Contribution ID: **28** Type: **Oral**

Electricity and Water cogeneration using a Small 75MWth PWR

This paper investigates a hybrid desalination strategy, using both Direct Contact Membrane Distillation (DCMD) and Sea Water Reverse Osmosis (SWRO), for cogeneration of water and electricity using a small PWR of 75 MW(th).
Blending the water produced by SWRO with that produced by DCMD has two main advantages. One is the improvement of the quality of the water produced, as compared to that obtained with the SWRO plant. The other is the reduction of the cost of water production, as compared to that attained by the DCMD plant alone.
The SWRO plant uses the electricity generated on site by the small PWR. The water production of the SWRO plant is determined using the electricity consumption of 4 kW(e)h per cubic meter, which is a value typical of a real-scale SWRO plant.
On the other hand, we divide the steam produced in the steam generator into two parallel Rankine cycles. The first of those cycles operates at pressures and temperatures typical of a Rankine cycle optimized for electricity generation. In the second cycle, steam expansion in the turbine is shortened to a pressure just below the atmospheric pressure. Thus, steam condensation occurs at a temperature just below 100 °C, which allows heating the seawater in the second Rankine cycle condenser up to 92 °C. The external heating required for the DCMD desalination process comes exclusively from cooling the two Rankine cycle condensers. So, a specific electricity consumption of 8.47 kW(e)h per cubic meter has been obtained for the DCMD process. These computations used the DE-TOP program, developed by the IAEA, which simulates the Rankine cycles of PWRs, and the DESAL-PLANT program, developed at IEN/CNEN, which models a DCMD desalination plant with heat recovery.
Finally, estimates of water and electricity production are presented, considering the mean seawater temperature of the Brazilian northeast.

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YES

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Track Classification: Topical Group A: SMR Design, Technology and Fuel Cycle: Track 5: Non-Electric Applications for SMR