Supporting Information for

Continuous microfluidic particle separation via elasto-inertial pinched flow fractionation (eiPFF)

Xinyu Lu and Xiangchun Xuan*

Department of Mechanical Engineering, Clemson University, Clemson, SC 29634-0921, USA

* To whom correspondence should be addressed. E-mail: xcxuan@clemson.edu; Fax: +1 864 656 5630; Tel: +1 864 656 7299.

Determination of the fluid properties in Table 1 in the main text

The zero-shear viscosity, η_0, of the glycerol/water-based PEO solutions was calculated using the viscosity blending equation[1] via the reported viscosity values of aqueous PEO[2] and glycerol[3] solutions. The obtained values appear to be consistent with the experimental data reported by Yang et al.,[4] Nam et al.[5] and Rodd et al.[6,7] The overlap concentration, c^*, for PEO solutions was calculated from the expression of Graessley,[8] $c^* = 0.77/[\eta]$ ppm where $[\eta] = 0.072 M_w^{0.65} = 897$ ml/g is the intrinsic viscosity given by the Mark-Houwink relation.[2] We noticed that adding glycerol into the aqueous PEO solution had been found by Rodd et al.[6] to decrease the intrinsic viscosity and hence increase the overlap concentration. This effect was, however, estimated to be less than 10% for the solvent we used. Therefore, the prepared non-Newtonian fluids are in the dilute (500 ppm PEO/glycerol solution) or semi-dilute (all others) regime. They all exhibit a mild shear-thinning effect as reported in earlier studies.[4-7] The effective relaxation time of the prepared PEO solutions was estimated from the following empirical formula,[9]

$$\lambda_e = 18\lambda_{Zimm}(c/c^*)^{0.65} \tag{1}$$

where λ_{Zimm} is the relaxation time predicted according to Zimm theory,[10]

$$\lambda_{Zimm} = F\frac{[\eta]M_w\eta_s}{N_A k_B T} \tag{2}$$

In the above $F = 0.463$ is the pre-factor estimated from the Remann Zeta function using a solvent quality exponent 0.55,[2] η_s = 1.8 mPa·s is the solvent (i.e., 21 wt.% glycerol/water) viscosity,[3] N_A is the Avogadro's constant, k_B is the Boltzmann's constant, and T is the absolute temperature.

Clarification of eq 6 in the main text

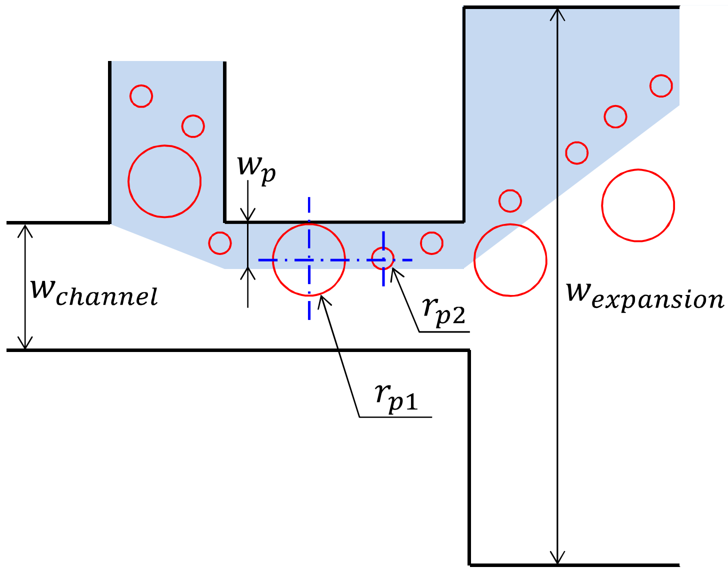

Figure S1. Schematic explanation on how eq 6 in the main text is obtained. The symbols w_p, $w_{channel}$ and $w_{expansion}$ represent the widths of the sheath-fluid focused particle solution, the main-branch, and the channel expansion, respectively. The symbols r_{p1} and r_{p2} are the radii of the two types of particles to be separated via PFF.

The particle separation in traditional PFF arises from the dissimilar center positions for particles of different sizes in a laminar flow. [11] As seen from Figure S1, when the larger particles of radius r_{p1} are aligned by the sheath fluid, their center is r_{p1} away from the sidewall. Since the center of the smaller particles with radius r_{p2} can at most overlap with that of the larger ones for separation via PFF, as indicated by the dashed-dotted line in Figure S1, the width of the particle solution in the main-branch (highlighted by the background color) should be no more than $r_{p1} + r_{p2}$. This latter value is exactly the $w_{p,max}$ in eq 6 in the main text.

References

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