Supplementary information for RME paper – Figures A to C

Figure A – Illustrating the changes in zeta potential of FUSO 800nm Silica colloids as a function of pH at an electrolyte concentration of 0.1M NaCl.

Figure B – Illustrating the size distribution of FUSO 800nm Silica colloids at 2 different pH values. Aggregation is observed pH 4.5 whilst at pH 6 the particles remain monodisperse in an electrolyte concentration of 0.01M NaCl.
Figure C – Variation in size distribution of FUSO 800nm Silica colloids dispersed in pH 6 water over time at 4 different electrolyte concentrations; a) no added electrolyte, b) 0.01M, c) 0.1M and d) 1M NaCl.
**Diffusion limited process calculations**

Assuming ideal dispersion of primary particles with radius = 400nm

### Total number of particles

Total mass of particles in the continuous phase (@4wt% in 25ml) = 1g = 1×10⁻³ kg

Volume of 1 particle (particle radius = 400nm), \( V = \frac{4}{3} \pi r^3 = 2.68 \times 10^{-19} \text{ m}^3 \)

Density of Fuso Silica = 2600 kg m⁻³

Mass of 1 particle = Density × Volume = 6.97×10⁻¹⁶ kg

Total no of particles in 25ml @4wt% = \( \frac{\text{Total mass of particles}}{\text{Mass of 1 particle}} \) = 1.44×10¹²

### Droplet Coverage

Volume of oil droplet (radius = 75×10⁻⁶ m), \( V = \frac{4}{3} \pi r^3 = 1.77 \times 10^{-12} \text{ m}^3 \)

Total volume of dispersed phase = 5ml = 5×10⁻⁶ m³

Total no of droplets (with radius = 75×10⁻⁶ m) = \( \frac{\text{Total volume of dispersed phase}}{\text{Volume of 1 droplet}} \) = 2829655

Surface area of droplet, \( A = 4\pi r^2 = 7.1 \times 10^{-8} \text{ m}^2 \)

Area occupied by HCP packing (particle radius = 400nm) = 5.54×10⁻¹³ m²

No of particles to cover all droplets = \( \frac{\text{Total no of droplets} \times \text{surface area of 1 droplet}}{\text{area occupied by HCP packing}} \) = 3.6×10¹¹

No of particles to cover 1 droplet (monolayer) = 1.3×10⁵

### Diffusion of particles

Diffusion Coefficient, \( D = \frac{k_p T}{6 \pi \eta r} = 5.36 \times 10^{-13} \text{ m}^2 \text{s}^{-1} \)

Debye length (background electrolyte concentration = 0.1mol/L), \( \kappa = 1 \text{nm} = 1 \times 10^{-9} \text{ m} \)
Time for diffusion, \( t = \frac{x^2}{2D} = 9.33 \times 10^{-7} \text{ s} \)

**Lifetime of droplet on membrane**

Volumetric flowrate, \( Q = 0.1 \text{ ml min}^{-1} = 1.67 \times 10^{-9} \text{ m}^3\text{s}^{-1} \)

Volume of 1 droplet (150µm) = \( 1.77 \times 10^{-12} \text{ m}^3 \)

Lifetime of droplet on membrane = \( 1.06 \times 10^{-3} \text{ s} \)

If assuming the smallest droplet size is the same as the pore size i.e. 80µm

Volume of 1 droplet (80µm) = \( 2.68 \times 10^{-13} \text{ m}^3 \)

Lifetime of droplet on membrane = \( 1.60 \times 10^{-4} \text{ s} \)

**Assuming aggregated particulate system with radius = 1.6µm**

**Total number of particles**

Total mass of particles in the continuous phase (@4wt% in 25ml) = 1 g = \( 1 \times 10^{-3} \text{ kg} \)

Volume of 1 particle (particle radius = 1.6µm), \( V = \frac{4}{3} \pi r^3 = 1.72 \times 10^{-17} \text{ m}^3 \)

Density of Fuso Silica = 2600 kg m\(^{-3}\)

Mass of 1 particle = Density \times Volume = \( 4.46 \times 10^{-14} \text{ kg} \)

Total no of particles in 25ml @4wt% = \( \frac{\text{Total mass of particles}}{\text{Mass of 1 particle}} = 2.24 \times 10^{10} \)

**Droplet Coverage**

Volume of oil droplet (radius = 75×10\(^{-6}\) m), \( V = \frac{4}{3} \pi r^3 = 1.77 \times 10^{-12} \text{ m}^3 \)

Total volume of dispersed phase = 5ml = \( 5 \times 10^{-6} \text{ m}^3 \)
Total no of droplets (with radius = \(75 \times 10^{-6}\) m) = \(\frac{\text{Total volume of dispersed phase}}{\text{Volume of 1 droplet}}\) = 2829655

Surface area of droplet, \(A = 4\pi r^2 = 7.1 \times 10^{-8}\) m

Area occupied by HCP packing (particle radius = 1.32µm) = \(8.90 \times 10^{-12}\) m

No of particles to cover all droplets = \(\frac{\text{Total no of droplets} \times \text{Surface area of 1 droplet}}{\text{Area occupied by HCP packing}}\) = \(2.20 \times 10^{10}\)

No of particles to cover 1 droplet (monolayer) = \(7.8 \times 10^3\)

**Diffusion of particles**

Diffusion Coefficient, \(D = \frac{kT}{6\pi r}\) = \(1.57 \times 10^{-13}\) m²s⁻¹

Debye length (background electrolyte concentration = 0.1mol/L), \(\kappa = 1\)nm = \(1 \times 10^{-9}\) m

Time for diffusion, \(t = \frac{x^2}{2D}\) = \(3.18 \times 10^{-6}\) s

**Lifetime of droplet on membrane**

Volumetric flowrate, \(Q = 0.01\) mlmin⁻¹ = \(1.67 \times 10^{-9}\) m³s⁻¹

Volume of 1 droplet (150µm) = \(1.77 \times 10^{-12}\) m³

Lifetime of droplet on membrane = \(1.06 \times 10^{-3}\) s

If assuming the smallest droplet size is the same as the pore size i.e. 80µm

Volume of 1 droplet (80µm) = \(2.68 \times 10^{-13}\) m³

Lifetime of droplet on membrane = \(1.60 \times 10^{-4}\) s