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Application of ultra/nano filtration membrane on mining Uranium from seawaters

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Introduction
Nuclear energy is a green and renewable energy. Uranium, as an important resource for nuclear energy, exists in seawater at a concentration of 3.3 µg/L, forming highly stable Ca-UO2-CO3 and Mg-UO2-CO3 complex. Though dilute, this amounts to an estimated 4.5 billion tons of uranium, which is approximately 1000 times more than that is available from conventional sources such as terrestrial ores. Uranium in seawater will be a near-limitless resource for nuclear fuel in the future, and its recovery will avoid the deleterious effects of terrestrial mining on the environment. Although there are many difficulties to overcome, mining of U from seawater is the most promising.

Title
The objective of this work is to test the possibility to separate Uranium from other salts in natural and recomposed water systems by ultra/nano filtration process realized with inorganic membranes, and to understand the rejection mechanism, the interaction of membrane with solution species. For this goal, various physical-chemical parameters, such as MWCO, pH value of solutions, temperature, applied pressure, ionic strength/salinity, solution composition, are evaluated for their influence on metal rejections. Electric repulsion and steric effect are two mechanisms deducing the interaction of solution species and membrane surface thus the rejections. Speciation distribution of each solution is studied with phreeqC software. Mass conservation law is applied to estimate the error. Concentrations of retentate and permeate are measured by ICPOES and ICPMS for determining the rejections.

Conclusion
Electric repulsion and attraction is the main mechanism of interaction between membranes and solutions species. pH is the principle factor which influences the rejection of every specie. There is a selectively big reject of U(VI) to Na at pH 3 and 8.25 in solutions of U and NaHCO3. MWCO does not influence the rejections of U or Ca except that the IEP of different membranes can be slightly different. The salinity influences a lot the rejection of U in solutions presenting NaHCO3 and NaCl (1-35g/L). U rejection decreases with the increase of salinity, but is still considerably rejected until salinity 10 g/L. With the CaCl2 solutions of increasing concentration at pH 3 and the same for MgCl2 at pH 3, the salt concentration influences a lot the rejection of both Ca and Mg. Both these experiments prove that high salinity shields the electric repulsion, by consequent decreases the rejection. On the other hand, U can be rejected from sodium in solutions contained only U and Na from NaHCO3, NaCl or Na2SO4 at pH 8. U can be separated from sodium salts and be concentrated in a concentration experiment, so as Ca and Mg in the solutions respectively of CaCl2 at pH 3 and of MgCl2 at pH 3. Finally, filtration experiments with complicate natural and recomposed solutions including seawaters, Rhone River and theses solutions doped with U are conducted. In all the natural or recomposed seawater solutions, none of the species (U, Na, Mg, Ca, K) is rejected. However, it is proved that with the inorganic membranes, the presence of CaCl2 or MgCl2 hinders the rejection of every specie in solutions including U.

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