Water Hardness Removal by Electrochemical Precipitation

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Abstract

The possibility of alkaline scale precipitation and removal by electrolytic devices has long been recognized. The scale removal principle of the electrochemical technique is based on the creation of a high pH environment around the cathode by the water and the oxygen reduction reactions which release hydroxyl ions. The alkaline environment induces precipitation of the calcium hardness in the form of CaCO$_3$ and of the magnesium hardness, in the form of Mg(OH)$_2$.

Despite the commercial availability of such equipment, the use of electrochemical scale control methods has been quite limited. Currently, the main field of application of electrolytic devices is for reducing the hardness of water recirculating in cooling towers. The lack of authoritative technical information on electrochemical scale removal reflects the paucity of research and development efforts in a technology which holds considerable promise for expanding the rather limited scope of viable scale control techniques.

The objectives of our research project are to evaluate the potential of the electrochemical technique for RO desalination processes in general and for increasing water recovery levels in particular. Our research results include development of models for characterizing the cell resistance in the absence and in the presence of a deposit on the cathode, demonstration of the possibility for effective cathodic precipitation of a CaCO$_3$ deposit in the presence of anti-scalants and characterization of the effects of some of the major operating parameters on the rate of electrolytic deposition of CaCO$_3$ and on energy efficiency.

Results of systematic experiments will be displayed showing the effect of current intensity on the specific area requirement and on the specific energy consumption in the precipitation of CaCO$_3$ from anti-scalant stabilized concentrates. The possibility of avoiding chlorine generation by using metal such as zinc or brass as anodes will be presented. Finally, a theoretical model enabling correlation of the kinetics of electrolytic deposition of CaCO$_3$ will be shown.

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