Concentrate Management in Desalination

Case Studies

Edited by
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ASCE
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ENVIRONMENTAL & WATER RESOURCES INSTITUTE

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Chapter 1 – Introduction

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Background of EWRI work

In 2004, there were no industry-wide concentrate management performance standards for the types of desalination and water reuse technologies identified in "*Desalination and Water Purification Technology Roadmap*" [U. S. Bureau of Reclamation and Sandia National Laboratories, 2003], especially for inland desalination facilities that do not have ready access to ocean disposal. Additionally, brackish and sea-water desalination and concentrate management regulations vary significantly from state-to-state, region-to-region, and internationally, in terms of both field testing and monitoring requirements. Much of the United States contains extensive brackish ground water resources [Krieger *et al.*, 1957]. Since much of this supply underlies more easily-accessible and higher-quality fresh water resources, it has remained primarily untapped; but as fresh water resources become increasingly scarce and water demands increase, treatment of brackish water sources has gained consideration, especially as desalination technologies are improved and costs become more competitive.

In 2005, several organizations including the American Water Works Association, Ground Water Protection Council, Water Reuse Foundation, and the Environmental Protection Agency agreed to work cooperatively through an American Society of Civil Engineers (ASCE), Environmental and Water Resources Institute (EWRI) group to develop a consensus–based assessment and provide recommendations and guidance on sound and commonly acceptable concentrate management practices for new and existing desalination and water reuse facilities.

Through ASCE/EWRI, and with the support of Sandia National Laboratories, working group members were recruited from a wide-range of interested water professionals; including water resource managers, water technology developers, water utilities, and regulatory agencies; this group became the Concentrate Management Working Group (CMWG). The CMWG was designed to leverage the expertise of government, industry, and research organizations involved in desalination, water reuse, technology evaluation, and environmental protection to provide broad perspective on concentrate management issues.

The initial meeting of the CMWG (officially called the EWRI Task Committee (TC) on CM in Desal) was held in September 2004, in Phoenix, AZ in conjunction with the Water Reuse Association national conference. Subsequent meetings of the

CMWG were held in December 2004 (Las Vegas, NV) and in March 2005 (Phoenix, AZ).

During the 2007 EWRI Congress in Tampa, FL, the members of the EWRI task committee and others made presentations under the organized Desalination and Water Reuse Track generated by Sandeep Sethi. A regular funded meeting of the EWRI task committee was also conducted during the annual ASCE/EWRI Congress in Tampa, Florida on May 15, 2007. Attendees included Conrad Keyes (Chair), Ernie Avila (suggested TC Rep to the Water, Wastewater, & Stormwater Council of EWRI from the task committee), Amit Pramanik, Clayton Johnson, Findlay Edwards, Kenneth Mercer, Sandeep Sethi (Recording Secretary), and Val Frenkel. The following areas were determined to be the major viable options for concentrate management and subcommittees were formed to study each option:

Concentrate Management to Oceans and Bays
Discharge of Concentrate to Surface Waters and Sanitary Sewers
Discharge by Deep Well, Land Disposal, and Evaporation Ponds
Zero Liquid Discharge

It was subsequently decided to have each subcommittee generate case studies in their respective areas.

Case Study Topical Areas

This Committee Report (or Monograph) is a summary of Case Studies associated with concentrate management in desalination in each of the areas defined previously. The members (or authors) from the 2010-2011 EWRI task committee for the development of CM in Desal Case Studies that have been involved in providing case studies in relation to the topics of the current four subcommittees of the EWRI Concentrate Management in Desalination (CM in Desal) technical committee of FY 2009 are (see Appendix A):

Discharge of Concentrate to Oceans & Bays – Nikolay Voutchkov and Val S. Frenkel

Discharge of Concentrate to Sanitary Sewer and Surface Waters – Khalil Atasi & Colin Hobbs, Michael Fahy, and Berrin Tansel

Discharge of Concentrate to Deep Well Injection, Land Applications, & Evaporation Pond – Michael Fahy, Kenneth Mercer, and Berrin Tansel

Zero Liquid Discharge Concentrate Disposal Systems – Sandeep Sethi and Berrin Tansel

The task committee officers (Chair – Conrad Keyes, Vice Chair – Michael Fahy, and Secretary – Berrin Tansel) followed this process in the creation of this Committee

Report:

(1) Determined the appropriate case studies generated by the CM in Desal subcommittees that could be used from the four topical subcommittee areas for the document;

(2) Discussed the required introduction and general material and began the selection of additional case studies as needed at its first meeting in El Paso, TX on October 9, 2009;

(3) Selected appropriate authors and/or current material for the four major areas as designated by the subcommittee topics to be included in the document;

(4) Reviewed the developed materials at other task committee activities in FY 2010;

(5) Promoted the activities of this task committee among other professional organizations;

(6) Reviewed and combined updated materials and generated a Final Draft for review and comments by the Desalination & Water Reuse technical committee during 2011;

(7) Revised the Final Draft for the concluding review by the Desalination & Water Reuse technical committee before the end of FY 2011; and

(8) Prepared the final materials for the EWRI publications process.

Scope of the Monograph

The following chapters and appendices are provided in this Committee Report:

Chapter 2 - Overview of Processes and Configurations – Sethi & Frenkel & Mercer

Chapter 3 - Regulatory Setting – Mercer

Chapter 4 - Environmental Issues – Tansel & Keyes

Chapter 5 - Economic Evaluation – Keyes & Fahy

Chapter 6 - Implementation/Case Studies – Keyes & Fahy & Tansel

Appendix: Concentrate Management Case Studies

Appendix A-1 Ocean and Bays Disposal (Subcommittee Chair – Jim Jensen)

Nikolay Voutchkov – Carlsbad, CA plant
Val Frenkel – Marin Municipal WD plant, San Rafael, CA
Val Frenkel – Charles Meyers WW plant, Santa Barbara, CA

Appendix A-2 Sanitary Sewer or Surface Water Disposal (Subcommittee Chair – Harold Thomas)

Mike Fahy, John Balliew, & Anthony Tarquin – Pilot Research of Non-Irrigation Season
Flows to River
Khalil Atasi and Colin Hobbs – Ormond Beach, FL (dual – land application/sewer)
Berrin Tansel - Joe Mullins RO plant

Appendix A-3 Deep well Injection, Land Disposal, and Evaporation Ponds (Subcommittee Chair – Ken Mercer)

Mike Fahy & Kenneth Mercer & Scott Reinert - EPWU Kay Bailey Hutchinson plant
Berrin Tansel - North Collier Regional plant
Berrin Tansel – Melborne, FL plant
James Jensen – Dalby Stage 2 plant, Queensland, Australia

Appendix A-4 Zero Liquid Discharge (ZLD) and Near ZLD (Subcommittee Chair – Sandeep Sethi)

Berrin Tansel - NASA Closed Loop
Sandeep Sethi – South Florida WMD

References

Krieger, R. A., Hatchett, J. L., and Poole, J. L., (1957). "Preliminary Survey of the Saline-Water Resources of the United States", Geological Survey Paper 1374, U.S. Geologic Survey, Washington, D.C.

Treanor, P. and V. S. Frenkel (2009). "Desalination Considerations", *Civil Engineering,* ASCE, Vol. 78, No. 6, June 2009, Reston, VA, pp. 50-55.

U.S. Bureau of Reclamation and Sandia National Laboratories (2003). Desalination and Water Purification Technology Roadmap, Report for Program #95, A report of the Executive Committee, January 2003

Chapter 2 – Overview of Desalination Processes and Configurations

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Introduction

The by-product or residual stream generated during desalination of brackish water, seawater, or treatment of wastewater for reuse applications is termed 'concentrate'. This chapter provides an overview of desalination processes and conventional concentrate management methodologies, including citations to the configurations of the Case Studies in Appendix A.

The two major, commercialized technologies for desalination include membrane and evaporative (also known as 'thermal') technologies. While evaporative technologies have been extensively used in the Middle East, the United States has almost exclusively relied on membrane processes for desalination. Additionally, in recent years the use of membranes for desalination has become more predominant in the world in comparison to evaporative technologies due to technological advancements and cost advantages of membrane processes. The focus of this document as it relates to concentrate management is on the membrane desalination processes.

Membrane Desalination Processes

The commonly accepted definition of desalination or desalting is separation of dissolved salts and minerals from water. The sum total of dissolved constituents can be expressed as the bulk parameter Total Dissolved Solids (TDS) and measured in mg/L or ppm. TDS has a direct relationship with conductivity and a rule of thumb expression is:

TDS (ppm) = 0.67 x conductivity (µS/cm) (Eq. 2-1)

There are three general classes of membrane desalting processes, namely:

- Reverse osmosis (RO)
- Nanofiltration (NF), and
- Electrodialysis (ED) and electrodialysis reversal (EDR).