BARC commissioned Seawater Desalination Plant dedicated to the nation

The state-of-the-art indigenous technology caters to the sustained requirement of process water at IREL OSCOM in Chatrapur, Odisha by processing seawater.

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Taking a leaf out of Government of India's renewed push for high-end technology innovation and increased deployment of home-grown capabilities (spirit of 'Atmanirbhar Bharat') in diversified areas of science and technology applications, Bhabha Atomic Research Centre has setup a seawater desalination facility within the operations of Odissa Sand Complex (OSCOM) at Chatrapur. The newly commissioned seawater desalination plant was dedicated to the nation by Prime Minister of India on March 5, 2024. The desalination facility comprises 4.5 million litres per day (MLD) Seawater Reverse Osmosis (SWRO) plant and 0.5 MLD Multi Effect Distillation Thermo Vapor Compression (MED-TVC) desalination plant. Importantly, total 5 MLD high quality water generated from this desalination facility adequately meets full-scale requirement of process water in the day-to-day operations of OSCOM complex and drinking water supply of nearby areas.

Process Description

Multi-Effect Distillation with Thermo Vapor Compression (MED-TVC)

Two units of 250 m^3/d MED-TVC plant (0.5 MLD total product capacity) were designed, installed and commissioned to meet the demand of high-quality process water at OSCOM, IREL. The units are designed to produce an average 11 m^3/hr distilled water of conductivity <5 µS/cm directly from sea water without any pre-treatment, using 1.1 TPH steam (@ 10 bar) from the IREL boiler. This plant uses multiple evaporators in series and thermo vapor compressor (TVC) to achieve the steam economy (10 kg distilled water per kg of steam). The high-quality distilled water produced from the plant will be used for boiler make-up water of OSCOM. Each evaporator consists of a horizontal tube bundle and the feed seawater is sprayed on top of the tube bundle, which then drips from an array of tubes until it is collected at the bottom of the effect.

Feed water forms a thin film on the outer side of the tube surface and gets heated due to the condensing steam inside the tube. Sub-atmospheric pressure is maintained inside the

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effect to reduce the boiling temperature, thereby minimising the scaling threat to evaporator tubes. A fraction of the heated seawater boils to form water vapours. After separating the entrained seawater droplets, the vapour flows into the tube bundle of the next effect, heating and evaporating more seawater. The vapour condenses to produce fresh water while transferring the latent heat to evaporate a portion of feed seawater in the next effect and this process continues for 6 effects in the MED plant. TVC is used to improve the overall steam economy. The vapour produced in the last effect is compressed in the TVC using medium-pressure steam (10 bar) and reused in the first effect.

This plant offers several advantages such as high steam economy; compact evaporator due to high heat transfer coefficient in thin film; reduced scaling potential due to low temperature operation. The plant is equipped with a PLC-SCADA system that enables precise control over the various process parameters. The system automation minimizes the need for manual intervention, resulting in optimum workforce requirement for plant operation. The plant utilizes high-quality, corrosion-resistant materials to ensure long-lasting operation in a marine environment (SS 316L shell and Ti grade 2 tubes). The plant requires 40 kW electrical power. VFD controlled pumps are used for smooth operation. With proper operation and maintenance, the MED-TVC plant is expected to have a design life of 40 years. The scaled-up version (1 MLD) MED TVC Technology is available for technology transfer.

Seawater Reverse Osmosis (SWRO)

The SWRO plant is designed to produce water at the rate of about 4500 m^3/day with salinity (TDS) of less than 500 ppm from seawater with an overall electrical power consumption of Total 940 kW. 950 m^3/hr of seawater is drawn from deep sea 900 m away from shore location through sea water pump house station located at Gopalpur Ports Ltd (GPL) adjoining OSCOM, IREL. Seawater is first pre-treated by passing it through clarifier, multigrade filter and then sent through ultrafiltration membranes for making it free from suspended solids. The treated water is then pressurised by high pressure pumps & fed to RO membrane modules for removal of dissolved salts from seawater. These membranes are manufactured by BARC technology licensees based on the BARC's know-how for the preparation of sea water reverse osmosis (SWRO) membrane. The performance of these membranes is at par with the commercially available membranes. The RO product (187.5 m^3/hr) having total dissolved solids less than 500 ppm, conforming to WHO guidelines and Indian drinking water standard IS-10500 after suitable post-treatment is supplied to reservoir of OSCOM. The concentrated seawater from desalination plant is discharged back to deep sea through diffuser.

Successful deployment of indigenous desalination technologies at IREL OSCOM is a major step towards ensuring high quality water availability in DAE units as a part of 'Atmanirbhar Bharat'. Through indigenisation of SWRO

technology, BARC aims to provide a viable import substitute to industry and municipalities. The MED-TVC technology, with its high efficiency, low maintenance requirements, and ability to produce high-purity water, holds immense potential to meet the water demand in various industries facing severe challenges. As the country strives for greater water sustainability, BARC-developed seawater desalination technologies are poised to play a significant role in capacity building to bridge the gap between demand and supply in the coming years for ensuring water secure India.

Benefits of BARC commissioned Seawater Desalination Plant

The successful commissioning of the seawater desalination plant offers significant benefits. These are as follows:

Enhanced Process Water Security & Operational Availability: The desalination plant ensures a reliable and consistent source of high-quality water for various process water requirements of IREL OSCOM facility, minimizing disruptions due to water scarcity at IREL OSCOM

High-Purity Distilled Water: The MED-TVC plant produces distilled water with a conductivity less than 5 µS/cm, ideal for applications requiring high-quality water, such as boiler makeup water and various process water needs within the facility.

Societal benefits: As a part of CSR activities of IREL, the potable water from the desalination plant can be supplied to nearby village.

The article has been compiled and edited by Saurabh, K. P. Bhattacharyya, A. K. Adak, K. T. Shenoy and Madhav N., of BARC.

Inside view of Seawater Desalination Plant equipped with BARC Technology commissioned at OSCOM in Odisha.