MEMORANDUM

To: Saqib Shirazi, P.E., Innovative Water Technologies, Texas Water Development Board (TWDB)

FROM: Lianfa Song, PhD, Texas Tech

SUBJECT: Demonstration of High Recovery and Energy Efficient RO System for Small-Scale Brackish Water Desalination – May 2011

DATE: May 27, 2011

CONTRACT: 1004831107

Recent Project Activities:

1. We repeated tests conducted during the previous quarter for total dissolved solids (TDS) concentrations of 1,000 ppm, 2,500 ppm and 5,000 ppm with new (brackish) membranes due to fouling problems encountered. We expanded the range of flowrates for feed and recycled concentrate (recirculation) and determined energy requirements for permeate production for all TDS levels and flowrates. Graphical data from tests conducted this quarter are presented below in Figures 1 and 2.

2. To better assess system energy efficiency and identify ways to improve efficiency, we examined the energy consumed by the high-pressure feed pump and the energy consumed by the recirculation pump. We estimated hydraulic resistance of the membranes from experimental data to determine whether or not system operating pressures created by the high-pressure feed pump were reasonable. The hydraulic resistance was determined to be in fairly close agreement with manufacturer's specifications. In order to assess energy consumption by the recirculation pump, we compared crossflow pressure drops observed during tests with maximum values specified by the membrane manufacturer. Observed pressure drops were higher than the manufacturer's specified pressure drop (15 psi) at all TDS levels and flowrates.

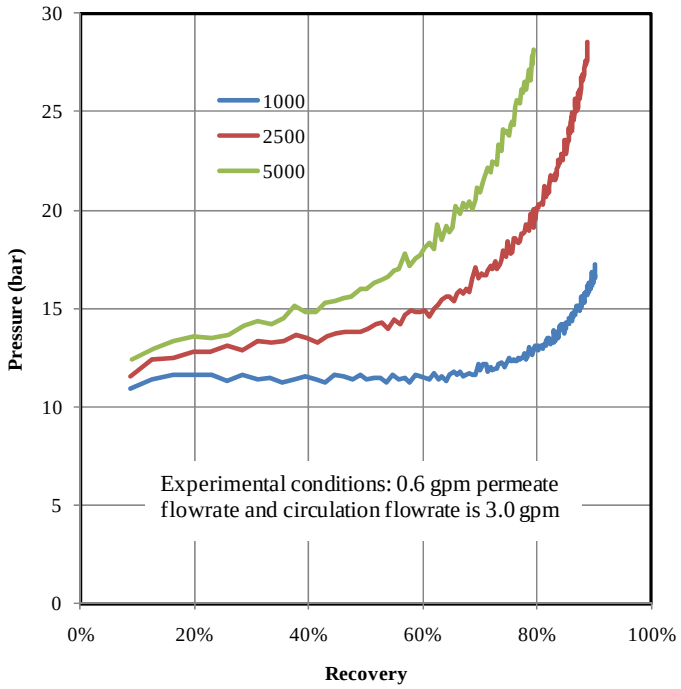

Figure 1. Pressure profiles during membrane filtration in the parallel RO system

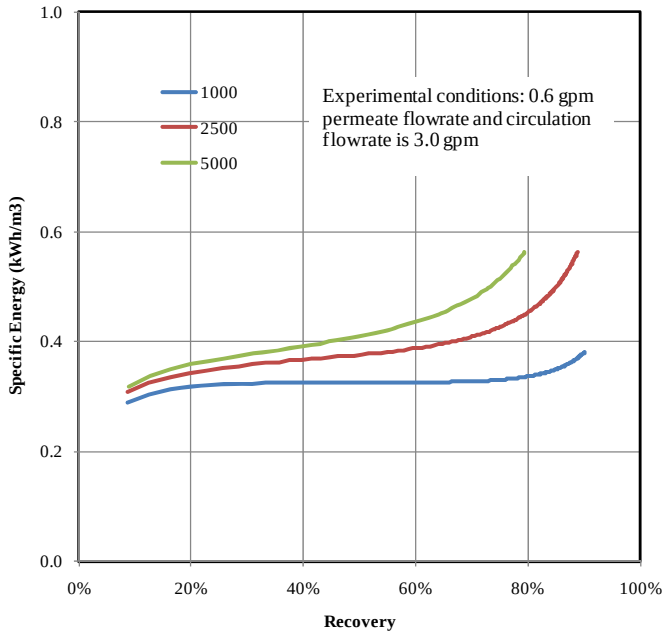

Figure 2. Specific energies as functions of recovery in the parallel RO system

3. In response to higher than expected crossflow pressure drops, we examined the membranes and identified fouling as an ongoing problem. Chemical analysis was performed on membrane deposits, solids found in the membrane pressure vessels and deposits on the walls of the holding tank. Iron compounds were identified as potential foulants. In response to the fouling problem, we thoroughly cleaned and flushed the system, replaced membranes and made process and design changes to reduce fouling and improve flushing of the holding tank. These changes are provided below in 3a through 3c.

    3a. Reversed flow configuration through holding tank. Recycled concentrate now enters the tank from the bottom of the tank and feed used to flush the tank enters from the top of the tank.

    3b. Changed the source of sodium chloride from water softener salt to a low-iron grade of sodium chloride

    3c. Will operate the system on a less intermittent basis. Will reduce periods of downtime by flowing fresh water through system between tests. This should reduce the likelihood of bacterial growth within the system.

4. Identified potential suppliers of colloidal silica for the next phase of research, i.e., the determination of fouling potential at different crossflow velocities.

Issues Encountered:

1. Observed crossflow pressure drops were much higher than the maximum single membrane pressure drop (15 psi) specified by the manufacturer. This observation has been made at all flowrates and TDS concentrations. Recirculation pump head needed to overcome the pressure drops represents a large percentage of the total energy consumption of the process.

2. Fouling was observed on membranes. Sampling and analysis of deposits on membranes and deposits on walls of holding tank indicate that iron compounds are potential foulants. Ignition of the sample in a muffle furnace indicates that very little, if any, of the membrane fouling is due to biomass, although additional testing may be needed to confirm this.

3. As reported previously, flushing of the holding tank is not sufficiently thorough to allow the system to operate during multiple “normal”/discharge” flow cycles. As described in the previous section, the flow configuration of the holding tank has been reversed in order to remedy this problem.

Items to be Addressed and Anticipated Project Activities:

During the next reporting period, i.e., quarter, we will repeat the tests at various TDS concentrations, feed flowrates and recirculation flowrates using the purer grade of sodium

chloride and the new holding tank configuration to determine whether or not these modifications will solve the fouling problem. If these changes do not reduce the crossflow pressure drop, other factors will be examined and appropriate process changes will be made.

Once the fouling problem has been sufficiently resolved and the crossflow pressure drop has been adequately addressed, the next phase of the research will begin. We are in the process of identifying a supplier for colloidal silica which will be used in fouling tests at the crossflow velocities specified in the original proposal.