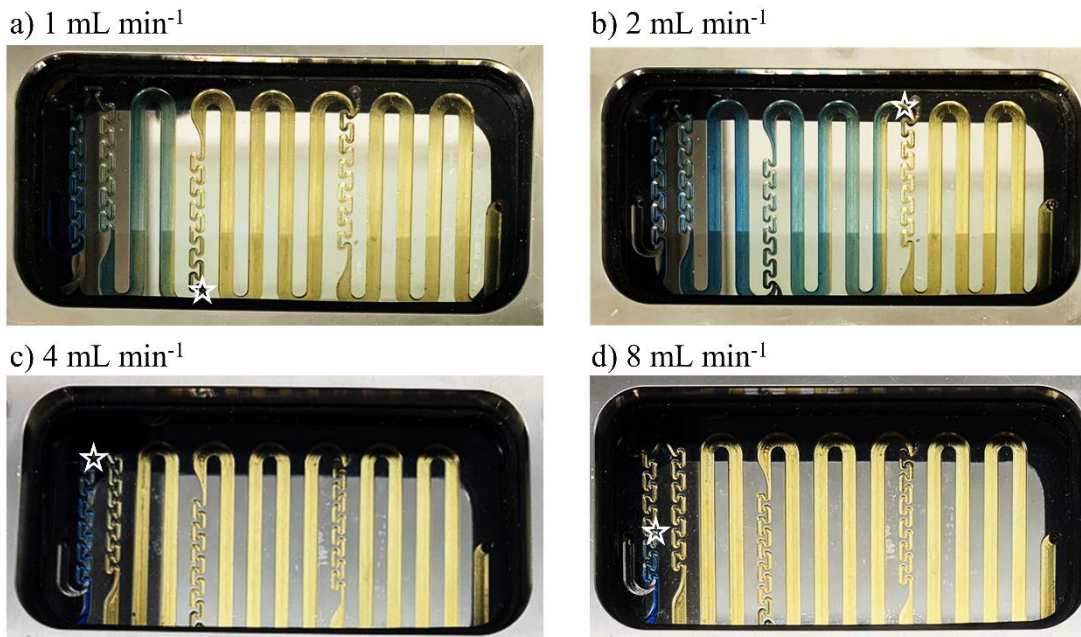


Figure S5 Images of the reaction channel in steady-state for neutralization of 1 M HCl with 1.1 M NaOH. Color change from blue to yellow marked with white asterisk due to change from alkaline to acidic milieu due to complete neutralization. $T_{MB} = T_{in} = 25\text{ }^{\circ}\text{C}$.

On one hand, it can be seen that the distance to the color change point is halved, when the volumetric flow rate is halved from 2 to 1 mL min⁻¹. On the other hand, it is evident that when the volumetric flow rate is doubled from 4 to 8 mL min⁻¹, the distance to the color change point is halved. This optical observation already indicates that two different flow regimes are present.

The results of the mixing time scale determination are plotted for corresponding flow rates over the energy dissipation rate, as shown in Figure S6.

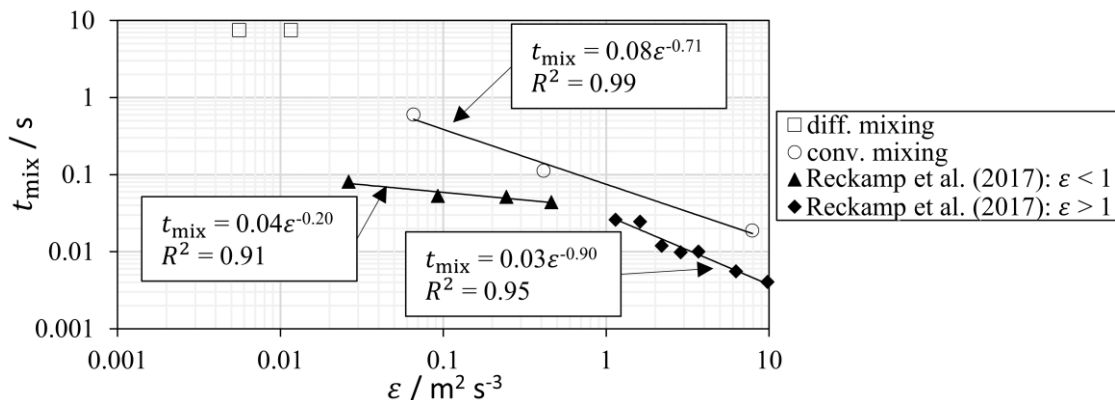


Figure S6 Mixing time over energy dissipation rate with comparison with experimental data from Reckamp et al. (2017).

For $\varepsilon < 0.02$, which corresponds $Re < 50$, mixing time is constant at a value of approximately 7.5 s indicating diffusive mixing regime. In this regime, flow velocity does not influence mixing time. Between energy dissipation rates of 0.02 and 0.065 ($Re = 50$ and $Re = 100$), a change in mixing time of an order of magnitude is evident. For $Re \geq 100$, mixing time, which indicates the convective mixing regime. The exponent of the power law trend line equals -0.71 for the process plate characterized. The exponent determined here is thus closer to the theoretical value of -0.5 than that of Reckamp *et al.* (2017), which is -0.9. The deviation from the theoretical value is, on the one hand, due to the subjective determination of the location of the color change and the subsequent determination

of the reactor length up to the color change. Both aspects were estimated based on images and, therefore significantly influence the results of the mixing time. On the other hand, the mixing time is not exclusively a function of the energy dissipation or the pressure loss, but depends, as stated by Reckamp *et al.* (2017), on other factors such as the micromixer design.



Figure S7 Self-developed graphical user interface for calorimetric measurements.



Figure S8 Left: printed circuit board and INA219 breakout boards for calibration of the PEs and measurement of electrical current during isothermal operation mode. Right: printed circuit board and respective breakout boards for calorimetric measurements