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Towards Greener Liquid-Liquid Extraction Using Hydrotopes and Synergism Between Amphiphiles

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Abstract

Hydrometallurgy heavily relies on liquid-liquid extraction. Liquid-liquid extraction is a colloidal and interfacial process driven by chemical potential differences of cations dispersed in different liquids. Current methodology at lab, pilot or plant scale is systematic experiment plans to select best conditions. Phenomena as ubiquitous as synergy between extractants have no explanation, as well as the usage of solvotropes1 or hydrotropes to increase yield and reduce third phase formation.

Going beyond the classical modelling by supra-molecular chemistry and set of parallel transfer reactions modelled as decomplexation-recomplexation reactions, the "ieanics" approach considers only chemical potential differences between organized fluids (as for electron potential in doped semi-conductors). The solvent phase contain weak aggregates of complexing molecules sharing properties with water-poor reverse micelles 2. Chemical potential includes mixing entropy in disordered fluids 3. This approach relies on the identification by X-ray and neutron scattering of the extracting dynamic aggregates (as well as the precise measurement of the free energy of transfer4. Relative role of entropy versus solvation was understood for hydrotropes only in 2016. 5

Making greener knowledge-based processes heavily relies on this ieanics approach that uses quantities that are measurable instead of state of equilibrium constants between "complexes" and "speciation".

Several examples of processes for which predictive modelling allows minimization of effluents will be given:

Optimizing mole ratio between solvating and ion-exchanging extractant molecules: entropy only improving selectivity

Noble metal recovery from wastes using diamide using advanced molecular topology with matching affinity.

Probing the existence of uranyl tri-sulfates in the AMEX process in presence of modifiers 6

as well as new possibilities allowed by the usage of hydrotropes in a formulation for which small dynamic ultra-flexible microemulsions are formed.

Biography:

Thomas Zemb has obtained his master in nuclear engineering at ETH-Zurich, his thesis in biophysics at Institut Curie in 1978 and his habilitation in 1985 in solid state physics at the age of 32 years. He is Founding Director of the Institute for Separation Chemistry (ICSM), a joint venture between University of Montpellier, Atomic energy and alternative energy commission, CNRS and ENSCM. Full professor in colloids at INSTN since 1992. He designed and built several small angle scattering cameras specially designed to measure the weak scattering produced by aggregated extractant molecules. . He designed, built and used several original small angle scattering cameras specially designed to measure the weak scattering produced by aggregated extractant molecules.

-Humboldt-Gay Lussac price 2008 working at Max Planck in Potsdam and at University of Regensburg. -European Colloid Solvay Price for the understanding and usage of catanionic solids in 2003

-Thomas Graham medal in 2013 for the starting of ienaics approach of separation and recycling.

-Overbeek Gold medal for colloids and interfaces received in 2017 linked to the 300+ publications in international journals that appeared since the first one devoted in 1972 to zeolithes as possible storage material for paramagnetic wastes

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Speaker Publications:

1 "Mouvements moléculaires et cinétiques de polymérisation du méthacrylate de méthyle adsorbé sur zéolithe"; C.R. Acad. Sci. Paris/ 1973, 276, 121-124.

2 “Alkyl chain conformations in a micellar system from the nuclear spin relaxation enhanced by paramagnetic ions”;Chem. Phys. Lett/ Vol 88, 1982-Issue 1, 68-73.
3 “Concentration-dependent structure of sodium octanoate micelles”; Chem. Phys. Lett/ Vol 93, 1982- Issue 1, 91-94.
4 “Micellar structure from comparison of X ray and neutron small angle scattering”; J. Phys. (Les Ulis, Fr)/ Vol 46, 1985, 249-256.

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