Kinetic limitations for separation processes

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Chemical liquid-liquid extraction (solvent extraction) is a versatile unit operation fort the separation of ionic solutes. Separation is based on the preferential complexation of the target metal ions with a hydrophobic extracting agent, forming hydrophobic complexes. Chemical liquid-liquid extraction is widely applied on an industrial scale, mainly for the purification of metals and in the nuclear fuel cycle.

Extraction processes are sometimes designed on simple equilibrium models (such as McCabe diagrams). However, kinetic factors play an important role in chemical liquid-liquid extraction and must be taken into account [1]. This is usually done by deriving a transfer function and incorporating it into the models. A closer look at a heterogeneous process such as chemical liquid-liquid extraction tells that for a precise understanding both transport of educts and products and their reaction need to be considered.

The presentation describes the main equations and introduces experimental devices used to study kinetics. The two most suitable techniques are discussed: The rotating membrane cell (RMC) [2] and a constant interface stirred cell of proper design [3].

Several examples are discussed, showing both systems controlled by diffusion (i.e. where the chemical reaction is rather fast) and systems controlled by the chemical reaction. Another example identifies the action of a phase transfer catalyst on extraction kinetics.

Finally, some conclusions are drawn regarding the design of separation processes based on chemical liquid-liquid extraction.

[1] P.R. Danesi, Chapter 5 in: *Principles and Practices of Solvent Extraction.* J. Rydberg, C. Musikas, G.R. Choppin (eds), Marcel Dekker, NY, 1992.

[2] J.P. Simonin, J. Weill, *Rotating Membrane Cell technique for the study of liquid/liquid extraction kinetics.* Solvent Extr. Ion Exch. 1998, 16 (6), 1493–1514.

[3] W. Nitsch, *The concept of interfacial reactions for mass transfer in liquid-liquid systems.* Faraday Discuss. Chem. Soc. 1984, 77, 85–96.