J. Ind. Geophys. Union, 29(3) (2025), 148-155
https://doi.org/10.71122/JIGU.29(3)2025.0016

High capacity offshore low-temperature thermal desalination plant: A new perspective

Ashwani Vishwanath*, Purnima Jalihal and Abhijeet Sajjan
National Institute of Ocean Technology (NIOT), Pallikaranai, Chennai-600100, India
*Corresponding author: ashwani@niot.res.in

ABSTRACT

National Institute of Ocean Technology (NIOT) has been working on developing technologies to ameliorate the shortage of drinking water in island and other coastal areas. Towards this, various onshore desalination plants have been constructed and operated utilizing ocean thermal gradient. For high capacity ocean energy and desalination plant, going offshore is considered to be a viable option. This article discusses the experiences and work carried out for ocean thermal gradient based large capacity desalination plant. Offshore plants have their own complexities with regard to design of platform, moorings and sea water pipelines. These components were studied thoroughly and discussed in the article. The design philosophy and results have been presented for a design of 10 million liters per day (MLD) capacity desalination plant, mounted on semi-submersible platform moored in 1000 m water depth.

Keywords: Offshore thermal desalination plant, Semi-submersible, HDPE conduits, spread mooring, Kavaratti (Lakshadweep)

INTRODUCTION

Ocean is a vast source of energy and potable water, both of which need to be harnessed in a clean and green manner. Among different sources of energy from the ocean, ocean thermal gradient perhaps has the highest potential for both extraction of energy and fresh water since we are in the tropics. The process of extraction of potable water from the ocean has already reached its advanced state. Sea water desalination is attaining increasing attention of present day policy makers, especially with the growing demands that urbanization, population explosion, irregular rainfall and ground water contamination place on the fragile natural resources. Membrane and thermal desalination processes are both popular today.

Low temperature thermal desalination (LTTD) is one process that uses the availability of a temperature gradient between two water bodies or flows to evaporate the warm water at low pressure and condense the resultant vapour with cold water to obtain fresh water. The temperature difference that exists between the warm surface sea water (28^0~30^0 C) and deep sea cold water (7^0~15^0 C) could be effectively utilized to produce potable water and generate power (Rognoni et al., 2008). The advantage of using this method is that steam is not required.

National Institute of Ocean Technology (NIOT) under the Ministry of Earth Sciences (Government of India), strives to develop reliable indigenous technology to solve the various engineering problems associated with the harvesting of living and non-living resources in the Indian Exclusive Economic Zone (EEZ), which is about two-thirds of the land area of India. The LTTD process as mentioned above, which converts sea water into potable water using natural ocean thermal gradient, has been successfully demonstrated by NIOT at Kavaratti in Lakshadweep Islands for the first time ever in 2005 (Jalihal, 2022). Subsequently, this indigenized technology has been deployed in various islands of Lakshadweep recently. This technology has transformed the lives of the islanders by improving their health. NIOT has also worked on offshore based desalination plants for augmenting the freshwater requirements of mainland. The offshore plants are considered gateway for large capacity ocean thermal gradient based energy and desalination plants. Design of offshore plant is challenging due to the complexities of various offshore components such as platform, moorings, large sea water conduits, integration and installation, etc. Nonlinear time domain dynamic analyses need to be carried out for offshore components which are constantly in a dynamic environmental with wave and currents (Vishwanath et al., 2020). The article discusses those challenges, works and studies carried out by NIOT for high capacity offshore LTTD plant. It also outlines design methodology and results for the proposed 10 MLD capacity Semi-submersible mounted LTTD plant at 1000 m water depth.

OFFSHORE LTTD PLANT

The main components of the LTTD plant are: (i) Heat exchanger like shell and tube condenser, (ii) Duct that transfers vapour from the flash chamber to the condenser, (iii) Sea water pumps to supply the warm and cold sea water, (iv) Vacuum system that maintains the flash chamber, vapour duct and the vapour side of the condenser at the design vacuum, at about 26.5 mbar (abs), and (v) Pipelines to draw cold water from the required depth.The pipeline is the most challenging part of the system. In an onshore plant, as in the case of islands, the deep water is very close to the shore. This is a special feature in the Lakshadweep group of islands. Thus the pipe has been designed to be in a novel configuration with one end in shallow waters near the shore and the other end, held by a weight in deep waters. The inverted catenary configuration is possible due to the inherent buoyancy of the material of the pipeline. For the mainland application of this technology, the drawing of the cold water is the challenge since the distance to the deep water is about 40-50 km from the east coast of India. This necessitates that the plant be located on a platform which is