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Development of a new process for the selective extraction of uranium from phosphate rocks

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Commercially available phosphoric acid, obtained by action of sulphuric acid on calcium phosphate rocks (wet process phosphoric acid pathway –WPA), contains low concentration of uranium (30 to 300 ppm of U3O8) with high concentrations of iron (several g/L). Because of the high toxicity of uranium, the matter of removal uranium from WPA in terms of health safety has been considered at different times. In addition the worldwide uranium resources associated with phosphorite deposits are estimated at approximately 9 Mt which is an important secondary source of uranium for nuclear applications.

Liquid-liquid extraction processes have been developed during the seventies in order to recover uranium as a byproduct of industrial phosphoric acid. The production deased in the late 90s due to the decline in the price of uranium. Further studies are in progress at CEA with AREVA since 2009 to propose a new extracting molecule improving extraction performances of uranium and greater selectivity for uranium compared to other cationic impurities such as iron, the main impurity.

Parametric experiments in batch conditions led to select and optimize a new design of bitopic extracting molecule which shows a high extraction of uranium(VI) with a very high selectivity versus iron(III) from 5M H3PO4 . Extraction isotherms were acquired and helped to determine the stoichiometry of the complexes formed in organic phase. Kinetic studies were also conducted in a turbulent thermostated cell in order to verify that the chosen molecule is compatible with an industrial process. These acquisitions enabled the development of an extraction model for uranium and iron, taking into account the deviations from ideality of the aqueous phase. This model was implemented in the PAREX simulation code, developed by CEA to simulate the operations of solvent extraction in continuous laboratory contactors. A process flowsheet was proposed for the selective extraction of uranium from phosphoric acid solution and successfully implemented, on the laboratory platform PROUST at CEA Marcoule, using a synthetic solution first and then a solution of a genuine industrial phosphoric acid.

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