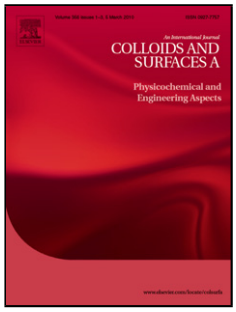

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A formulator's cut of the phase prism for optimizing selective metal extraction

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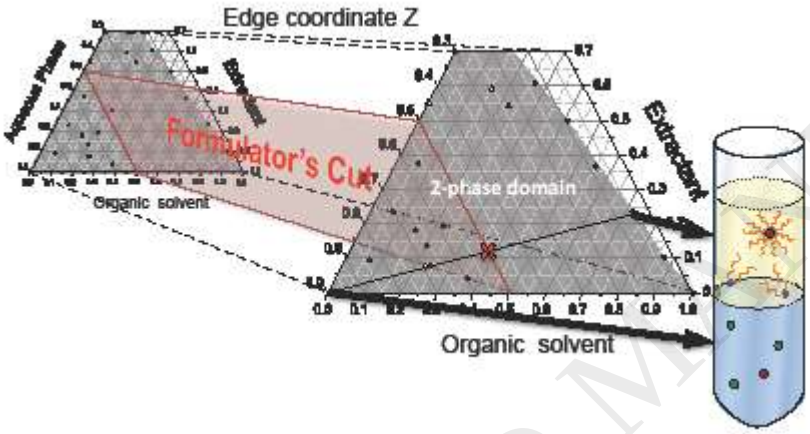
Graphical Abstract



Abstract : Solvent-based liquid-liquid extraction and stripping is the key separation method at the basis of all hydrometallurgical processes, such as those used to retrieve strategic metals from ores or waste material. During formulation of an efficient extraction system, chemical engineers often encounter instabilities and the formation of undesired phases. In order to avoid the appearance of those in practice, we propose a simple and convenient approach of the phase diagram, based on mole ratio of cations as the variable that controls interfacial curvature. The proposed *formulator's* cut through the Gibbs phase prism is more adapted than *fish-cuts* or similar ones in the case of extraction and stripping formulation optimized against variation in the feed composition.

Keywords*: Solvent extraction; Gibbs phase prism; microemulsions, colloidal stability*

1. Introduction

Solvent extraction is a versatile separation technique that exploits the different solubilities of chemical compounds in solvents of different polarity. Selective extraction and stripping are based on an uneven distribution of the solutes between two liquid phases in equilibrium. The method relies on contacting water-rich phases containing the species to be separated, with oil-rich phases containing an extractant. In the stripping region, solvent-rich phases loaded with extracted ions are contacted with water at a given pH to allow desextraction of the species. All these equilibria are Winsor-II equilibria.

Usually, one stage is not enough, so mixing devices are arranged in cascades. This method finds a wide application on a laboratory and industrial scale, e.g. in pharmaceutical [1] and perfume industry [2], recycling of rare earths from electronic waste [3] and in nuclear fuel waste management [4]. When metals need to be separated, solvent extraction is the key separation method in hydrometallurgy. In order to enhance the solubility of metal-ions in an nonpolar medium, oil-soluble extractant molecules with weak surface active property (or amphiphilicity) are added to the organic phase,