Advanced oxidation of iodinated X-ray contrast media in reverse osmosis brines: The influence of quenching

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Release of treated wastewater into the environment, and especially their widespread reuse in agriculture, exhibit several environmental concerns, such as the presence of organic contaminants found in trace amounts, better known as micro and nano-pollutants. These trace organic compounds can accumulate in soil and groundwater reservoirs and adsorb into the agricultural products.

Reverse osmosis (RO) in combination with advanced oxidation processes (AOPs) emerge as an alternative of choice for the safe removal and destruction of trace organic compounds. Efficiency of AOP strongly depends on the background composition of the water matrix.

The aim of this work was to assess the pattern and factors governing the oxidation of model pharmaceutical compounds in RO brines using UVA/TiO$_2$ as AOP.

Diatrizoate (DTZ), an iodinated X-ray contrast medium (ICM) was used as model compound. ICM are used in radiographic diagnostics and they are not metabolized in the human body. Furthermore, they are resistant to conventional wastewater treatment trains. Due to their multiple halogenated aromatic structure, ICM are known display reluctance to oxidation, and therefore can serve as right-hand markers for advanced oxidation techniques.

Experiments were performed with real and synthetic brines, both were spiked with the model compound DTZ (~800 ± 80 µg/L). Double distilled water (DDW) served as a reference.

Real brines: RO concentrate of a two stage-process (RO1, 2-fold concentration and RO2, 5 fold concentration) were obtained from the Technion-desalination pilot plant at the Nir Eztion wastewater treatment plant near Atlit.

Synthetic brines: In order to evaluate the contribution to quenching of organic matter as well as alkalinity, synthetic brine solutions were composed comprising the main dissolved organic matter (DOM) constituents (~20 mg/L) present in tertiary effluents and alkalinity. DOM was reconstituted based on Luria Bertani medium representing soluble microbial products (SMP) ≈ 75%, and fulvic acid-sodium salt representing natural organic matter (NOM) ≈ 5-20%. Sodium bicarbonate (~700 mg/L) was added to reconstitute the corresponding alkalinity present in RO brines.

UVA/TiO$_2$ resulted effective in removal of recalcitrant compounds in a background of low concentration of dissolved organic matter and alkalinity. A significant reduction in its effectiveness was faced when the background concentration of both DOM and alkalinity,
increased. DTZ oxidation mechanism involved direct oxidation of the aromatic ring and deiodination, namely, transformation and deiodination paralleled. In DDW, ~95% DTZ transformation and ~77% deiodination was achieved after 45 min irradiation. Synthetic brines solution resulted a useful tool to characterize the quenching made by DOM components and alkalinity. The major contribution to quenching resulted from SMPs, due to their relatively high concentration in tertiary effluents, compared to NOM, followed by alkalinity.