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Chapter 6

Processing of Desalination Reject Brine for Optimization of Process Efficiency, Cost Effectiveness and Environmental Safety

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Additional information is available at the end of the chapter

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1. Introduction

Reverse Osmosis (RO) is currently confirmed and generally approved as the most feasible technology for desalination of brackish groundwater being the most economic for its range of salinity over a wide range of production capacities, and in view of its lowest requirements of energy, and its application ease.

The currently acceptable norm of recovery of desalted water in projects of brackish water reverse osmosis (BWRO) ranges usually between 65 to 85 % according to raw water quality, level of chemical pretreatment and concept of plant design/operation, would it be intended to be a sophisticated facility of low operation cost or vice versa. The balance of 15 %, or above, the desalination reject stream in which the RO rejected components are concentrated, is disposed as a wastewater (WW). Among the disposal options selected to get rid of the desalination reject stream are: 1) Sewer stream, 2) Land application including percolation, 3) Deep well injection and, 4) Evaporation ponds. The last option is the most common in the Middle East in view of:

• The rather common high temperature
• The low ambient humidity
• The relatively low cost of land in desert areas

Disposal of RO reject water aims, in most of the alternatives, to just get rid of that stream without further water recovery which wastes the cost of initial pumping and chemical treatment. It is, therefore, evident that the increase of desalted water recovery is a main factor in determining the process cost effectiveness. On the other hand, a too high recovery would
lead to most, if not all, the membrane fouling problems and the subsequent decline of performance and eventually membrane damage [1]. The present work investigates the promotion of the RO desalination efficiency and cost effectiveness.

Desalination reject stream (DRS) represents, in fact, a WW disposal problem. It includes, in addition to increased salinity, higher concentrations of polyvalent ionic species [2] due to the preferential high rejection of e.g. hardness components, heavy metal cations (HMCs) [3] or radioactive isotopes [4], organics [5]. DRS includes also the residual pretreatment chemicals of the primary desalination step, i.e., coagulants as iron or aluminum salts or polyelectrolytes, disinfection by products, antiscalants [6].

In big RO desalination facilities, however, the surface area of evaporation ponds may attain several millions of square meters and represents, therefore, one of the main cost factors of the desalination projects [7] due to the cost of land and of installation of ponds, digging, lining, construction of dykes [8].

Besides the considerable cost of installation of evaporation ponds and their annual maintenance, they may cause considerable environmental threat through:

1. Possible leak of concentrated brine and possibly contaminated water to pollute the groundwater reserves.
2. Flooding of ponds which was reported for many existing desalination plants in view of inadequate initial design or operation problems. Flooding of contaminated reject would contaminate the neighboring habitat.

In view of the increasingly stringent environmental regulations related to disposal of WWs and the high cost of evaporation ponds the present laboratory and pilot investigation work aims to promote RO desalted water recovery and reduction of the disposed brine stream to a minimum value so as to realize:

1. Promotion of the desalination process efficiency and saving of groundwater reserves.
2. Saving of, or lowering the cost of installation and maintenance of evaporation ponds.
3. Conformity with environmental regulations of WW disposal.
4. Reducing environmental risks of pollution of groundwaters.

Processing of DRS is supported by:

1. The progressive development of water treatment chemicals as the introduction of anti-scalant of specific action as e.g. SiO$_2$ or SO$_4^{2-}$ specific antiscalants which enable safe operation of RO at higher recoveries despite the presence of higher concentrations of the scale forming components.
2. The creation of new generations of RO and NF membranes according to the trends of:
   a. Higher salt rejection
   b. Lower energy consumption