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Removal of harmful anions from water in the anion-exchange membrane process

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ABSTRACT

When water contains bromide ions (Br^-), ozonation favours the formation of bromates (BrO_3^-) classified as ions with carcinogenic implications for human organisms. The permissible concentration of bromates in drinking water for the European Union and United States is now 10 μg/l. We proposed the anion-exchange membrane separation process referred to in the literature as Donnan dialysis for the removal of bromides or bromates from water. As a result of anion exchange between two solutions separated with an anion-exchange membrane, harmful anions are replaced with neutral ones, i.e., chlorides. The process was performed in a laboratory dialytic set-up comprising 20 cell pairs with anion-exchange membranes, Selemion AMV or Neosepta ACS. The feed was natural water enriched with bromides (500 μg/l) or bromates (100 μg/l); the receiver was an NaCl solution (100 mM). As for bromides, Selemion AMV and Neosepta ACS provided similar removal efficiency: 86% and 90%, respectively. As for the other anions, removal efficiency depended on the membrane type. With Selemion AMV, sulphate and bicarbonate removal totaled 76% and 70%, respectively; with Neosepta ACS, sulphate ions were rejected almost entirely (removal efficiency, 3%), and bicarbonates were rejected partly (removal efficiency, 43% and below). The process is also an efficient method of bromate removal. With both membranes the exchange of bromates was high (93% (AMV) and 97% (ACS)). The exchange of associated anions (sulphates and bicarbonates) depended on the membrane type. Upon termination of the process, the concentration of bromates was reduced to a level much below 10 μg/l.

Keywords: Bromide; Bromate; Bicarbonate; Sulphate; Donnan dialysis; Anion-exchange; Anion-exchange membrane

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