Supplementary information for RME paper – Figures A to C

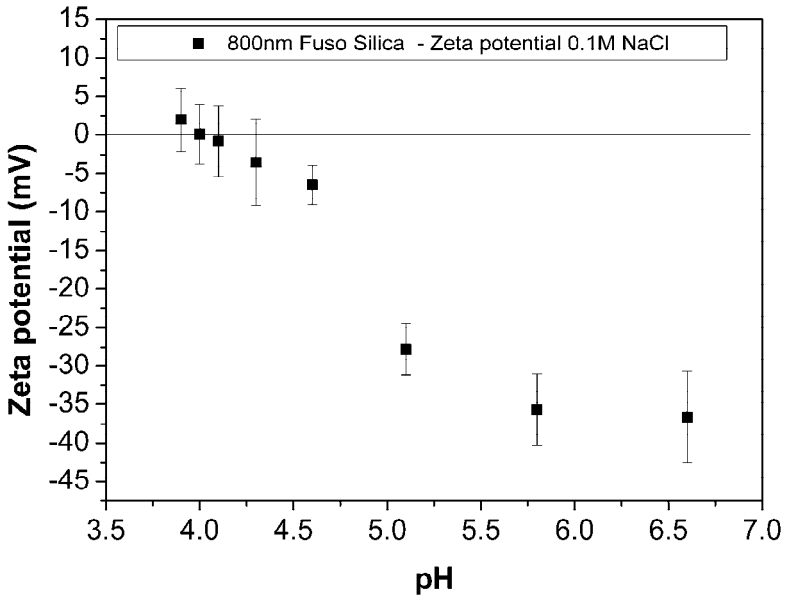

Figure A – Illustrating the changes in zeta potential of FUSO 800nm Silica colloids as a function of pH at an electrolyte concentration of 0.1M NaCl.

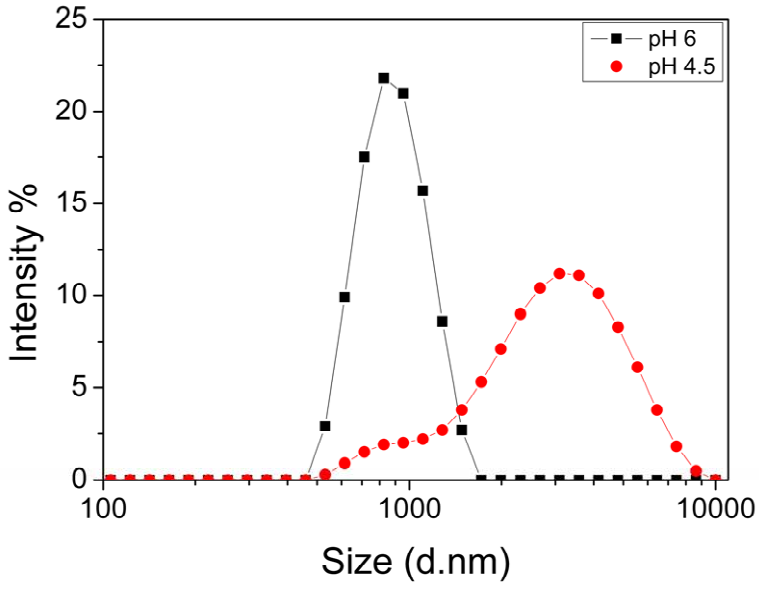

Figure B – Illustrating the size distribution of FUSO 800nm Silica colloids at 2 different pH values. Aggregation is observed pH 4.5 whilst at pH 6 the particles remain monodisperse in an electrolyte concentration of 0.01M NaCl.

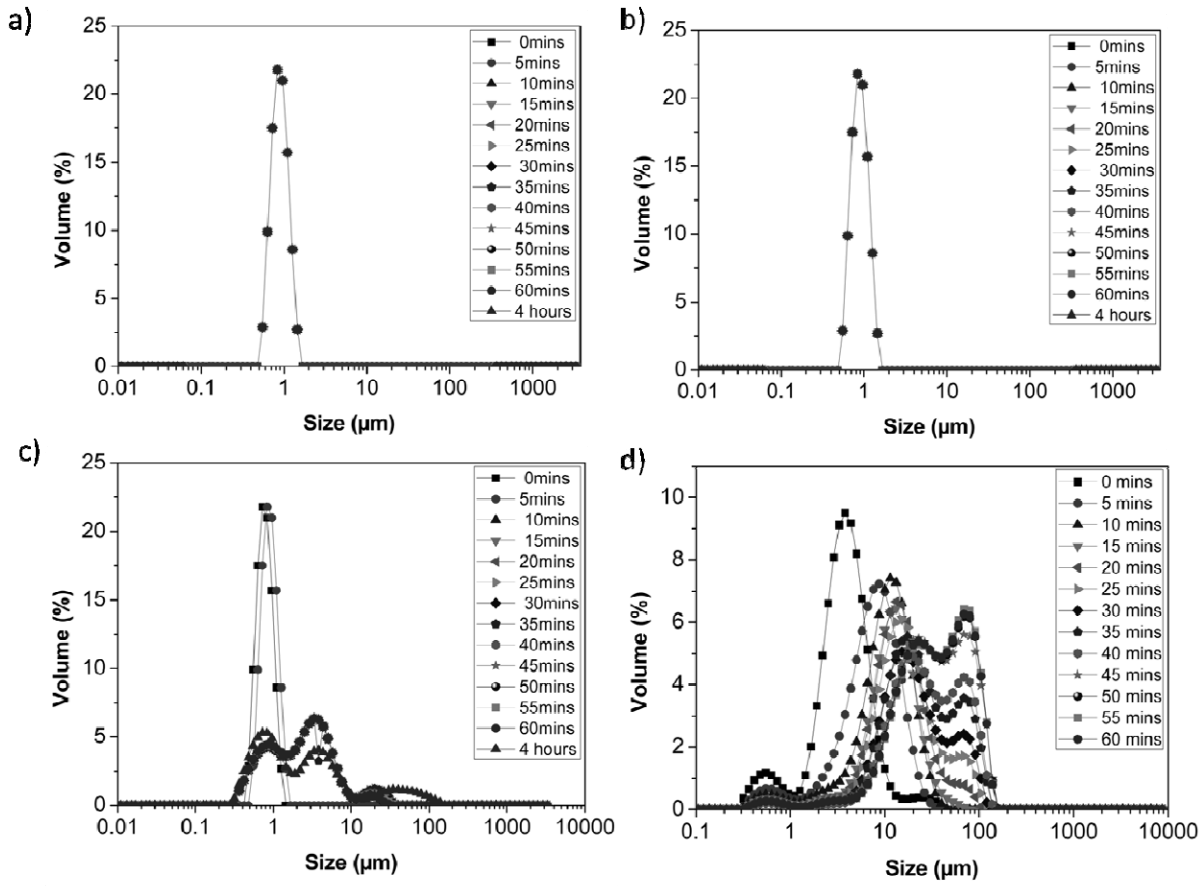

Figure C – Variation in size distribution of FUSO 800nm Silica colloids dispersed in pH 6 water over time at 4 different electrolyte concentrations; a) no added electrolyte, b) 0.01M, c) 0.1M and d) 1M NaCl.

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), $V = \frac{4}{3}\pi r^3$ = **2.68×10^{-19} 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% = $\frac{Total\ mass\ of\ particles}{Mass\ of\ 1\ particle}$ = **1.44×10^{12}**

Droplet Coverage

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

Total volume of dispersed phase = 5ml = **5×10^{-6} m^3**

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

Surface area of droplet, $A = 4\pi r^2$ = **7.1×10^{-8} m^2**

Area occupied by HCP packing (particle radius = 400nm) = **5.54×10^{-13} m^2**

No of particles to cover all droplets = $\frac{Total\ no.of\ droplets \times surface\ area\ of\ 1\ droplet}{Area\ occupied\ by\ HCP\ packing}$ = **3.6×10^{11}**

No of particles to cover 1 droplet (monolayer) = **1.3×10^{5}**

Diffusion of particles

Diffusion Coefficient, $D = \frac{k_B T}{6\pi\eta r}$ = **5.36×10^{-13} m^2s^{-1}**

Debye length (background electrolyte concentration = 0.1mol/L), κ = 1nm = **1×10^{-9} m**

Time for diffusion, $t = \frac{x^2}{2D}$ = **9.33×10^{-7} s**

Lifetime of droplet on membrane

Volumetric flowrate, Q = 0.1 mlmin^{-1} = **1.67×10^{-9} m^{3}s^{-1}**

Volume of 1 droplet (150µm) = **1.77×10^{-12} m^3**

Lifetime of droplet on membrane = **1.06×10^{-3}s**

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

Volume of 1 droplet (80µm) = **2.68×10^{-13} m^3**

Lifetime of droplet on membrane = **1.60×10^{-4}s**

Assuming aggregated particulate system with radius = 1.6µm

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 = 1.6µm), $V = \frac{4}{3}\pi r^3$ = **1.72×10^{-17} m^3**

Density of Fuso Silica = **2600 kg m^{-3}**

Mass of 1 particle = Density × Volume = **4.46×10^{-14} kg**

Total no of particles in 25ml @4wt% = $\frac{Total\ mass\ of\ particles}{Mass\ of\ 1\ particle}$ = **2.24×10^{10}**

Droplet Coverage

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

Total volume of dispersed phase = 5ml = **5×10^{-6} m^3**

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, $A = 4\pi r^2$ = **7.1×10^{-8} m^2**

Area occupied by HCP packing (particle radius = 1.32μm) = **8.90×10^{-12} m^2**

No of particles to cover all droplets = $\frac{\text{Total no.of droplets} \times \text{surface area of 1 droplet}}{\text{Area occupied by HCP packing}}$ = **2.20×10^{10}**

No of particles to cover 1 droplet (monolayer) = **7.8×10^{3}**

Diffusion of particles

Diffusion Coefficient, $D = \frac{k_B T}{6\pi\eta r}$ = **1.57×10^{-13} m^2s^{-1}**

Debye length (background electrolyte concentration = 0.1mol/L), κ = 1nm = **1×10^{-9} m**

Time for diffusion, t = $\frac{x^2}{2D}$ = **3.18×10^{-6} s**

Lifetime of droplet on membrane

Volumetric flowrate, Q = 0.01 $mlmin^{-1}$ = **1.67×10^{-9} m^3s^{-1}**

Volume of 1 droplet (150μm) = **1.77×10^{-12} m^3**

Lifetime of droplet on membrane = **1.06×10^{-3}s**

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

Volume of 1 droplet (80μm) = **2.68×10^{-13} m^3**

Lifetime of droplet on membrane = **1.60×10^{-4}s**