

Full scale demonstration of osmotic power in high salinity

Quintal, Jhony - Main Author¹; Bindseil, Mathilde Flemming - Co-Author¹; Nakao, Takahito - Co-Author²; Hirata, Shinsuke - Co-Author²; Overgaard, Mads - Co-Author³; Thorøe, Kurt - Co-Author⁴; Culmsee, Jesper - Co-Author¹; Pedersen, Lars Storm - Co-Author¹; Guo, Haofei - Co-Author¹

¹SaltPower, ²TOYOBO CO., LTD., ³Nobian, Dansk Salt A/S, ⁴Semco Maritime

Main topic: Forward osmosis/Pressure retarded osmosis

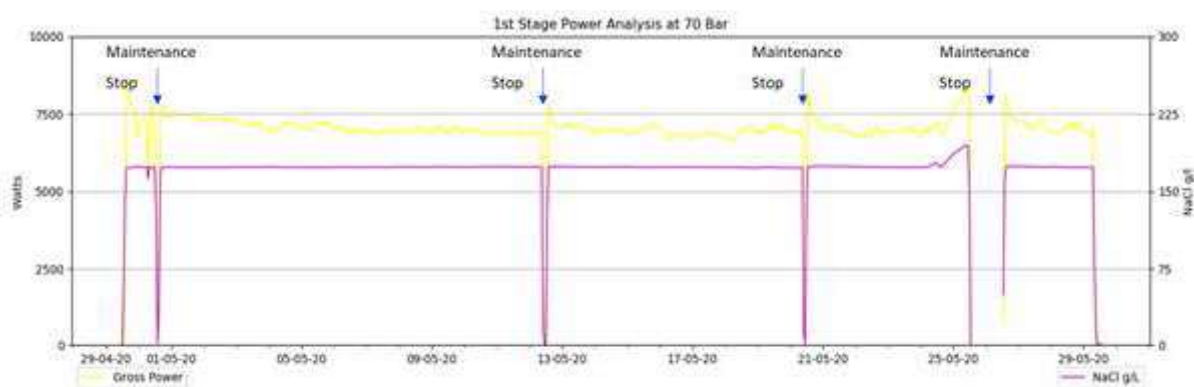
Osmotic power can be generated by pressure retarded osmosis (PRO) aided by semi-permeable media. Where two different salt concentration aqueous solutions are separated by membrane barrier, meanwhile water from low saline phase penetrates through connected membrane pores to meet and dilute high saline solution, leading to salinity gradient, which can be further converted into electricity, so called blue energy. Although the idea itself is highly attractive especially in application of seawater desalination, research work of PRO for power generation has been retarded several times in the past two decades due to the insufficient efficiency. Positive results seems only available in lab-scale with prototype membranes. So far there is not a commercialized full scale PRO plant even Mega-ton claimed their project successfully achieved 17 W/m² power density [1].

Monumentation of full-scale PRO for power generation was revived at Europe, by Jørgen M. Clausen in 2015, after failure of Statkraft project. The founder of SaltPower believes a success of high power output using high salinity brines instead of seawater [2]. This concept is further confirmed by scientific research [1]. Today, resources of high brine solutions are more versatile and richer than oil, and makes it possible to be alternative power solution for green energy generation. SaltPower is therefore striving for developing a technical solution to transform salt into power.

Solution mining is the process of extracting salts by leaching from underground deposits. When doing this, a valuable high saline solution is extracted and used for salt production and simultaneously an underground cavern is formed which is ideally suited for large scale storage of gas, like natural gas or hydrogen from renewable sources. Such solution mining forms the basis for the salt production at Nobian, Dansk Salt A/S where a full scale demonstration PRO plant is designed and built-up by SaltPower and Semco Maritime.

This article presents a long-term test with above demonstration unit using Toyobo proprietary 10-inch hollow fiber membrane module with hypersaline draw solution at pressure up to 70 bar. Initial results show relative stable membrane performance and power output within 2000 hrs duration by hypersaline PRO process, as predicted.

Figure 1 Power generated from salt by PRO



Reference 1:

H. T. Madsen, T.B. Hansen, T. Nakao, S. Goda, E.G. Sjøgaard. Energy Conversion and Management 226 (2020) 113504.

Reference 2:

<http://saltpower.net/applications/>