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Solar Driven Desalination Using MD - Case Study

Ala Kullab

The aim of this thesis project is to investigate the potential optimisation of using integrated membrane distillation (MD) with solar energy systems for desalination. Applications in Palestine and nearby regions are of particular interest.

The project contains the following components:

- Explore potential to provide combined heat and electricity, possibly with solar thermal and/or solar PV
- Perform experimental work on air-gap MD unit (equipment owned by Xzero AB and located at the Dept. of Energy Technology, KTH, Stockholm)
- Perform energy/mass balance simulations (Aspen Utilities)
- Perform economic analysis (equipment, installation, land requirement and operating costs)
- Propose specification for future pilot plant

Advantages of the System

- Provide high quality drinking water
- Sustainable, clean and free power supply
- Low operation temperature => Flat Plate Solar Collector
- Low operation temperature => more operation time than other solar desalination systems
- Simple mechanical properties => Easy O&M (comparing with RO)
- Low sensitivity to variation in process variables (pH, TDS), Comparing with RO =>High feed concentration can be used =>Lower pumping rate

Disadvantages

- High energy intensity (heat recovery needed)
- Volatile cannot be completely separated
- Sensitive to weather conditions (comparing with conventional power supply)
- Large Land requirements (High capital cost)
- Lower production rate (comparing with RO)

Removing arsenic from ground-water in Bangladesh

Ashiq Moinul Islam

With a population of about 140 million living in a total area of 144000 sq. km, Bangladesh is the most densely populated country in the world. Lack of adequate water supply network has forced people to install millions of tube wells over the last several decades. Presence of arsenic in the sedimentary aquifers, extensive extraction of ground-water and use of that as drinking water has been causing the nation to suffer from a huge problem caused by arsenic.

This is said to be the largest mass poisoning of a people in the history of mankind. Millions of people have been at risks alone in Bangladesh with thousands already showing symptoms of arsenic poisoning. Continuous use of high arsenic contaminated water can cause cancers of the skin, bladder, kidney, and lung, and diseases of the blood vessels of the legs and feet, as well as possibly diabetes, high blood pressure, and reproductive disorders.

Apart from Bangladesh arsenic problem has been reported in several other countries including Argentina, Canada, Chile, China, Hungary, India, Japan, Mexico, New Zealand, Taiwan, Thailand and the United States.

HVR Water Purification AB has been trying to commercialize a house-hold level water purifier which is based on a novel technology called the membrane distillation process. This purifier can efficiently remove all non-volatiles from drinking water including arsenic. So much money and time have been spent on other methods to get rid of arsenic problem from ground water, but unfortunately no solution has been found yet.

So membrane distillation process and its application like HVR water purifier deserve much attention from different concerned international agencies, governments etc.
Larger community level purifier can also be built and placed in the arsenic affected areas in countries like Bangladesh. The membrane distillation process does not remove only arsenic, it removes all other impurities from drinking water. If due attention is given for its proper development and implementation, this new technology can become a real lifesaver.

Membrane Distillation and Application in Thermal Cogeneration

Liu Chuanfeng

Power generation industry requires high quality water, so called ultra pure water. In a general cogeneration power plant, there are three fields where water purification techniques are required, e.g. make up water for boiler/ steam cycle, make up water for district heating network and flue gas condensate treatment. For example, a 400 MW_{el} power plant requires around 20m^3/hr make up water for both boiler and district heating network.

Since the driving force of membrane distillation (MD) is thermal energy, power generation industry should be another promising field where MD can be adopted. Nowadays the dominant water technologies are ultra filtration and RO.

Two options can be chosen for integrating MD into thermal cogeneration power plant. One is to combine a district heating network with MD, the other is to utilize low grade steam as heat source for MD. After economic analysis, all estimates compare extremely well to reverse osmosis systems if we consider that MD is not still commercialized. There is large room to improve MD technology regarding cost saving in the future.

This investigation shows that membrane distillation is a promising technology for demineralized water production in thermal cogeneration plants. Experimental trials conducted to date indicate that this technology meets certain requirements related to general operations.

Heat and mass balance calculations combined with an economic analysis show that substantial installed and operational cost savings could be realized. For the 10m^3/hr application under consideration, projected demineralized water costs are estimated at around 10-12 SEK/$m^{3.}$