S2.2.4 and PP8 - *Numerical Simulations for Designing Sieve-free Cross-flow Filtration Systems*

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A traditional filtration process involves separating particles of size (a) larger than the pore size (Rp) from a solvent for a given permeate flux. Particles fill the filter membrane pores during the course of the filtration process and form a filter cake requiring filter replacement. A strong cross-flow over the membrane can prevent the deposition of particles on the surface and increase the life of the filter. This cross-flow can also be tailored to separate particles smaller than the pore size of the membrane through a process we term “sieve-free separation”. Brownian dynamics simulations are used to demonstrate a hydrodynamic mechanism to explain particle retention in a cross-flow filtration system. The particles roll along the membrane surface and cross the pore throats faster than they can be drawn into the pore. The minimum value of the strength of the cross-flow (Γ) necessary to retain a non-Brownian particle of size a< Rp is computed. A similar analysis is extended for a weakly Brownian particle (Pe = Ua/D ≫1, D being the Brownian diffusivity of the particle and U is the permeate velocity) where a retention length is calculated as a function of Pe and Γ. The retention length can provide an estimate of the length of

the membrane and the strength of the cross-flow required to achieve a given transmission ratio. Finally, this analysis is extended to compute the transmission ratio of a polydisperse suspension of particles. The results presented in this study should aid in the design of a filtration system.

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Ioana-Cristina Butu is a senior undergraduate student at Cornell University, majoring in chemical engineering and minoring in computer science. She is passionate about the rising role of computer science in other engineering disciplines, and her primary academic interests lie at the interface between chemical engineering, biotechnology, and computer science. She is currently pursuing research to investigate particle motion near a porous membrane of a cross-flow filtration system using Computational Fluid Dynamics and Brownian Dynamics simulations. Cristina aims to earn a Ph.D. within the field of chemical engineering and to later pursue an R&D career in the industry.

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