Supplementary Information

Microfluidic Design for Highly Viscous Fluids: Pumping and Metering

Sarah L. Perry, Jonathan J.L. Higdon, and Paul J. A. Kenis*

Department of Chemical & Biomolecular Engineering, University of Illinois at Urbana-Champaign, Urbana, IL 61801, USA.
Correspondence email: (P.J.A.K.) kenis@illinois.edu.

Typical Values of β for Microfluidic Channels:

Tables S1 - S3 give calculated values for β for a variety of microfluidic geometries assuming a Young's modulus of E = 1000 MPa, a Poisson's ratio of σ = 0.5, and a value for the numerical constant c = 1.

Table S1. Calculated values for β as a function of channel width and applied pressure assuming an initial channel height of h_0 = 10 µm.

h_0 (µm)	10	*w* (µm)				
		50	100	250	500	1000
P_{in} (kPa)	6.89	3.4E-02	6.9E-02	1.7E-01	3.4E-01	6.9E-01
	34.5	1.7E-01	3.4E-01	8.6E-01	1.7E+00	3.4E+00
	68.9	3.4E-01	6.9E-01	1.7E+00	3.4E+00	6.9E+00
	103	5.2E-01	1.0E+00	2.6E+00	5.2E+00	1.0E+01
	138	6.9E-01	1.4E+00	3.4E+00	6.9E+00	1.4E+01
	172	8.6E-01	1.7E+00	4.3E+00	8.6E+00	1.7E+01
	207	1.0E+00	2.1E+00	5.2E+00	1.0E+01	2.1E+01

Table S2. Calculated values for β as a function of channel width and applied pressure assuming an initial channel height of h_0 = 20 µm.

h_0 (µm)	20	*w* (µm)				
		50	100	250	500	1000
P_{in} (kPa)	6.89	1.7E-02	3.4E-02	8.6E-02	1.7E-01	3.4E-01
	34.5	8.6E-02	1.7E-01	4.3E-01	8.6E-01	1.7E+00
	68.9	1.7E-01	3.4E-01	8.6E-01	1.7E+00	3.4E+00
	103	2.6E-01	5.2E-01	1.3E+00	2.6E+00	5.2E+00
	138	3.4E-01	6.9E-01	1.7E+00	3.4E+00	6.9E+00
	172	4.3E-01	8.6E-01	2.2E+00	4.3E+00	8.6E+00
	207	5.2E-01	1.0E+00	2.6E+00	5.2E+00	1.0E+01

Table S3. Calculated values for β as a function of channel width and applied pressure assuming an initial channel height of h_0 = 50 µm.

h_0 (µm)	50	*w* (µm)				
		50	100	250	500	1000
P_{in} (kPa)	6.89	6.9E-03	1.4E-02	3.4E-02	6.9E-02	1.4E-01
	34.5	3.4E-02	6.9E-02	1.7E-01	3.4E-01	6.9E-01
	68.9	6.9E-02	1.4E-01	3.4E-01	6.9E-01	1.4E+00
	103	1.0E-01	2.1E-01	5.2E-01	1.0E+00	2.1E+00
	138	1.4E-01	2.8E-01	6.9E-01	1.4E+00	2.8E+00
	172	1.7E-01	3.4E-01	8.6E-01	1.7E+00	3.4E+00
	207	2.1E-01	4.1E-01	1.0E+00	2.1E+00	4.1E+00

Universal Curve Fitting for Lag Volume:

Here are more of the details associated with the polynomial fits used to create the universal curves for lag volume as a function of time for all β.

We defined the lag volume V_{lag} as the difference between the volume of fluid which would be metered at steady-state V_{ss} and the actual, or transient volume *V(t)* (Figure 4a).

$$V_{lag}\left(t\right) = V_{ss} - V\left(t\right)$$

The trends in lag volume as a function of time for all values of β can be condensed onto a single curve by normalizing the value of the transient lag volume to the steady-state value of the lag volume V_{lagss} and by using a 2nd order polynomial scaling for the dimensionless diffusive time. The resulting data was then fit to a simple exponential curve by least squares analysis with a value of k = 8.39 for the fitting constant. A plot of both the data and the resulting curve fit are given in Figure 4b.

The fit parameters *A* and *B* for the polynomial scaling of time were obtained by matching values of the effective time for each value of β to the case of β = 0.001 when the lag volume parameter = 0.4 and 0.9.

$$\tau^*_{scale} = A\tau^{*2} + B\tau^*$$

Plots of both *A* and *B* as a function of β are given in Figure S1 along with the associated polynomial fit of the curves. The R^2 values for each of these curves were > 0.999.

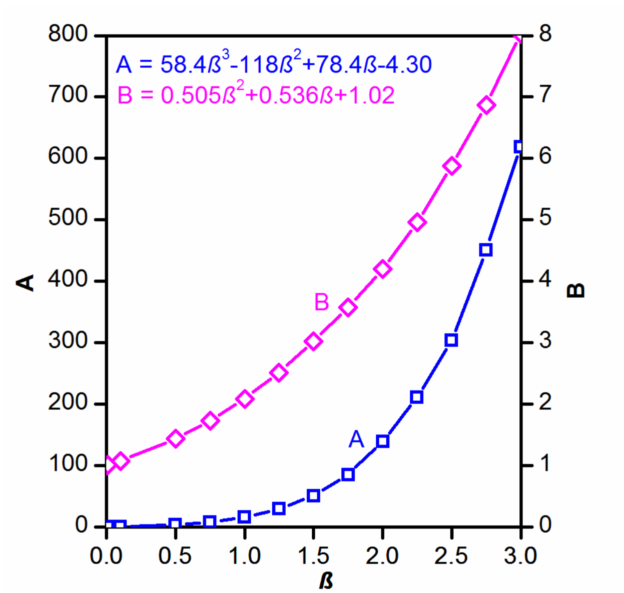

Figure S1. A plot of the fit parameters *A* and *B* for reversing the normalization the universal lag volume curve as a function of β. Polynomial fits are shown.