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Reverse osmosis effluents: biogeochemical and mineralogical investigation

ENCARNACIÓN RUIZ-AGUDO[1], LUCIAN C STAICU[2], PAULINA J WOJTOWICZ[2], MIHÁLY PÓSFAI[3], DIEGO BARAGAÑO COTO[4] AND JOSÉ LUIS R GALLEGO[4]

[1]University of Granada (Spain)
[2]University of Warsaw
[3]University of Pannonia
[4]University of Oviedo

Presenting Author: encaruiz@ugr.es

Industry is constantly searching for methods to treat waste fluxes in an attempt to minimize its environmental impact. Reverse osmosis (RO) is an efficient treatment system, generating a *permeate* stream (purified water passing through the membrane) and a *retentate* stream, which concentrates the constituents rejected by the membrane. Currently, a hot research area is the treatment of the retentate, as it is a high-strength and metal-rich solution of environmental significance. In this study, we present a multidisciplinary approach involving *bioremediation* and *chemical precipitation* for the treatment of a real retentate (As ~2300 µg L^{-1}, Se ~160 µg L^{-1}, SO_4^{2-} ~1500 mg L^{-1}, HCO_3^- ~480 mg L^{-1}, Ca^{2+} 520 mg L^{-1} etc.) generated by a full-scale RO unit. The biological treatment involves the use of *Shewanella* sp. O23S, a metal-resistant bacterium specialized in the metabolism of arsenic (As) and selenium (Se) [1, 2]. The bacterium has the capacity to reduce As(V) to As(III) and Se(VI) and Se(IV) to biogenic Se(0) through anaerobic respiration. Various electrons donors were tested, and the investigation was complemented by a thermodynamic competition study using As(V), Se(VI), and Se(IV), single and in combination. The analytics used included ICP-MS, ion chromatography, mineralogical and electron microscopy analysis. The inoculum performed best against Se (~60% removal) with lactate as electron donor, while the addition of cysteine led to a higher performance (~87%). The chemical approach involved the precipitation of sulfate as barite, $BaSO_4$, a mineral with high commercial value [3], at different contact times and Ba:SO_4 concentrations. Process optimization resulted in >70% As, ~79% Mo, and >80% Se removal with barite. An in-depth mineralogical characterization of $BaSO_4$ was performed and the removal mechanism of the contaminants was proposed and discussed.

[1] Uhrynowski et al. (2019) *Int. J. Mol. Sci.* 20, 1018. [2] Staicu et al. (2021) in preparation. [3] Staicu et al. (2020) *Minerals* 10, 188.