Ultrafiltration Behaviour of CuO Particles Prepared without and with Different Surfactants using PAN and PES Membranes

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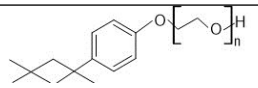
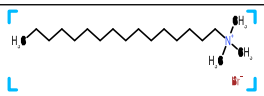
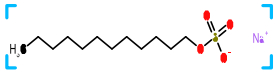
SUPPORTING INFORMATION

Table S1 contains the characteristics of the surfactants used to synthesize particles (CuO/TX-100, CuO/CTAB and CuO/SDS), which includes their charge type, their molecular weight, critical micelle concentration (CMC), Micelle diameter, zeta potential in distilled water and their chemical structure.

Table S 1: *Molecular weight and micelle diameter and zeta potential of the surfactants*

Surfactant	**Type**	M_w **(g/mol)**	**CMC**	**Micelle Diameter (nm)**	**Zeta Potential (mV)**	**Chemical Structure**
Triton X-100 (TX-100)	Non-ionic	647	0.25	7.4	-10.1±0.653	
Cetyltrimethylammonium Bromide (CTAB)	Cationic	364	0.99	7	29.84±5.772	
Sodium Dodecyl Sulfate (SDS)	Anionic	288	7.49	3.7	-54.11±3.407	

In order to check the free surfactant concentrations in the experimental particle solutions the following procedure was applied. Standard surfactant solutions of 1%, 0.5%, 0.25% and 0.125% v/v concentration for TX-100 surfactant and w/v concentrations for CTAB and SDS surfactants were prepared. The absorbance values were reported using UV-Visible spectrophotometer for each concentration at the maximum light absorption wavelengths (λ max) for each surfactant; 274.8nm, 205.5nm and 228.5nm for TX-100, CTAB and SDS respectively.

Experimental particle solutions of 50mg/L and 100mg/L were prepared for CuO/TX-100, CuO/CAB and CuO/SDS and filtered with a 0.45µm syringe filter, considering their micelle diameters were reported to be smaller than 0.45µm (Table S1). The absorbance of the filtered solutions measured and determined to be negligible, as observed in Figure S1.

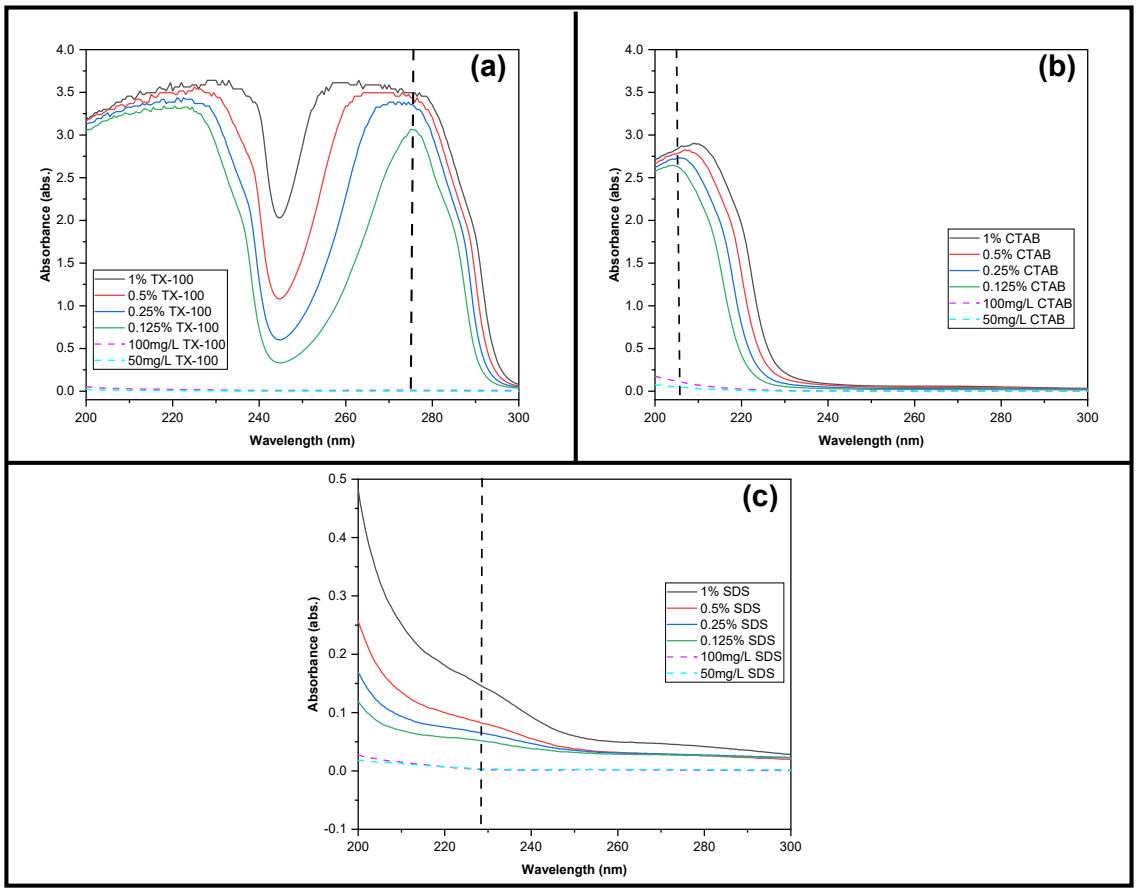


Figure S 1: *UV-VIS Spectrophotometer scan of all standard surfactant solutions in comparison to the experimental CuO particle solutions filtered; (a) TX-100 surfactant; (b) CTAB surfactant and (c) SDS surfactant*

The IUPAC has further classified the observed hysteresis loop, and the shape of the loop is correlated with the material's textural properties (Figure S2). Depending on the shape the hysteresis loop takes, the pore shape can be interpreted.

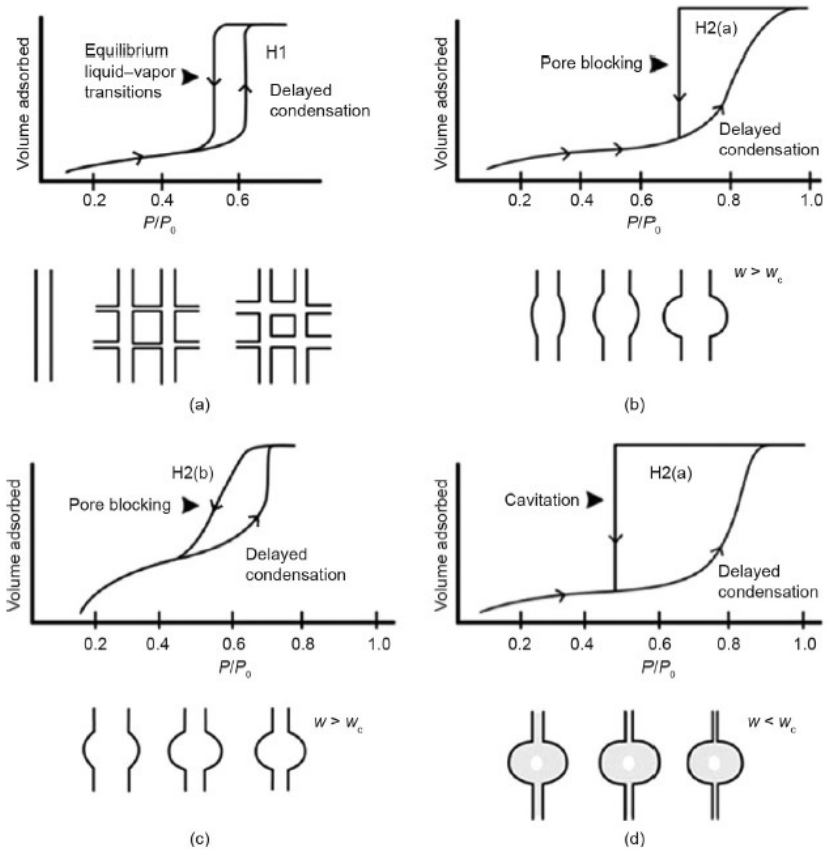


Figure S 2: *Classification of Hysteresis Loops, (a) Type H1; (b) Type H2(a); (c) Type H2(b; (d) Type H2(a) as presented in* (1,2)

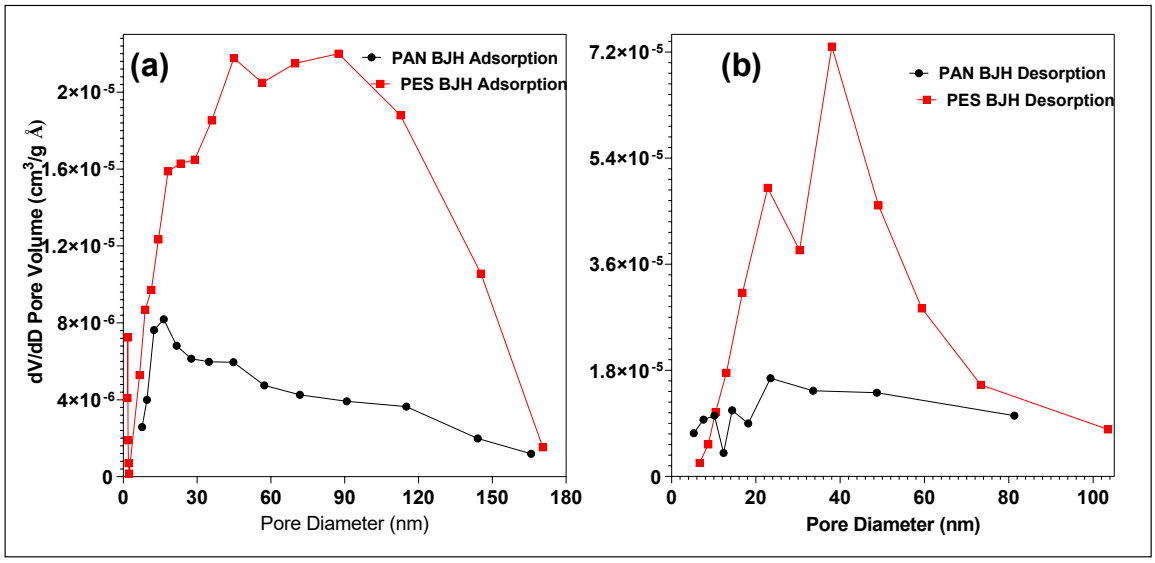


Figure S 3*: BET pore volume distribution of PAN and PES membranes. BJH adsorption and desorption isotherm data was used for the calculation of the distributions.*

Figure S4 shows the particle size distribution of the aggregated CuO particles (CuO/NS, CuO/TX-100, CuO/CTAB and CuO/SDS) in solution.

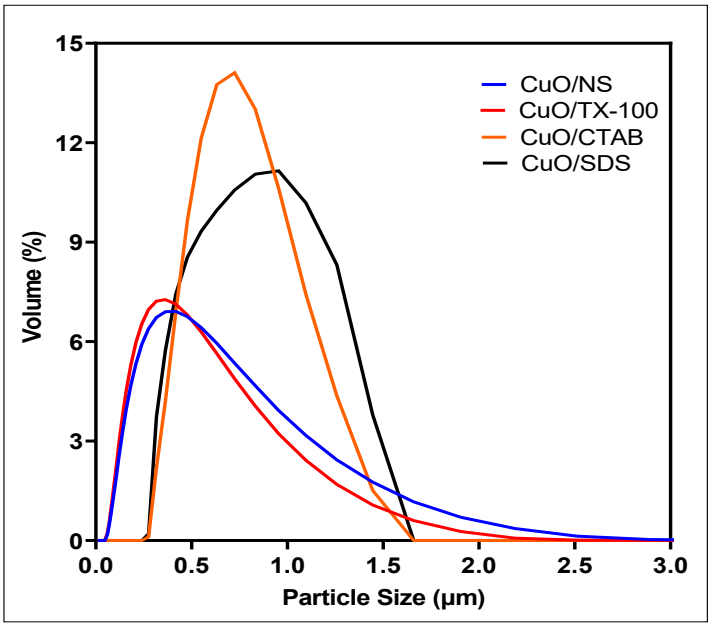


Figure S 4: *Particle size distribution of the aggregated CuO particles*

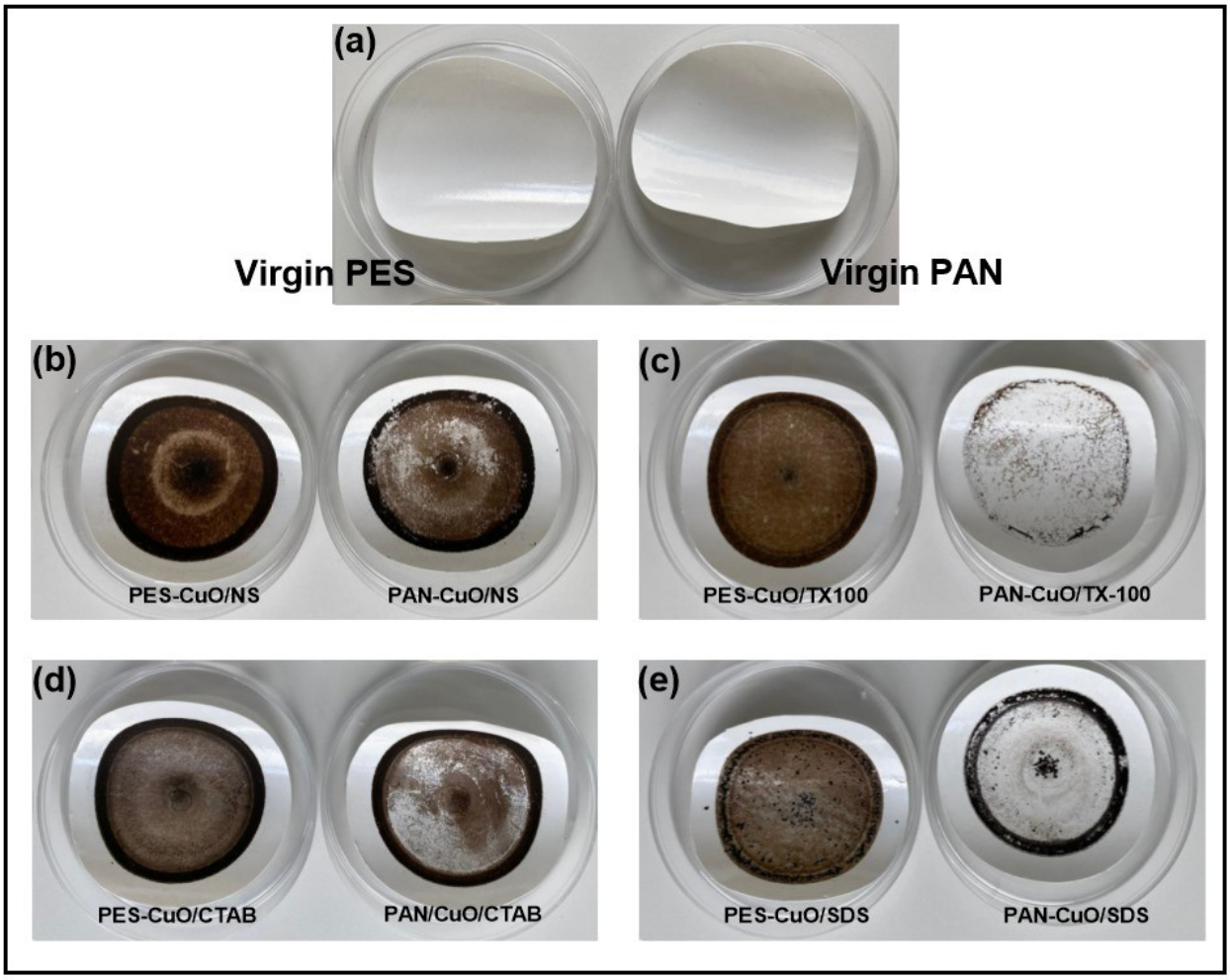


Figure S 5: *Picture of particles on membrane after filtration at 50 mg/L particle concentration. (a) Virgin PAN and PES membranes (b)CuO/NS on PAN and PES membranes; (c)CuO/TX-100 on PAN and PES membranes; (d) CuO/CTAB on PAN and PES membranes and (e) CuO/SDS on PAN and PES membranes*

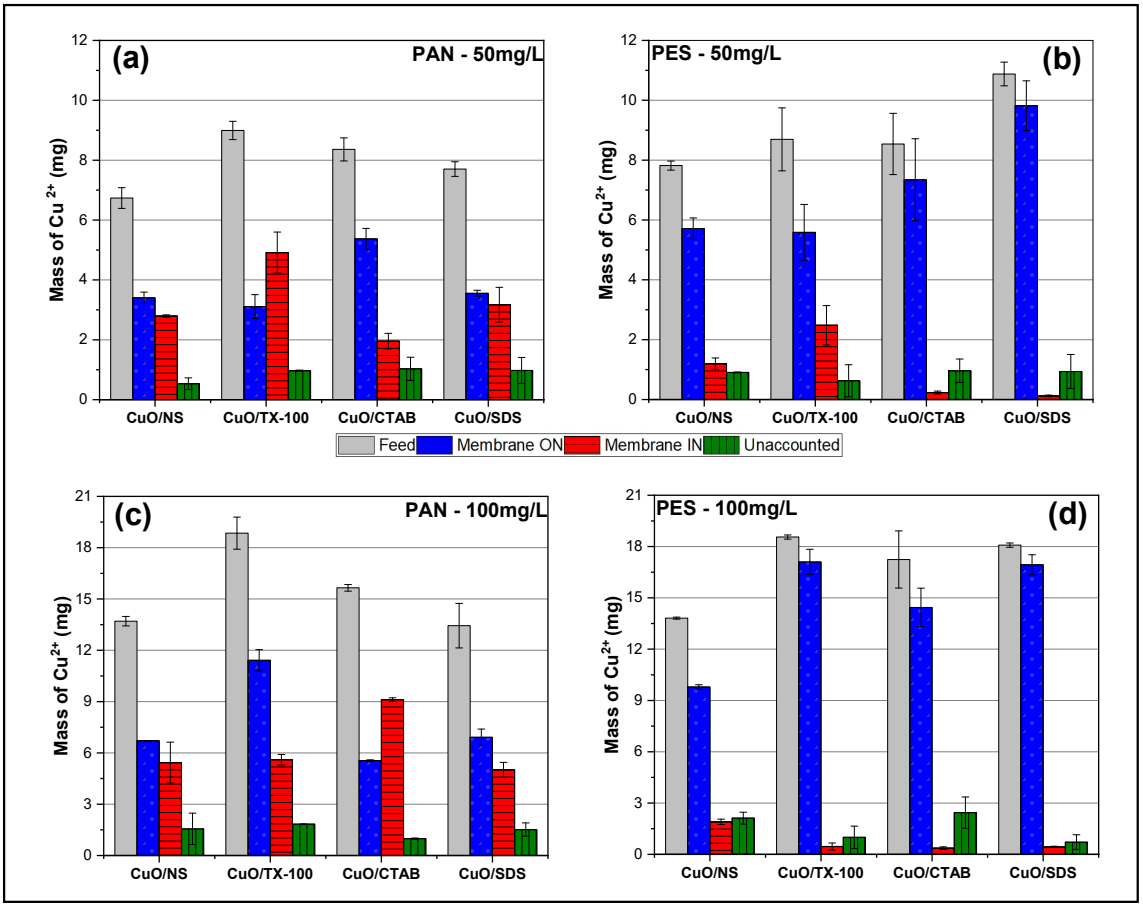


Figure S 6: *The Mass of Cu^{2+} in feed, membrane IN, membrane ON and unaccounted for all particle filtration experiments a) PAN-50 mg/L CuO b) PES-50 mg/L CuO c) PAN-100 mg/L CuO d) PES-100 mg/L CuO*

References

1. Thommes M, Kaneko K, Neimark A V., Olivier JP, Rodriguez-Reinoso F, Rouquerol J, et al. Physisorption of gases, with special reference to the evaluation of surface area and pore size distribution (IUPAC Technical Report). Pure Appl Chem. 2015;87(9–10):1051–69.

2. Cychosz KA, Thommes M. Progress in the Physisorption Characterization of Nanoporous Gas Storage Materials. Engineering [Internet]. 2018;4(4):559–66. Available from: https://doi.org/10.1016/j.eng.2018.06.001