

Masdar's Renewable Energy Seawater Desalination Pilot Program

Forward Osmosis Pilot Plant of Trevi Systems

August 2017



Background

In 2013, Masdar launched the renewable energy seawater desalination pilot program to develop and demonstrate highly energy-efficient, cost-competitive advanced and innovative seawater desalination technologies that are suitable to be powered by renewable energy.

The demonstration includes 5 pilot plants situated in Ghantoot, Abu Dhabi; each pilot plant was operated over around 15 months to determine the technical performance and reliability of the demonstrated technologies. The 5 pilot plants demonstrated different advanced and innovative desalination technologies.

Site Location

All pilot plants treated seawater from the Arabian Gulf with an average salinity of 42,000 mg/l. Seawater, electricity, and heat were provided and measured by Masdar. The location of the pilot plant is depicted in Figure 1.



Figure 1: Location of the pilot plant site in Ghantoot, Abu Dhabi, UAE

Pilot Plant Performance

The pilot plant of Trevi Systems incorporates a truly novel technology for water desalination based on the forward osmosis process. It has the potential to become a unique solution for the treatment of highly saline waters that uses very low electricity and heat.

The construction of the 50 m³/d pilot plant was completed in January 2016. The pilot plant has been in operation between then and July 2017, with some periods of non-operation due to system reconfigurations. Trevi Systems has significantly improved the energy efficiency of the pilot plant in the course of the demonstration period by adjusting its configuration and by installing some new equipment. A notable improvement was the commissioning of a new coalescer in January 2017 to improve separation of the draw solution and product water, based on a revised coalescer design developed and tested at Trevi Systems' laboratory in Petaluma, CA. The operation of the pilot plant ended in July 2017 as agreed upon between Trevi Systems and Masdar.



Figure 2: Trevi Systems Pilot Plant

The achieved performance data show that the forward osmosis process performs well. The produced water complied with the potable water standards of Abu Dhabi. Furthermore Trevi Systems had the product water analyzed for total organic carbon (TOC) to detect if any components of the organic draw solution infiltrate into the product water. The analysis showed that no significant amounts of the polymer were present in the product water (TOC < 0.02 mg/l).

The pilot plant achieved a specific energy consumption of 1.47 kWh/m³ (electric) and 134 kJ/kg (low temperature heat, at a supply temperature of 90°C and a return temperature of 75°C) at a flow rate of 1.1 m³/h. Figure 3 provides a graphical overview of multiple energy consumption measurements. Implementation of the technology at larger scale is expected to reduce the energy consumption to around 1.2 kWh/m³ (electric) and 100 kJ/kg (low temperature heat).

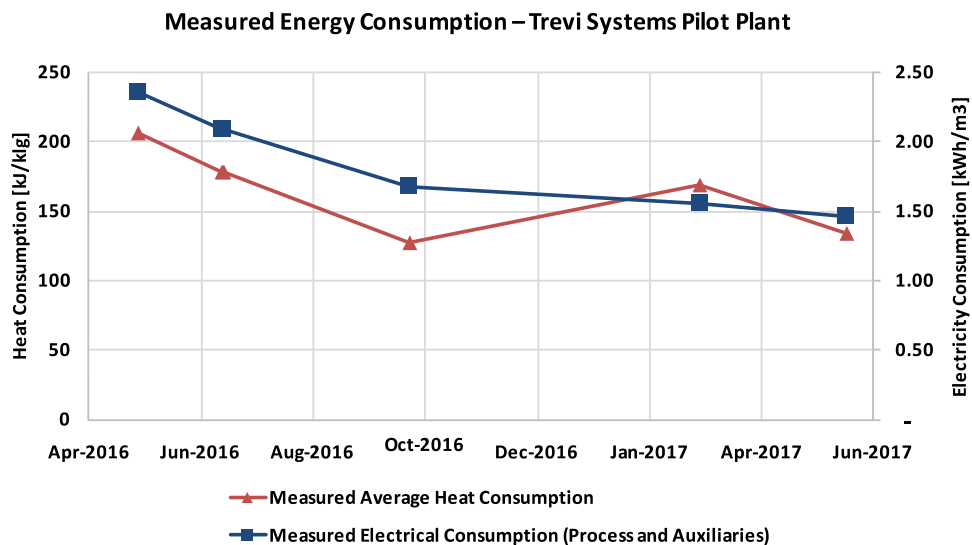


Figure 3: Measured energy consumption

Trevi Systems' demonstration of its novel forward osmosis technology is a big step forward in the development of this new technology with unique advantages, such as low pressure operation, low electricity consumption, and ability to treat very difficult feed waters. The technology still needs to undergo further development phases before being mature enough for application in larger-scale commercial projects. The demonstration in Ghantoot is a critical element in the technology advancement of forward osmosis.