230c High Recovery Desalination of Agricultural Drainage Water: Integration of Accelerated Chemical Precipitation with Ro Membrane Desalination

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Adverse geological conditions have forced agricultural communities in the San Joaquin Valley (California) to practice artificial tile-drainage to avoid the loss of fertile land due to salinity build-up in the crop root zone. Sustainable continuation of this practice demands an appropriate strategy for reclamation and reuse of agricultural drainage (AD) water (TDS of 3000-15,000 mg/L). Although desalination using low-pressure RO membranes is a promising strategy, membrane surface scaling by mineral salts has been a major road block for wide spread implementation of membrane desalination. To alleviate the impact of membrane scale formation, product water recovery levels are typically limited to about 50-75% recovery, even with the use of antiscalants. In addition to loss of valuable resources, desalination at such recovery levels presents major brine disposal challenge. In the present study, a number of different non-thermal approaches to enhancing product water recovery (beyond the typical 50-75%) in membrane desalination were evaluated.

Enhanced product water recovery for desalting of agricultural drainage (AD) water was experimentally demonstrated in bench-scale systems by the integration of an accelerated chemical precipitation (ACP) process with RO membrane desalting. ACP was used to reduce the concentration of scale precursors (e.g. Ca^{2+}, Ba^{2+}, Sr^{2+}, Silica) prior to a membrane desalting operation. The ACP process involved inducing and accelerating mineral precipitation through the dosing of chemicals (e.g. NaOH) and mineral seeding, followed by microfiltration and pH adjustment. Thermodynamic simulations of various process configurations (RO-ACP-RO and ACP-RO) served to identify the range of optimal operating parameters, including chemicals dosage and attainable reduction in scaling potential for a given feed water composition. The above was supplemented by experimental batch precipitation studies, in which the effects of water composition, chemicals dosage, and mineral seed loading were evaluated in terms of the removal of scale precursors. Membranes scaling diagnostic studies were performed to assess the scaling potential of the final brine concentrate produced at the target water recovery as affected by ACP and antiscalant dosage. Membrane scaling was evaluated based on flux decline measurements and membrane surface analyses (SEM-EDS).

The present study showed that the attainable product water recovery for AD water, which is often dictated by the gypsum saturation level, can be sufficiently controlled by the level of calcium removal in the ACP step. However, the attainable product water recovery can also be dictated by the feed water silica concentration. In certain cases of extreme silica concentration in the feed water, silica removal was explored via adsorption onto metal hydroxides in the ACP step. A preliminary economic analysis of the proposed overall ACP/RO process was conducted and will be presented for different process configurations.