

Roles of dynamic metal speciation and membrane permeability in the metal flux at permeation liquid membranes

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In natural waters, trace metals are present in a large number of different forms, such as “free”, hydrated metal ion or complexed with small inorganic ligands, small or colloidal natural organic ligands, etc. In order to understand their toxicity and bioavailability for microorganisms in environmental systems, the study of the role of different metal species is a key issue. Permeation liquid membrane (PLM) is a promising technique for trace metal dynamic speciation, because it is a simple technique, its sensitivity is high due to its preconcentration capability and the processes of metal transport through PLM are similar to those occurring in plasma membrane of biological cell. It is based on the transport of the metal ions through a lipophilic liquid membrane, by complexation with a lipophilic ligand which serves as carrier. The important parameters which influence metal speciation study with Permeation liquid membrane are the diffusion layer thickness and the diffusion coefficients of the metal ion and its complexes, the chemical association and dissociation rate constants of the metal complexes, the partition coefficient of metal ion between the test (source) solution and the membrane, the nature and concentration of the carrier in the membrane and the membrane thickness.

A general model for the steady-state flux of metal through the PLM, has been developed for solutions containing excess of ligand compared to the metal, by considering all these parameters and the associated processes. It is applicable to complexes with any degree of lability (labile, semi-labile, non-labile and inert). It leads to a number of limiting cases for fully labile, fully inert or kinetically controlled complexes. This model has been validated experimentally with complexes with varying degree of lability, in particular: Pb-NTA, Pb-TMDTA, Pb-Diglycolate, Cu-Diglycolate and Cu- N-(2-Carboxyphenyl)glycine complexes. It enables to predict the role of the different types of complexes on the bioavailability of metals for organisms.

References:

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