FIRST EVER FLOATING BARGE MOUNTED LOW TEMPERATURE THERMAL DESALINATION PLANT BY INDIAN SCIENTISTS

Fig 1: NIOT's barge Sagar Shakti with First Ever Floating Desalination Plant

Water seems to be a superabundant natural resource on planet earth. However, only 0.3 per cent of the world's total amount of water can be used as clean drinking water. Man requires huge amounts of drinking water every day and extracts it from nature for innumerable purposes. As natural fresh water resources are limited, sea water plays an important part as a source for drinking water as well. In order to use this water it has to be desalinated. Sea water desalination is a real challenge. The base method for sea water desalination is distillation. Approximately 620 kWh of evaporation enthalpy is necessary to obtain 1 t of drinking water.

This article is dedicated to the First Ever Floating 1 MLD Floating Barge Mounted, Low Temperature Thermal Desalination plant commissioned by scientists of National Institute of Ocean Technology, Chennai.

Since 2004 NIOT has been deeply involved in R&D activities related to Low Temperature Thermal Desalination (LTTD) for providing potable water from sea water to alleviate the scarcity of drinking water faced by coastal communities. For the first time ever NIOT successfully commissioned a 0.1 MLD plant at Kavaratti island in Lakshadweep, which has been in operation since May 2005.

Encouraged by the results of indigenously designed & 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 mainland where the deep sea water is available 30 to 40 KM from the shore as compared to islands where deep sea water is available close to the shore. A floating barge mounted desalination plant of 1 MLD was commissioned in April 2006 off Chennai.

Fig 2: Sagar Shakti with First Ever Floating Desalination Plant under rough sea conditions.

Sea water contains dissolved salts having a concentration of about 35,000 ppm which is too high for use by human beings. This level must be reduced below 500 ppm before it can be used. Distillation is the oldest and the most commonly used method of desalination, where sea water is evaporated and vapours then condensed giving clean water. The latent heat of water is about 540 kcal/kg making the process highly energy intensive and 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 method the energy requirement for the evaporation of water are taken from sea which makes the process eco-friendly and uses renewable source of energy.

LTTD uses the temp difference which exists between the surface layer water (28°-30°C) & deep sea layer water (7°-10°C) existing in an ocean to produce potable water.

The picture below (Figure 3) gives the Plant layout of LTTD installed at Kavaratti:

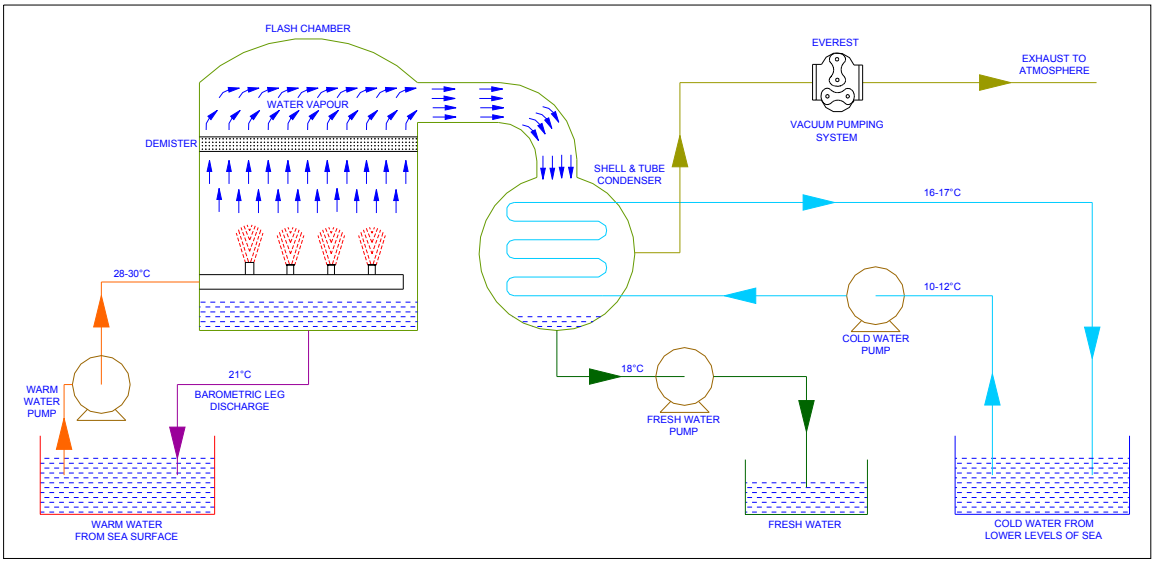

Fig 3: Plant Layout for Low Temperature Thermal Desalination Plant

The basic principle of Low Temperature Thermal Desalination Plant is as under:

The surface sea water at about 28˚C – 30˚C is pumped into flash chamber which is maintained under low pressure of about 25 mbar absolute (below the saturated vapour pressure of water). The warm sea water 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 & tube condenser and the return water, loosing temp by about 7˚C is returned back to the sea. The main condenser has a circulation of cold sea water at a temp of 12˚-13˚C, pumped from the lower layers of sea & is used for the condensation of the evaporated water vapour. The condensate thus produced is fresh drinking water fit for human consumption. The cold water pumped used in the condenser can subsequently be 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 & plankton and when discharged on sea surface becomes a potential breeding area for fish and other marine life.

LTTD method of producing fresh water from sea water consists of flash evaporator, main condenser, fresh water & warm water pump and a vacuum pumping system. Since the major equipment is static the entire project requires low maintenance, having long operational life (Refer schematic diagram). The surface sea water is pumped into the flash chamber where low pressure is maintained. Almost 1% of 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 & tube condenser and almost all of them are condensed. 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˚-18˚C, can be used for other cooling applications such as air conditioning etc before discharging back into the sea. During the process of evaporation non condensable gases released from the sea water & the plant leakage load are constantly pumped by a vacuum system to ensure that absolute pressure in the range of 25 mbar is maintained in the vessel. The estimated consumption of energy per KL on a medium size plant is estimated around 8 units/Kl of fresh water generated. As per the current rate of energy, the estimated cost of generation is about 3 paise/lt which is very economical as compared to other conventional methods presently in use. To improve, additional technique of de-aeration of sea water prior to its admittance in the flash chamber was planned which resulted in higher efficiency, yield and low power consumption.

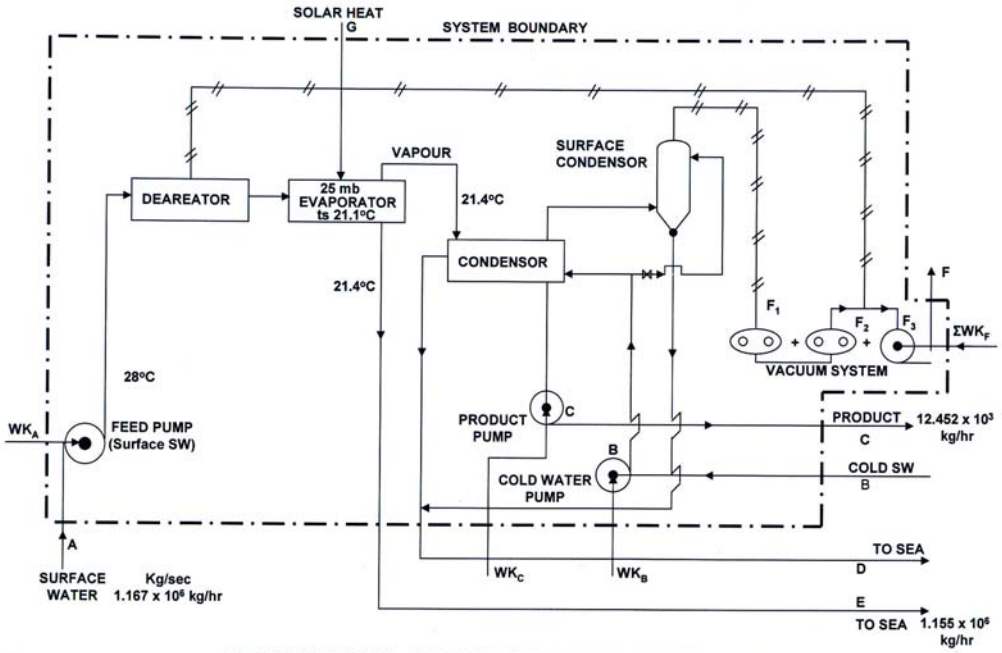

Fig 4: Typical 0.3 MLD Low Temperature Thermal Desalination System Configuration

The main features of LTTD plant are:

- No pretreatment 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 which can be used to enhance marine life.

Everest has been proud to be associated with this project. Vacuum experts at Everest have designed and manufactured complete de-aerator & condenser vacuum system capable of handling total non condensable & carry over water vapour load maintaining system pressure of 25 mbar. Everest …….leaders in Vacuum technology and manufacturers of Dry Mechanical Vacuum Boosters once again proved their capability to design, manufacture and deliver a vacuum system to meet the stringent needs of Indian scientists. We wish to thank our scientists for putting into actual use of concept, known for a long time but never attempted before.

Achievements of Floating 1 MLD Plant:

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

Operation Parameters:

- Fresh Water Generated: 1 MLD
- Warm Water Temperature: 28° C
- Cold Water Temperature: 10° C
- No. of Units: 2
- Warm Water Flow Rate: 569 Kg/sec/unit
- Cold Water Flow Rate: 500 Kg/sec/unit
- Vacuum Level: 23 mbar
- Saturation Temperature: 20° C
- Cold Water Pipe Length: 850 meter
- Cold Water Pipe Diameter: 1000mm
- Total Power Requirement: 220 KW

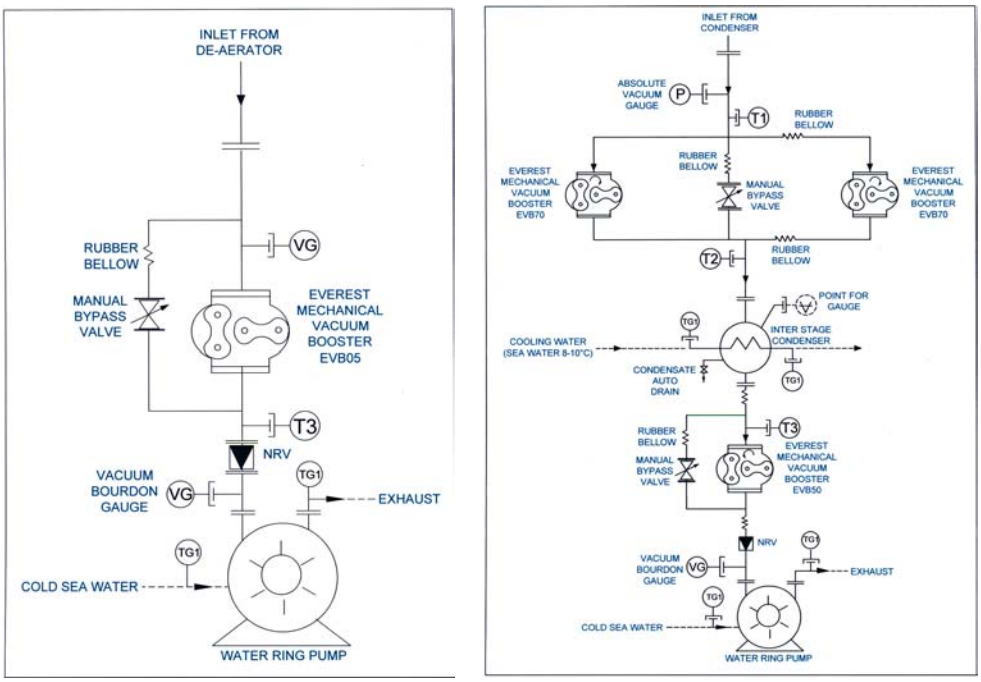

Fig 5 & 6: Line Diagram for De-aerator & Condenser Vacuum Systems
(Supplied by Everest Transmission, New Delhi)

Fig 7: View of Floating Barge Monted Desalination System
Aboard Sagar Shakti stationed near Chennai

Fig 8 & 9: Cold Water Pumps of the
Floating Barge Mounted Desalination System

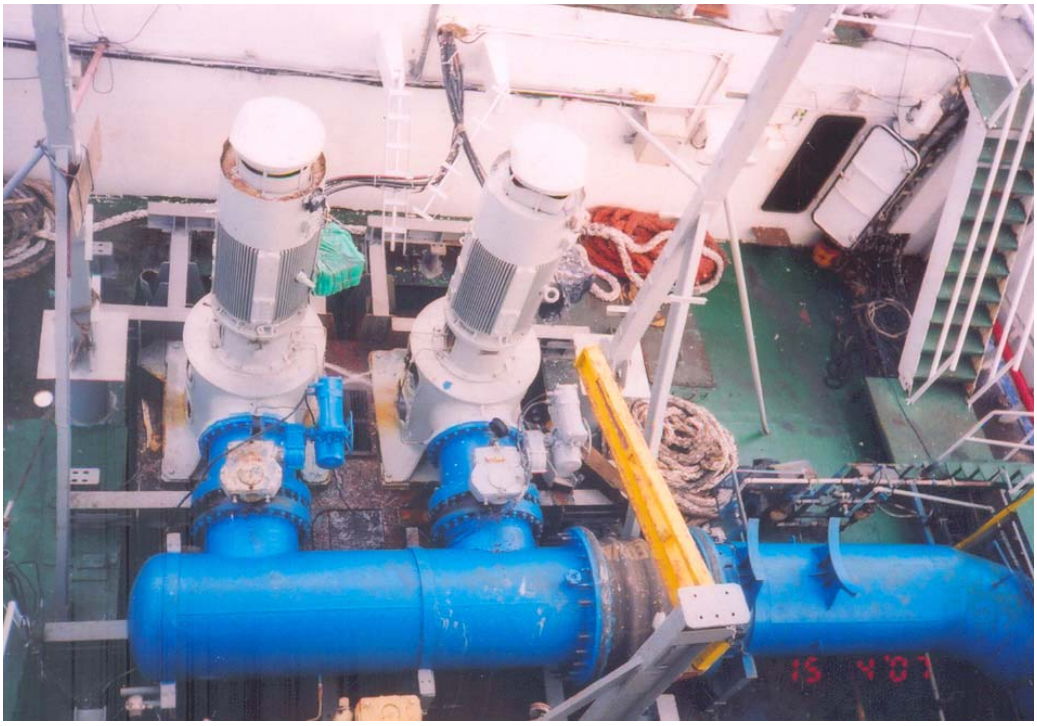

Fig 10: Warm Water Pumps of the Floating Barge Mounted Desalination System

Fig 11, 12 & 13: De-aerator & Condenser Vacuum Systems supplied by Everest Transmission, New Delhi.

Fig 14, 15 & 16: Flash Chamber of the Floating Barge Mounted Low Temperature Thermal Desalination Plant

Fig 17: Condenser of the Floating Barge Mounted Low Temperature Thermal Desalination Plant

Fig 18 & 19: Geo Bags being used to tow fresh drinking water produced on the World's First Floating Barge Mounted Low Temperature Thermal Desalination Plant to shore

Fig 20 & 21: Scientists & Everest's Technical Team having a taste of the first batch of drinking water produced

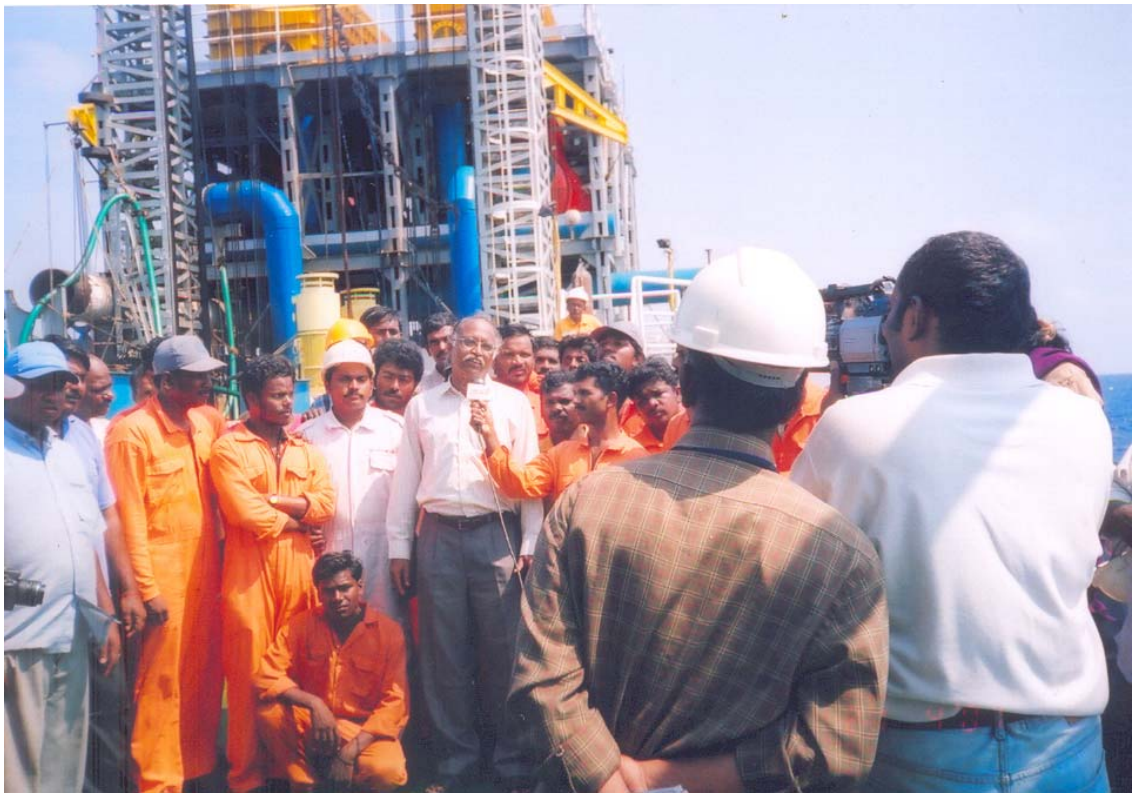

Fig 22: Dr. Kathiroli, Director, NIOT congratulating all present for their success during the trial runs conducted on the World's First Floating Barge Mounted Low Temperature Thermal Desalination Plant

The above 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.

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