The First Floating Barge Mounted LTTD Plant by Indian Scientists

By Everest Transmission

NIOT's barge Sagar Shakti with the first ever floating desalination plant

The Sagar Shakti is the first ever 1MLD floating barge mounted, low temperature thermal desalination plant commissioned by scientists of the National Institute of Ocean Technology, Chennai.

Water seems to be a superabundant natural resource on our planet. However, only 0.3% of the world's total amount of water can be used as clean drinking water. As natural fresh water resources are limited, seawater plays an important role as a source for drinking water. In order to use this saline water, the process of desalination becomes a necessity. Seawater desalination is a real challenge. The base method for seawater desalination is distillation. Approximately 620kwh of evaporation enthalpy is necessary to obtain 1t of drinking water. Since 2004, National Institute of Ocean Technology(NIOT) has been deeply involved in R&D activities related to low temperature thermal desalination(LTTD) for providing potable water from seawater to alleviate the scarcity of drinking water faced by coastal communities. For the first time ever NIOT successfully commissioned a 0.1MLD plant at Kavaratti Island in Lakshadweep, which has been in operation since May 2005.

Encouraged by the results of the indigenously designed and commissioned land based plant at Kavaratti, NIOT went a step ahead by venturing into a rather difficult and complex task of setting up a floating barge mounted LTTD plant. Floating desalination plants are required to serve the mainland where the deep sea water is available 30-40km from the shore as compared to islands where deep sea water is available closer to the shore. A floating barge mounted desalination plant of 1MLD was commissioned in April 2006.

Seawater contains dissolved salts having a concentration of about 35,000ppm, which is too high for the use by human beings. This level must be reduced below 500ppm before it can be used for drinking purposes. Distillation is the oldest and the most commonly used method of desalination, where seawater is evaporated and the vapours are then condensed giving clean water. The latent heat of water is about 540kcal/kg making the process energy intensive. Conventional distillation columns prove uneconomical for production due to high input energy requirements. Various techniques are being used to recover the latent heat like multi-effect evaporators, which can lower the energy requirement costs drastically. In LTTD methods the energy requirement for the evaporation of water are taken from the sea which makes the process eco-friendly and uses renewable source of energy. LTTD uses the temperature differences which exists between the surface layer water (28°-30°C) and deep sea layer water (7°-10°C) existing in an ocean to produce potable water. Figure 1 gives the plant layout of LTTD installed at Kavaratti.

Basic principle of LTTD plants

The surface seawater at about 28°-30°C is pumped into a flash chamber which is maintained under low pressure of about 25mbar absolute (below the saturated vapour pressure of water). The warm seawater in the flash chamber evaporates due to low pressure being maintained, taking latent heat of evaporation from the warm water stream itself. The evaporated water vapours move towards the shell and tube condenser and the return water, loosing temperature by about 7°C and returned back to the sea. The main condenser has a circulation of cold seawater at a temperature of 12°-13°C, pumped from the lower layers of sea and is used for the condensation of the evaporated water vapour. The condensate thus produced is fresh potable water fit for human consumption. The cold water used in the condenser can be subsequently used for air conditioning as the return temperature of this water is around 17°-18°C. This water being pumped from the lower levels of the sea is rich in minerals and plankton and when discharged on sea surface becomes a potential breeding area for fish and other marine life.

The LTTD method of producing fresh water from seawater consists of flash evaporators, main condensers, fresh water pumps, warm water pump and a vacuum pumping system. Since the major equipment is static, the entire project requires low maintenance and thus having long operational life (Figure 1). The surface seawater is pumped into the flash chamber where low pressure is maintained. Almost 1% of the water is evaporated in the flash chamber and the rest of the water freely flows back into the sea as the flash chamber is maintained at a barometric height. The vapours evaporated in the flash chamber are driven over the main shell and the tube condenser. The cold source of water pumped from lower layers of the sea takes away the condenser heat. The discharge water of the condenser, available at about 17°C-18°C, can be used for other cooling applications such as air conditioning etc before being discharging back into the sea. During the process of evaporation non-condensable gases are released from the sea water and the plant leakage load is constantly pumped by a vacuum system to ensure that absolute pressure in the range of 25mbar is maintained in the vessel. The estimated consumption of energy per KL on a medium size plant is estimated around 8units/Klt of fresh water generated. As per the current rate of energy, the estimated cost of generation is about 3paise/lt, which is very economical as compared to other conventional methods presently in use. To improve, additional technique of desalination of seawater prior to its admittance in the flash chamber was planned which resulted in higher efficiency, yield and low power consumption.

The main features of the LTTD plant are:

- No pre-treatment of feed water required
- Assured consistent quality water, fit for drinking as per WHO standards
- Operational simplicity and easy maintenance
- Zero environmental pollution
- Use of renewable energy
- Highly nutrient cold water available that can be used to enhance marine life

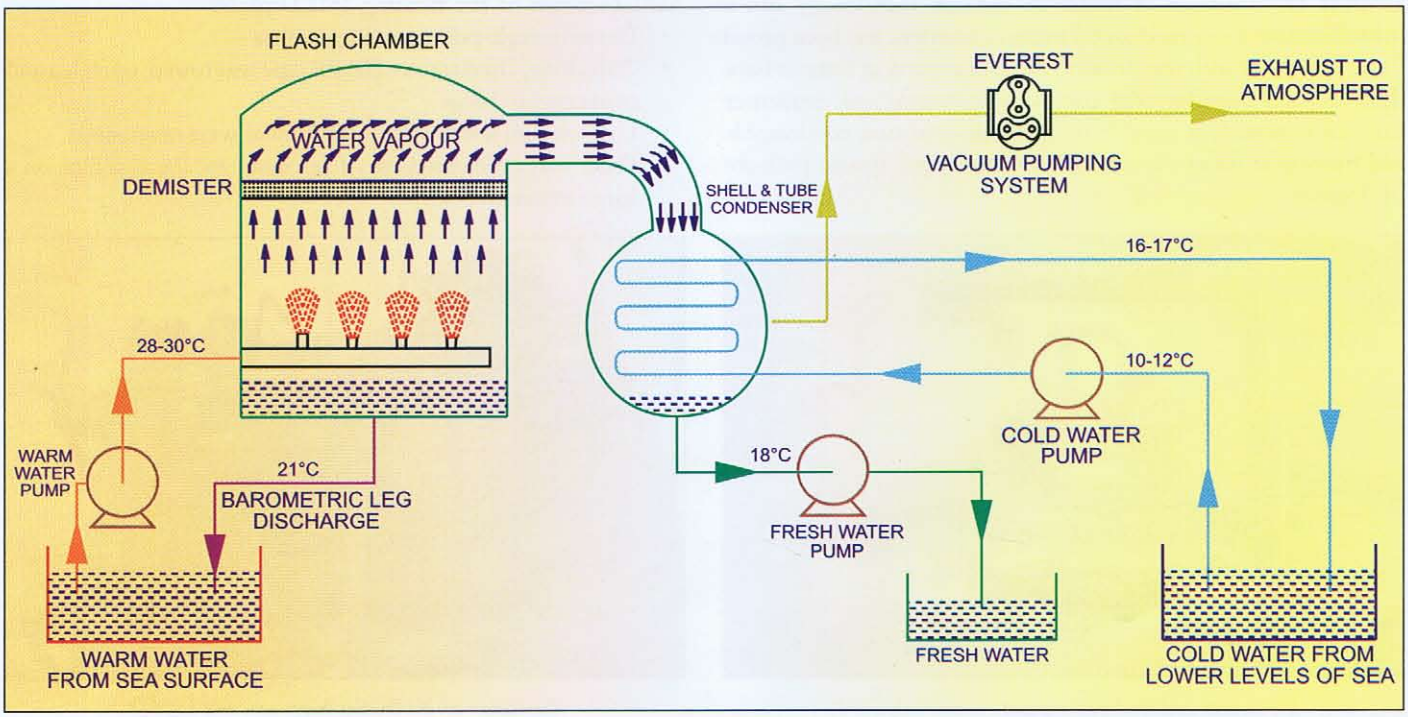
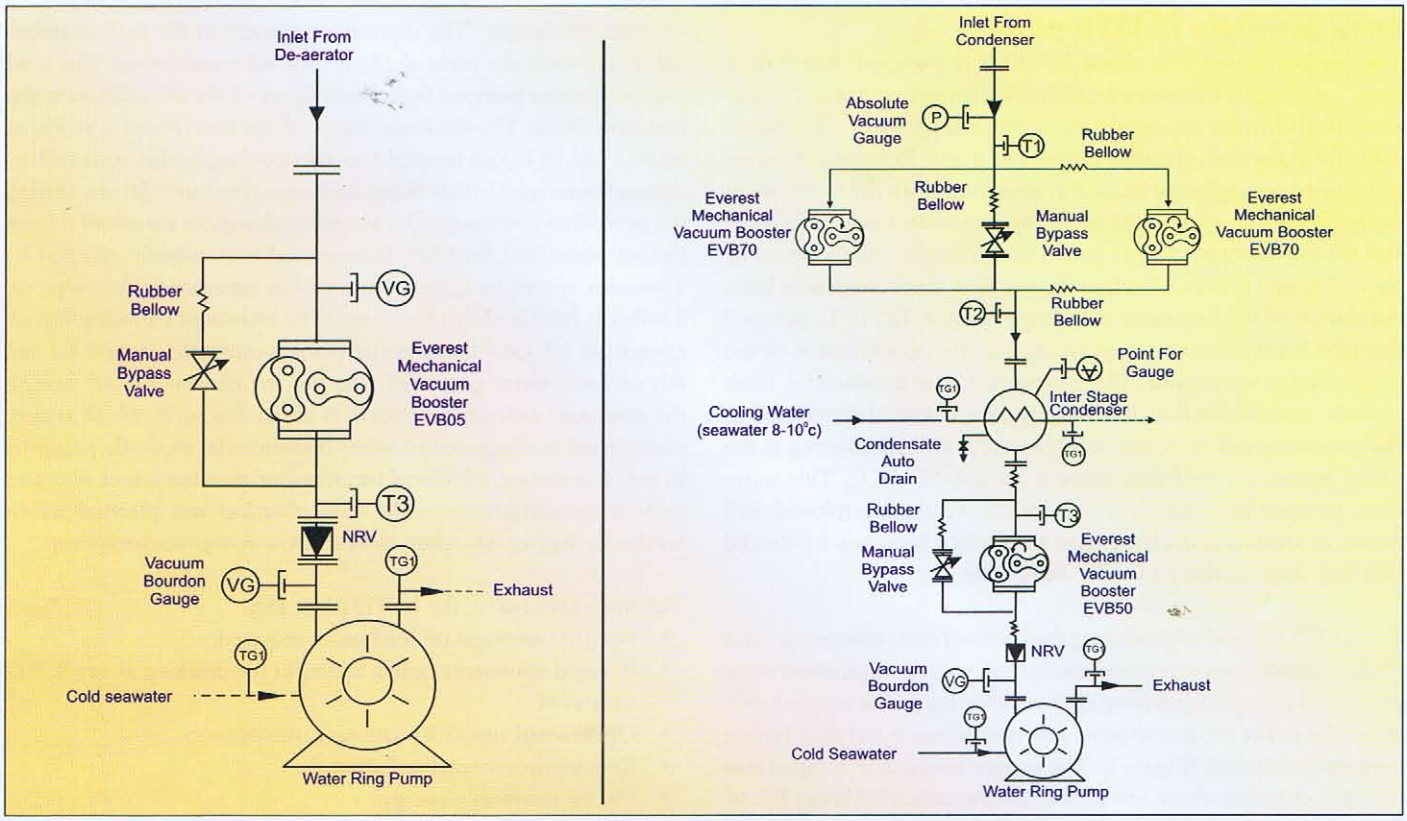


Figure 1: Plant layout for LTTD plant



Line Diagram for de-aerator & condenser vacuum systems (supplied by Everest Transmission, New Delhi)

Everest Transmission, a leader in vacuum technology and a manufacturer of dry mechanical vacuum boosters, has been proud to be associated with this project. Vacuum experts at Everest have designed and manufactured complete de-aerator and condenser vacuum system. It is capable of handling total non condensable and carry over water vapour load, maintaining a system pressure of 25mbar.

Achievements of the floating 1MLD plant:

- Deepest single point mooring in Asia
- 700m long, 1m diameter HDPE pipe was towed, upended and connected to barge
- Low vacuum levels of around 25mbar were maintained
- Fresh water generated out of sea water for the first time on a barge mounted plant

De-aerator and condenser vacuum systems supplied by Everest Transmission, New Delhi

Condenser of the floating barge mounted LTTD

Geo Bags being used to tow fresh drinking water produced on the plant

Operation parameters:

- Fresh water generated: 1MLD
- Warm water temperature: 28°C
- Cold water temperature: 10°C
- No. of units: 2
- Warm water flow rate: 569Kg/sec/unit
- Cold water flow rate: 500Kg/sec/unit
- Vacuum level: 23mbar
- Saturation temperature: 20°C
- Cold water pipe length: 850m
- Cold water pipe diameter: 1,000mm
- Total power requirement: 220KW

The technology can extensively be used in many chemicals plants for treatment of effluent. In fact a project on similar lines has already been conducted for concentration of sodium chloride solution in one of the large pesticide manufacturing units in India. The technical team at Everest, after being exposed to revolutionary technique of LTTD, gained valuable information and practical experience which has been put into commercial use by chemical and pharmaceutical Industry to economize production.

About the Article

The article is compiled by the technical team of Everest Transmission.
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