GEOTHERMAL DESALINATION

European Geothermal Energy Council

Current Situation

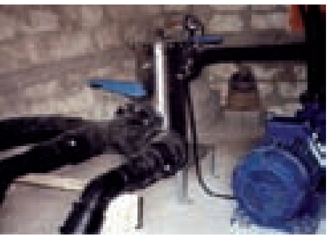
The World Health Organization (WHO) has estimated that 1000 cubic meters per person per year is the benchmark level below which chronic water scarcity is considered to impede development and harm human health.

Kimolos: *geothermal wellhead pump motor.*

97.5% of the total global stock of water is saline and only 2.5% is fresh water. Approximately 70% of this global freshwater stock is locked up in polar icecaps and a major part of the remaining 30% lies in remote underground aquifers. In effect, only a miniscule fraction of freshwater (less than 1% of total freshwater or 0.007% of the total global water stock) that is available in rivers, lakes and reservoirs is readily accessible for direct human use.

Geothermal energy is a source of renewable energy and the oceans are a major alternative source of water.

Desalination is very energy-intensive, and sustainable energy systems urgently need to be developed. Desalination technology is providing safe drinking water even to some 'water-rich' nations where pollution reduced the quality of natural waters. Thus, as a means of augmenting fresh water supplies, desalination contributes significantly to global sustainability. Desalination techniques such as those driven by geothermal heat have increased the range of water resources available for use by a community.



Kimolos: seawater pump, filter and distribution line.

Seawater desalination is one of the most promising fields for the application of geothermal energy due to the coincidence, in many places of the world, of water scarcity, seawater availability and geothermal potential. During the 90s the Kimolos Project was a research project that successfully demonstrated the technical feasibility of geothermal seawater desalination using low enthalpy geothermal energy.

Geothermal Solution

Low enthalpy (t>60°C) geothermal energy can effectively drive a sea or brackish water desalination unit in order to produce fresh water for drinking and/or irrigation. As a geothermal plant, whether used for power generation or for space heating or other applications, has large quantities of available heat at low cost, the most cost effective method for seawater desalination is to provide directly geothermal heat to a MED (multi effect distillation) plant.

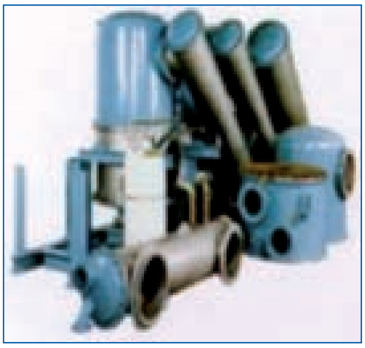
Why should geothermal energy be preferred in a desalination process ?

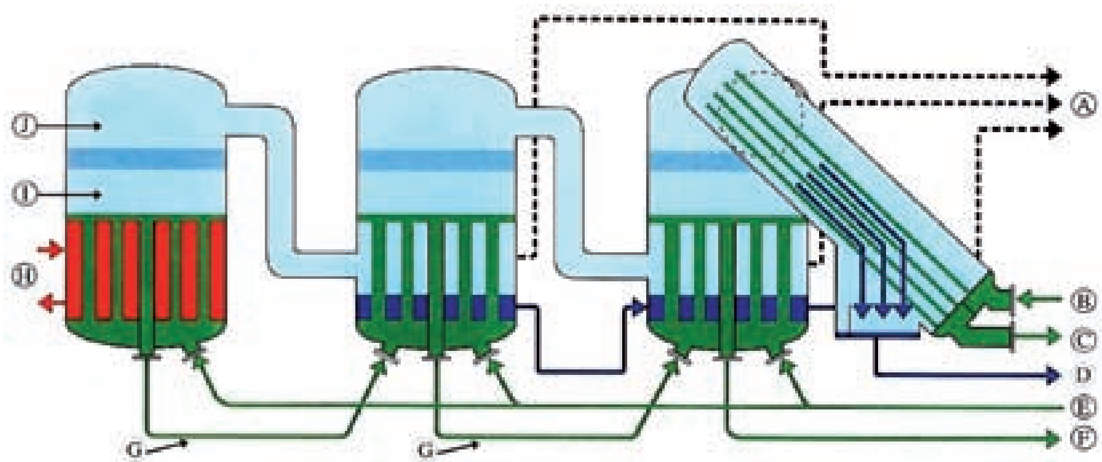
1. Geothermal energy provides a stable and reliable heat supply 24 hours a day, 365 days a year, ensuring the stability of the thermal processes of desalination.
2. Geothermal production technology, i.e. to extract hot water from underground aquifers, is mature.
3. Low temperature MED desalination technology is also mature.
4. Geothermal desalination yields fresh water of high quality.
5. MED desalination method has low energy requirements maximizing the fresh water output from a given low enthalpy geothermal potential and minimizing the corresponding costs.
6. Geothermal desalination is cost effective, as fresh water costs of less than 1 Euro/m^3 are possible.
7. Geothermal desalination is friendly to the environment, as only renewable energy is used with no emissions of air pollutants and greenhouse gasses.
8. Geothermal desalination aids local development and improves employment perspectives.
9. Geothermal desalination saves foreign currency as no imported fossil fuels are used.
10. Geothermal desalination has been successfully demonstrated on the island of Kimolos, Greece through a project supported by the European Commission (THERMIE GE.438.94.HE).

Multi Stage Distillation - MED

MED powered by geothermal energy is preferred due to lower energy requirement in comparison with other desalination processes. MED method is based on the multi-effect distillation rising film principle at low evaporation temperatures (less than 70°C) due to low, almost vacuum, pressure prevailing in the vessels. The rising effect principle takes advantage of the fact that the inner tube surfaces are always covered by a thin film of feed water that prevents scale formation.

- Evaporation through multiple-effect is a very energy efficient technology, as in each vessel (effect) the feed water boils utilizing the heat released by condensing vapor from the previous effect.
- MED results in excellent water quality with a salinity level close to 10 ppm.
- Fewer stages (effects) are needed in an installation compared to an MSF system, resulting in lower costs per m^3 of produced fresh water.



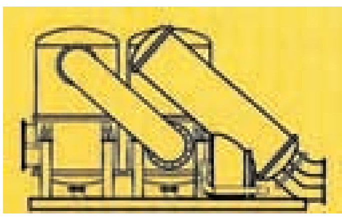


A. *Suction ejectors*
B. *Sea cooling water inlet condenser*
C. *Sea cooling water outlet condenser*
D. *Freshwater outlet*
E. *Feed-water inlet*
F. *Brine outlet*
G. *Brine heat recovery*
H. *Heat supply*
I. *Wet generated vapour*
J. *Dry vapour*

Case study – Kimolos unit

A pilot unit to demonstrate the feasibility of exploiting the low enthalpy geothermal potential of the island for the production of fresh water through geothermal water desalination with the objective to achieve water sufficiency for the island .

- geothermal water flow rate of 60 m^3/h at a wellhead temperature of 61-62°C is utilized from a borehole 188 m deep
- the desalination method used is MED with distillation under vacuum in vertical tubes and a two stage desalination unit has been installed (D-TU-2 -1200 - ALFA LAVAL DESALT)
- the total production of fresh water is approximately 80 m^3 /day
- the produced water cost is estimated of the order of 1.6 €/m^3 (including only annual operation costs), which is satisfactory for a small unit if this size; desalination costs are expected to be considerably lower in large scale geothermal desalination plants.



The Kimolos geothermal desalination unit.

Advantages

At sites where drinking water is scarce and geothermal resources with temperatures of 60-100 °C can be developed at acceptable costs, it is appropriate to use geothermal desalination. For reservoirs with higher temperatures there is also the option to generate geothermal power for use in a desalination plant.

Water scarcity is an increasing problem around the world and everybody agrees that seawater desalination can help to palliate this situation. Among the energy sources suitable to drive desalination processes, geothermal energy is one of the most promising options, due to the coupling of the disperse nature and availability of geothermal energy with water demand supply requirements in many world locations.

During the 90s, a Geothermal Desalination Project carried out in Kimolos island, Greece, demonstrated the technical feasibility of geothermal seawater desalination, through low enthalpy geothermal energy utilization.

An objective is the development of a least costly and more energy efficient seawater desalination technology based on Multi-Effect Distillation process. Specific proposed technological developments (new design of absorption heat pump, hybridization with other energy, cogeneration and recovering of salt) are expected to both improve the energy efficiency of the process and process economy.

The expected result would be an enhanced MED technology with market possibilities and suitable to be applied in the Mediterranean area and similar locations around the world.

- Seawater desalination in itself is an expensive process, but the inclusion of geothermal energy sources and the adaptation of desalination technologies to this renewable energy supplies can in some cases be a particularly less expensive and economic way of providing water.

- The use of geothermal energy for thermal desalination can be justified in some regions with the presence of cheap geothermal reservoirs or in decentralized applications focusing on small-scale water supply in coastal regions (e.g. village communities), provided the ability and willingness to pay for desalination is sufficiently large.

- What may also prove a feasible option is the use geothermal power from cheap reservoirs in coastal areas to desalt seawater in RO-plants (reverse osmosis).

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