INTERNATIONAL SUMMER SCHOOL
on Direct Application of Geothermal Energy

Under the auspice of the
Division of Earth Sciences

THE KIMOLOS GEOTHERMAL DESALINATION PROJECT

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ABSTRACT

The Kimolos Geothermal Desalination Project is concerned with the exploitation of the low enthalpy geothermal potential of Kimolos island for the production of fresh water through geothermal water desalination, with the intent of achieving water sufficiency for the island.

Funding for the project was provided by the THERMIE EU-DGXVII program through contract No. GE-438-94-HE.

The island of Kimolos, faces pronounced water scarcity problems, as other Aegean Sea islands also do. Nevertheless, Kimolos Isl. is fortunate enough to possess a very significant source of environmentally friendly energy which is renewable and of low cost, that is the low enthalpy geothermal energy potential.

The desalination method applied is that of Multiple-Effect Distillation (MED) with distillation under vacuum in vertical tubes. The unit will use low enthalpy geothermal energy (with a wellhead temperature of approximately 61°C) as the heating and feed-water medium.

The unit, built during the period of 1998-1999 produced, in average, 3.24 m^3/h of fresh water, when a geothermal water flow-rate of 50 m^3/h at a wellhead temperature of 61°C was utilized. The fresh water produced had a Total Dissolved Solid (TDS) content of less than 10 ppm, according to the plant's built-in salinity meter.

Several tests to measure and quantify the differential production of the unit took-place during the monitoring period. Different geothermal water yields were tested against the fresh-water production rate of the unit.

According to the results of this project the exploitation of low enthalpy geothermal energy in the unit results in the substitution of at least 500 TOE/year [1 TOE (Tonnes Oil Equivalent) = 8,000,000 kcal/h].

Our intention in this demonstrative project is to demonstrate the technology of producing clear fresh desalinated water from low enthalpy geothermal resources on Kimolos Isl. Further-on, we investigate the technical and financial feasibility for applying and disseminating such innovative desalination schemes in other regions of Greece and the EU with similar renewable energy sources potential.

1. OBJECTIVES

The main objective of this project is to exploit part of the low enthalpy geothermal potential of Kimolos island for the production of fresh water through sea-water or geothermal water desalination, with the intent of achieving water sufficiency for Kimolos Island inducing further agricultural, industrial and tourist development on the island.

The desalination method applied is the Multiple-effect Distillation (MED) method with distillation under vacuum in vertical tubes. The unit will use low enthalpy geothermal energy as the heating and feed-water medium.

Renewable Energy Source driven sea water desalination units, such as those driven by low enthalpy geothermal energy, guarantee friendly to the environment, cost effective and energy efficient production of desalinated water in regions with severe water supply problems (such as several of the Aegean Islands), which nevertheless are fortunate enough to have renewable energy resources at first hand for immediate exploitation.

The island of Kimolos, similarily to numerous other Aegean Sea islands, faces pronounced water scarcity problems. On Kimolos Isl. drinking water is available through transportation by water tankers from Peireus, which lies some sixty nautical miles away and costs more than 5,28 € per cubic meter or in the form of bottled water at 0,44 € per 1.5 litres. Water for sanitary purposes originates from rain collector tanks gathered from the water rained down on the roof of the houses. Rain in the Western Cyclades is very scarce (with a rainfall less than 450 mm rain annually).

Nevertheless, Kimolos Isl., like other islands or regions facing similar water scarcity problems, is fortunate enough to possess a very significant source of environmentally friendly energy which is renewable and of low cost, that is the low enthalpy geothermal energy potential. With this desalination unit we intend not only to minimize this water scarcity problem but also to induce development on the island through water sufficiency.

Our intention in this demonstrative project is to demonstrate the technology of produ-cing clear fresh desalinated water from geothermal water on Kimolos Isl. In paral-lel we investigate the technical and finan-cial feasibility for further applying and disseminating such innovative desalination schemes in other regions of Greece and the EU.

2. GEOLOGICAL AND GEOTHERMAL BACKGROUND

The Island of Kimolos belongs to the Milos Island Volcanic Complex, which is part of the Active Aegean Volcanic Arc. High, Medium and Low Enthalpy geothermal resources have been detected in the Milos Island Volcanic Complex with temperatures rising on Milos Island as high as 330°C at a depth of 1100m and with numerous thermal springs of up to 90°C on Milos and Kimolos Isl (see Map 1).

The island of Kimolos, with a surface area of 36 km^2 is located in the northern part of the previously mentioned Milos Island Volcanic Complex (Fytikas *et al.*, 1984). The volcanic activity of the island was manifested before the lower Pleistocene being presently exhausted, the last volcanic eruptive cycle taking place, on the east side of the island, just 900,000 years ago.

On the Northern part of Kimolos island the geological, geophysical, geothermal and hydrogeological data all lead to the assumption that a significant reservoir lies at depths of 100 to 300 m within volcanoclastic and volcanic (lavas) rocks, being supplied from a system of deep faults.

A NE-SW tectonic lineament with numerous thermal springs aligned on it with temperatures of up to 65°C seems to continue to be active. Most of the volcanic eruptive activity has been affected by this, still active, lineament (Fytikas and Vougioukalakis, 1992). The existence of this tectonic lineament together with an older one, with a NW-SE direction, allow the flow of sea-water parallel to these systems, cold-water descending and hotwater ascending. According to geological, geochemical, geophysical, volcanological and geothermal data (Fytikas, 1995) it is determined that the geothermal resources on Kimolos Isl. are formed by the entrapment of ascending hot sea-water in porous volcanoclastic aquifers. The main hydrogeological characteristic is the existence of at least 6 aquifers isolated by impermeable pyroclastic material. These aquifers are characterized by very low resistivity values when geoelectrical surveying is performed (Tsokas, 1985 and Thanasoulas and Tsokas, 1985). The aquifers at the depth of 20-30 m have been found to have temperatures of 40 to 45°C, at depths of 50m temperatures of over 59°C and at depths of 200m bottom-hole temperatures of at least 61°C.

At greater depths (deeper than 800m), especially in the southeastern side of the island, temperatures may rise over 100°C or even higher.

The island is covered with a plentitude of rocks, products of extensive hydrothermal alterations, in fact one of the largest and of finest quality bentonite in the world lies just 2 Km from the region of Prassa (NNE region of the island).

Shallow exploratory boreholes (at least 10) drilled to depths of 40m have given temperatures of up to 35°C.

Two boreholes were drilled in the region of Prassa . The boreholes were named

PRASSA-1 and PRASSA-2. The technical specifications of the two boreholes are given in the following Table 2.1.

Map 1: The areas under investigation and their position within the Active Aegean Sea Volcanic Arc.

Table 2.1: Technical specifications of the Prassa-1 and Prassa-2 boreholes

	PRASSA-1	**PRASSA-2**
Total Depth	188 m	238 m
Diameter of Piping	8 5/8 ”	8 5/8 ”
Piezometer	100 m	115 m
Total Thickness of Aquifers	60 m	54 m
Hydraulic Conductivity (k)	2.2 10^{-6} m/sec	0.9 10^{-6} m/sec
Transmissivity (T) from the recovery pumping test	0.640 m^2/h	0.289 m^2/h
Number of Aquifers	6	3
Well head Temperature	61.5℃	49.2℃
Optimal Flow-rate	80 m^3/h	30 m^3/h

The chemical composition of the geothermal water of PRASSA-1 and PRASSA-2 boreholes based on analyses performed by IGMR on Oct. 1995 (537/13-10-95) is provided in the following Table 2.2.

A remarkable point of these analyses is the similarity of the geothermal water composition among the thermal springs, CRES-1 exploratory borehole, PRASSA-1 and PRASSA-2 and sea-water, the only difference being a slightly higher CO_2, Ca and SO_4 content of the geothermal water. This is probably due to dissolution of carbonate rocks in the subsurface, proving that the previously mentioned mechanism is responsible for the formation of the geothermal resources on this island.

From all chemical analyses performed on the low enthalpy geothermal water samples from Kimolos Isl. we obtain reservoir temperature of approx. 64 - 78°C from the SiO_2 geothermometer, 108-114°C from the Na/K geothermometer and 169 to 228°C from the Na-K-Ca geothermometer.

Two very important facts concerning the chemical composition of the geothermal water of PRASSA-1 are pointed out:

a) The geothermal water has a composition very similar to that of sea-water, with a slightly increased content of CO_2, Ca and SO_4 and a decreased content of Na and Cl.

b) *Harmful elements such as As, Pb, Zn etc. are almost not detectable and therefore, since the chemical composition of the geothermal water permits its use for desalination.*

Based on the previously mentioned results it was further decided to proceed and carry-on with our project by utilizing the geothermal energy provided from the PRASSA-1 borehole, due to it's suitable well-head temperature, hydraulic characteristics and chemical composition.

The second borehole PRASSA-2 although perfect in chemical composition has been abandoned due to its poor hydraulic characteristics and rather low temperature. On April 1996, Geotech Ltd. proceeded with further pump tests on the PRASSA-2 borehole which lead to similar conclusions as previously.

Table 2.2: The chemical composition (in ppm [mg/l]) of the liquid phase of the geothermal waters of boreholes PRASSA-1 and PRASSA-2 (Samples 1c and 2c analysed by IGMR 1995)

Element	PRASSA-1c	PRASSA-2c
Ca	1,066.1	1,042.1
Mg	1,240.3	1,230.6
K	391.0	391.0
Fe	1.3	0.9
Na	10,345.5	10,115.6
Mn	0.19	0.18
Zn	1.9	1.9
Pb	<0.05	<0.05
Cd	<0.005	<0.005
Ba	0.05	0.03
Ni	0.02	0.12
As	<0.010	<0.010
Hg	<0.001	<0.001
Cr	<0.05	<0.05
Al	0.275	0.080
Li	0.40	0.40
Sr	14.0	14.0
SiO_2	35.0	28.0
CO_2	128.0	110.0

HCO_3^-	108.6	109.8
Cl^-	19,217.2	18,578.9
SO_4^{2-}	3,563.8	3,568.6
NO_3^-	<0.5	<0.5
NH_4^+	<0.1	<0.1
F	0.75	0.60
B	2.75	2.75
pH	6.80	6.80
Conductivity (_S/cm)	47,986	45,965

Another scenario examined the use of PRASSA-2 as a reinjection borehole if the hydraulic properties permit it, which is however doubtful due to high bentonitization rate of this particular borehole.

The final design of the Geothermal Energy Desalination Plant, the sizing and order of equipment, the manufacturing, assembly/installation have all been based on the following characteristics and features:

- The well-head temperature level of the geothermal water
- The chemical composition and, hence, the possibility to desalinate the very same geothermal water
- The geothermal water quantity and hydraulic parameters of the aquifers
- The water needs of the island
- The technical and financial feasibility
- The possibility of future extension of the unit's production capability.

A very important factor that had a direct effect on the size and productivity of our unit water, and consequently on the optimal and final design of the unit, was the level of the well-head temperature of the geothermal water.

Nevertheless, since the well-head temperatures from PRASSA-1 finally is between

58 and 62°C the direct consequence has been an inevitable drop in the expected water production rate. As a result, the utilization of desalination systems larger than 2-effect were strictly prohibited due to the limits in the temperature gradient between effects. Hence, a smaller 2-effect desalination unit (namely D-TU-2-1200 – ALFA LAVAL DESALT) was considered, manufactured and contributed to the Kimolos project, instead of the originally planned 3-effect desalination unit.

Another significant point concerning the design of the unit is the slight difference among the geothermal water composition and that of the seawater, especially Ca and SO_4 content. This, according to the desalination unit provider ALFA LAVAL, can be easily overcome by increasing the anti-scalant dosage versus the typical figures or even through the blending of two suitable anti-scalants instead of one.

Moreover, since no corrosive substances or gases, such as H_2S, have been detected in the geothermal water, it is obvious that it can be freely desalinated.

Another important parameter that affected the optimal-final design of the plant and assisted us to proceed with the D-TU-2-1200 ALFA LAVAL unit, is that in case of an increase of the well-head temperature during the development of the geothermal field (which is according to the world-wide accepted geothermal field usual practice) we may expect a 3-4% rise of fresh-water productivity per 1°C increase of well-head temperature.

Furthermore, it may be possible in the near future to proceed with the drilling of a third borehole, PRASSA-3, in the close vicinity of PRASSA-1 to deeper aquifers within the Lavas (depths larger than 160m) and to depths of 250-300m which according to the geological-geothermal facts, may be able to give over 68°C with flow-rates of over 100 m^3/h, resulting to an increase of the D-TU-2-1200 fresh-water production over 5 m^3/h. Moreover, according to a probable future scenario, if well-head temperatures are over 70°C, it would be feasible (and this has actually been taken into account) to increase the size of the unit to a 3-effect by just adding and properly adjusting a third effect to the existing 2-effect D-TU-2-1200 unit, increasing the production capacity of fresh-water of the plant to over 9 m^3/h.

Another important issue, taken into consideration during the design phase of the desalination unit are the actual water needs of the island. It should be noted that during winter time the permanent population of the island is approximately 800 inhabitants, with water needs of approximately 40 to 50 m^3/day, whereas during the summer time the population and water needs doubles to 1,600 inhabitants and 100 to 120 m^3/day. This results to a total water demand, for both drinking and sanitary purposes, of 22,000 m^3/y. From this quantity 6,500 m^3/y or 29,5% are covered by rain-water management practices and from bottled-water, leaving a water deficit of approximately 15,500 m^3/y or 42.6 m^3 per day which equals to a production rate of 3.55 m^3/h in 12 hours per day.

The desalination unit has been designed to operate at this time stage in such a manner to produce with an average rate of approximately 75 m^3/day of fresh water through the pumping of 60 m^3/h of geothermal water with a well head temperature of approximately 60 ºC, see also Table 4.1.

Nevertheless, as already explained, this production capacity may be easily changed by simply decreasing or increasing the borehole pumping capacity from 50 m^3/h to 100 m^3/h.

With this planning we achieve whole availability of the fresh-water production and provide for future modest increase of the water needs or giving solution to draught problems. The cost of the produced fresh-water, since there is provision for subsidy of up to 50% (or even higher), according to the Greek Law for the operational costs of desalination units operated by municipalities, is estimated to be 1,03 €/m^3 for the case of a 90 m^3/day unit, when subsidy to the initial investment of 80% is achieved then the price of the water produced falls down to 0,94 €/m^3).

3. DISTILLATION OPERATION PRINCIPLE

The proposed MED-Vertical Tube distillation method is based on the multi-effect distillation rising film principle at low evaporation temperatures (less than 70°C -ALFA LAVAL, 1993), due to the reduced pressure (almost vacuum). The rising film principle takes advantage of the fact that the inner tube surfaces are always covered with a thin film of feed water that prevents scale formation. The working principle is as follows:

The vapor forms a column around the tube center which presses the feed water against the tube surface ensuring a continuous thin film of water on the tube surfaces hereby eliminating dry spots where scale may deposit.

A controlled amount of sea feed water is led into the bottom of each effect and into the tubes in the heat exchanger, where the low enthalpy geothermal energy in the form of hot water of less than 70 °C, as the heating medium, heats it up (see Figure 1).

Part of the sea-water is evaporated under vacuum, which is created by means of water ejectors connected to each effect. The vacuum makes it possible to lower the boiling temperature and thereby minimizing the amount of energy necessary for evaporating the feed water, and furthermore the low boiling temperature prevents deposits of scale inside the tubes.

The vapour generated in the first effect passes a separation compartment where the remaining feed water droplets are separated from the vapour and are extracted with the brine. The separated vapour leaves the first effect and flows through the vapour connection pipe to the heat exchanger in the second effect, and the vapour is now used as the heating medium for the second effect. Brine extracted from the first effect is mixed with sea feed water and is brought to evaporation by means of the heat from the vapour generated in the first effect. This process is repeated in the second, third, fourth etc., when these occur.

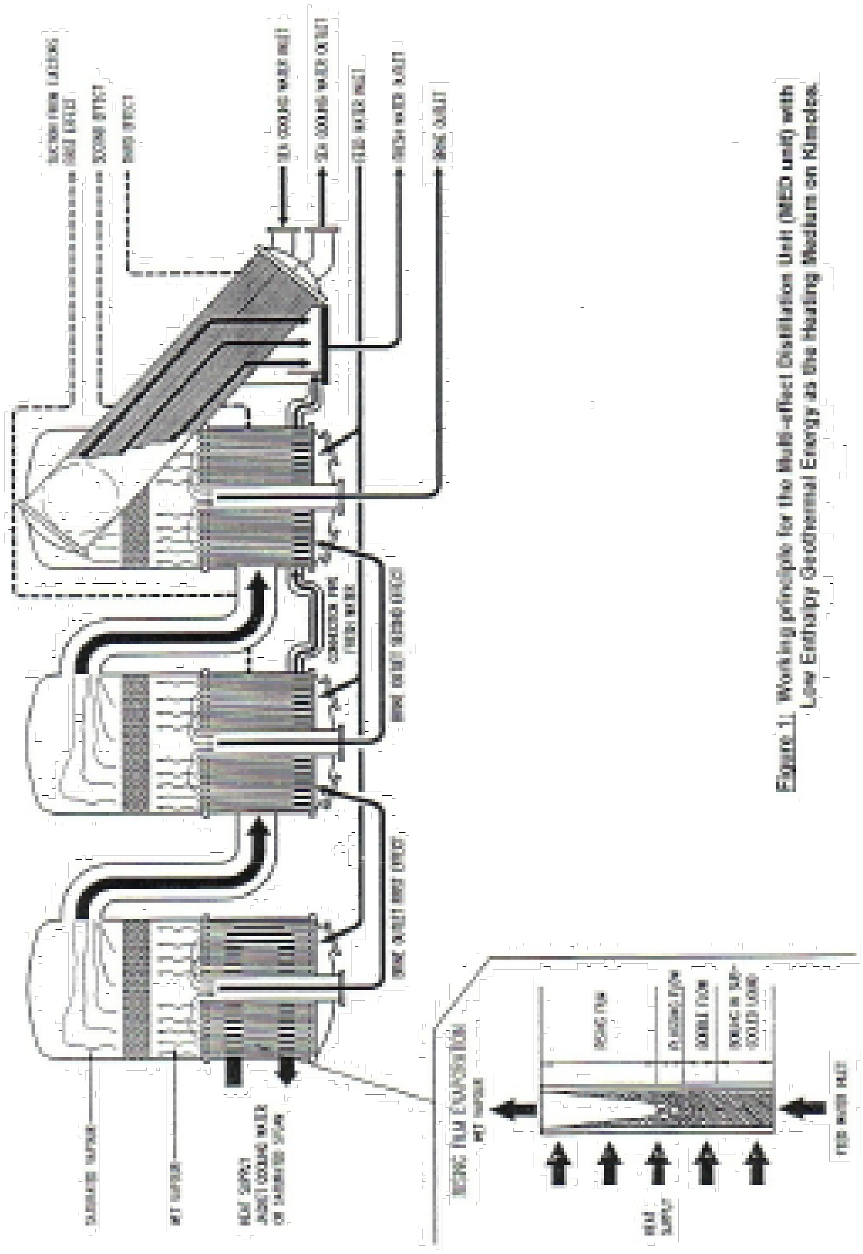


Figure 1: Working principle for the Multi-effect Distillation Unit (MED unit) with Low Enthalpy Geothermal Energy as the Heating Medium on Kimolos.

The vapor used for heating of the second, third, fourth etc. effects condenses on the outside of the heat exchanger tubes, and flows through the flash pipe in the bottom of the heat exchanger into the flash tank. Separated vapour from the third effect is led into the condenser where it is condensed on the outside of the condenser tubes in which sea cooling water is flowing. The condensate flow down into the flash tank at the bottom of the condenser. The condensate is extracted from the flash tank by the freshwater pump and is pumped into the fresh-water tank.

According to the GE/438/94/HE contract the desalination unit can be designed in such an innovative way so that in the case that the geothermal water chemical composition allows it, it will be feasible to desalinate the low enthalpy geothermal water itself, instead of the sea-water. This will result in an increase of the energy efficiency of the unit simultaneously decreasing the required capital investments and operational costs (no heat exchangers, no sea-water preheating etc.).

4. THE DESALINATION PLANT

The desalination plant has been installed at the Prassa site in an engine-room erected for the purposes of the project during the winter 1999 and the spring 2000. The dimensions of the engine-room are 8.15m in length by 5.00 m in width by 4.20 m in height. Within the engine-room is included the well-head, the D-TU-2-1200 distillation unit and the electrical-automation panel.

A geothermal water flow of an estimated well-head temperature of 60-62^{0}C with a flow rate of about 80 m^3/h is brought as the heating medium to the heat exchange stage of the first effect. The geothermal water after providing its thermal energy from 60-62^{0}C to 53^{0}C is divided into two streams, the first of which enters to the desalination unit as the feed water (with a flow rate of 50 m^3/h at 53^{0}C). The remainder of the geothermal water, which is not fed into the unit as the feed water, is discarded to the sea or may be reinjected. Following the desalination of the feed water there is a stream of brine water equal to approximately 46 m^3/h at approximately 32^{0}C which is also discarded to the sea.

A second sea-water pump room exists just by the sea. This sea-water pump room has been erected to enclose the sea-water cooling system sea-water pump, the sea-water filter, electrical panel and the head of the sea-water cooling system piping.

For details see Photos 1-5.

4.1. The D-TU-2-1200 Desalination Unit

The D-TU-2-1200 desalination unit was manufactured in Denmark by ALFA LAVAL DESALT A/S.

The productivity of the DTU-2-1200 desalination unit was tested, at the facilities of KYNDBY Power station in Denmark, before the unit was transported to Greece.

The basic parameters taken into consideration were the rate of the production of fresh-water versus changing parameters such geothermal (hot) water flow-rate, temperature, feed-water flow-rate and temperature.

Table 4.1 below, shows the change of productivity of the DTU-2-1200 unit based on variations of the geothermal water flow-rate (from 50 m^3/h to 80 m^3/h) and well-head temperatures (from 60 to 62ºC).

The calculations are based on the following assumptions:

a) Feed-water flow-rate 50 m^3/h
b) Feed-water temperature 53ºC
c) Seawater cooling temperature 20ºC
d) Evaporation Temperature in second effect 40ºC

4.2. The geothermal water system

The Geothermal water system of the unit consists of the PRASSA 1 borehole (which has been detailed in Chapter 2), of the Geothermal Water Pump (GWP) and of the piping which connects the borehole well-head, through the GWP, with the hot-water entrance of the Desalination Unit.

Table 4.1: The change of productivity of the DTU-2-1200 unit based on changes of the geothermal water flow-rate

	Geothermal water Well-head Temperature 60 °C	Geothermal water Well-head Temperature 62°C
Geothermal water flow-rate (m^3/h)	Fresh water production (m^3/h)	
50	2.89	3.09
60	3.55	3.80
70	3.98	4.25
80	4.33	4.62

4.2.1. The geothermal water pump

The geothermal water pump installed at PRASSA-1 is a multi-stage down-hole vertical shaft pump.

The technical specifications of the geothermal water pump are given in the following Table 4.2.

4.2.2. The sea-water cooling system and the sea-water and brine rejection system

Sea-water is used for the unit's cooling system, which is necessary to produce the vacuum in the distillation effects. The sea-water is pumped from a site near the Prassa geothermal springs, where a pumping station has been built just on the sea-side (see Map 2). The distance of this site from the plant site is approximately 200 m. This sea-water pump room has been erected to enclose the sea-water cooling system, the sea-water pump, the sea-water filter, electrical panel and the head of the sea-water cooling system piping.

The sea-water cooling system consists of the following components:

- Sea-water pump
- Sea-water filters
- The supply system pipeline to the desalination plant

The seawater pump has a yield of 250 m^3/h and pressure of 5 bar.

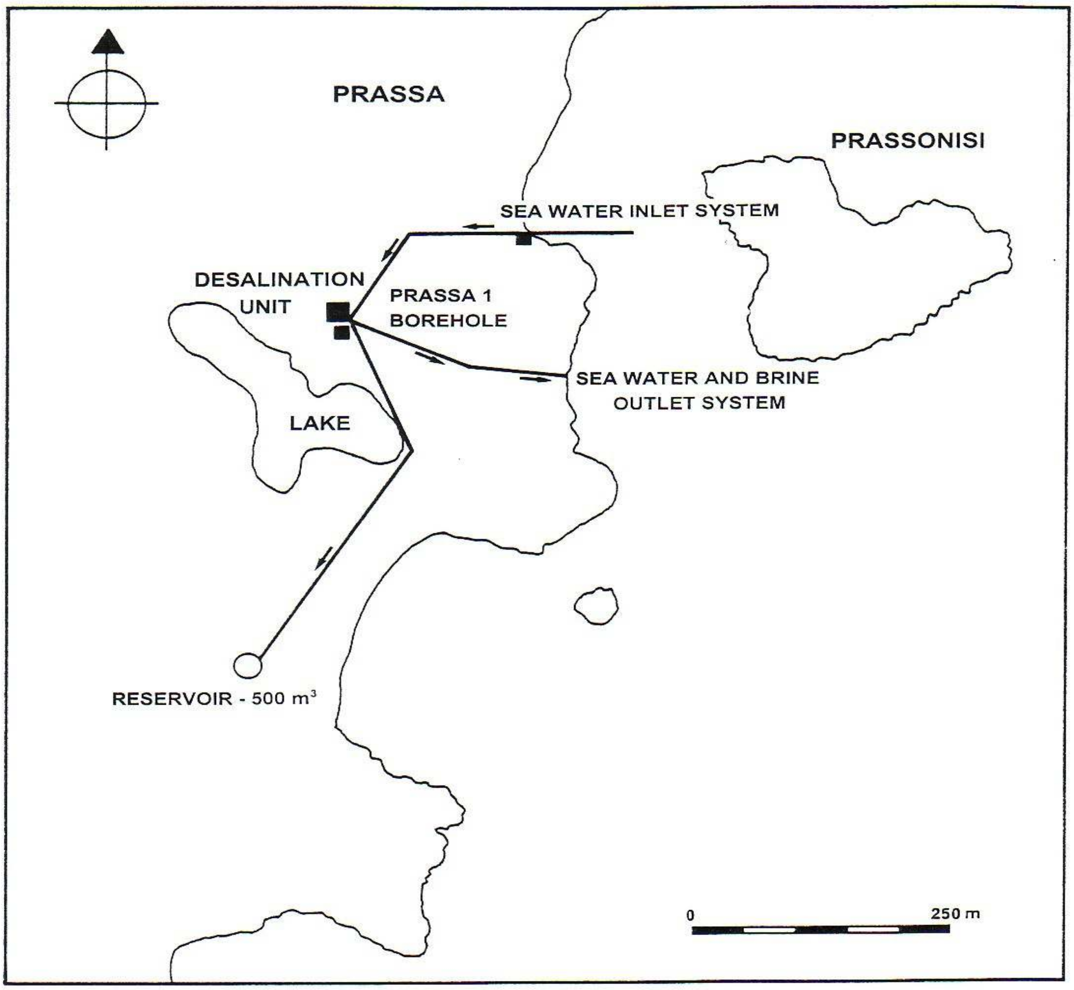
The supply system pipeline is further divided to three pipes which have been buried within a trench 0.5 m wide and 0.6 m deep, and covered by the excavation products. The pipes are plastic High Density Polyethylene (HDPE) 125 mm in diameter. The total pipe length from the sea pumping unit to the plant is 522 m (3x171m).

According to the final design the brine together with the remaining geothermal water are discarded into the sea. This is permitted due to the chemical composition (very close to sea water) of both fluids and their temperatures. This has been based on the Environmental Impact Assessment that has been carried out for the plant.

Table 4.2: Technical specifications of the geothermal water pump

Type of pump rotor	8 KHM
Number of stages	20
Nominal Power Consumption of Motor	60 HP
Nominal Head Pressure	90 m
Capacity - Speed	100 m^3/h - 1450 rpm
Water Pump Performance Rate	78-79%
Diameter of water outlet	5”
Impeller Material	Seawater resistant bronze
Material of Shaft	Stainless steel
Inverter	45 kW ABB

The sea-water and brine rejection system consists of 5 pipes, each with a diameter of 125 mm, which discards the sea-water and brine to the sea 50m to 80m south-east of the site of springs and 150m to the south-southeast of the plant site. The pipes have been placed within a trench 0.5 m wide and 0.6 m deep, and covered by the excavation products. They are also HDPE pipes with a diameter of 125 mm and the total length of the pipes is 456m (5x91m).



Map 2: Design Sketch-Map of the Desalination Unit at Prassa Kimolos.

5. THE UNIT OPERATION

The operation of the unit has proven that the Kimolos geothermal desalination unit operates in a very efficient way producing a considerable quantity of clear desalinated water with a noteworthy rational use of energy.

The unit, in average, produced 3.24 m^3/h fresh water when geothermal water of 50 m^3/h at 61°C was used. The produced fresh water was crystal clear with a Total Dissolved Solid content of less than 10 ppm, as directly measured by the plant's built-in salinity meter.

Several tests to measure and quantify the differential production of the unit took-place during the monitoring period. Different geothermal water yields were tested against the fresh-water production rate of the unit.

For example in one instance that the geothermal production flow-rate increased to the level of 70 m^3/h the fresh-water production of the unit exceeded 4.12 m^3/h. When the geothermal water yield fell down to 60 m^3/h the fresh-water production decreased to approximately 3.63 m^3/h.

The tests were performed in order to prove that the geothermal desalination unit fresh-water production depends largely on the geothermal water production rate, a fact that was proven during the initial monitoring stages of the unit operation.

A remarkable point was that even with a water yield of only 30 m^3/h the unit was able to produce 1.18 m^3/h of fresh-water.

Another significant parameter which seems to have contributed to the success of the project and the unit operation was that the well-head temperature of the PRASSA-1 borehole was measured at 61

– 61.5ºC, two degrees higher than the anticipated well-head temperature of 59ºC, which was employed during the optimal design of the unit. This improved temperature level difference, a factor crucial for thermal distillation units working under vacuum, has led to a significant increase of the finally measured production rate of the unit.

6. CONCLUSIONS

The final success of this geothermal application project is very crucial for the local population since this island encounters serious freshwater (drinking and irrigation) scarcity problems, not only during the summer Tourist period (which is very pronounced) but all around the year. It should be noted that during the winter time the permanent population of the island is approximately 800 inhabitants, with water needs of approximately 40 to 50 m^3/day, whereas during the summer time the population and water needs rise to at least 1600 inhabitants and 100 to 120 m^3/day.

The Geothermal Energy Desalination Plant designed, manufactured, installed, commissioned and operated through the GE/438/94/HE innovative-demonstrative project is virtually just the core unit on which the Municipality of Kimolos may proceed for further development depending on the needs and financial feasibility, having a pronounced impact to the local population.

The exploitation scheme under investigation concerns sea water or geothermal water desalination by the method of multi effect distillation under vacuum [MED unit] with the low enthalpy geothermal water acting as the heating medium (with temperatures of over 55ºC and up to 65ºC). Several cases are investigated, depending on the final wellhead temperature of the geothermal water, and the actual freshwater demands of the island. The possibility of desalinating the geothermal water itself is also examined. All of these parameters are correlated with the actual cost effectiveness of the desalination plant.

According to the results of this project the exploitation of low enthalpy geothermal energy in the unit results in the substitution of at least 500 TOE/year [1 TOE (Tonnes Oil Equivalent) = 8,000,000 kcal/h].

The actual dissemination of the results of this project will provide fresh water to developing regions of Greece, which face significant water scarcity problems, such as Milos, Santorini, Nisyros, Kos, Chios etc. The proposed utilization schemes will exploit a friendly to the environment energy source, which is at the same time of low energy production cost, being capable for further application in other geothermal rich EU regions which also face similar fresh water supply problems.

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PHOTOGRAPHS

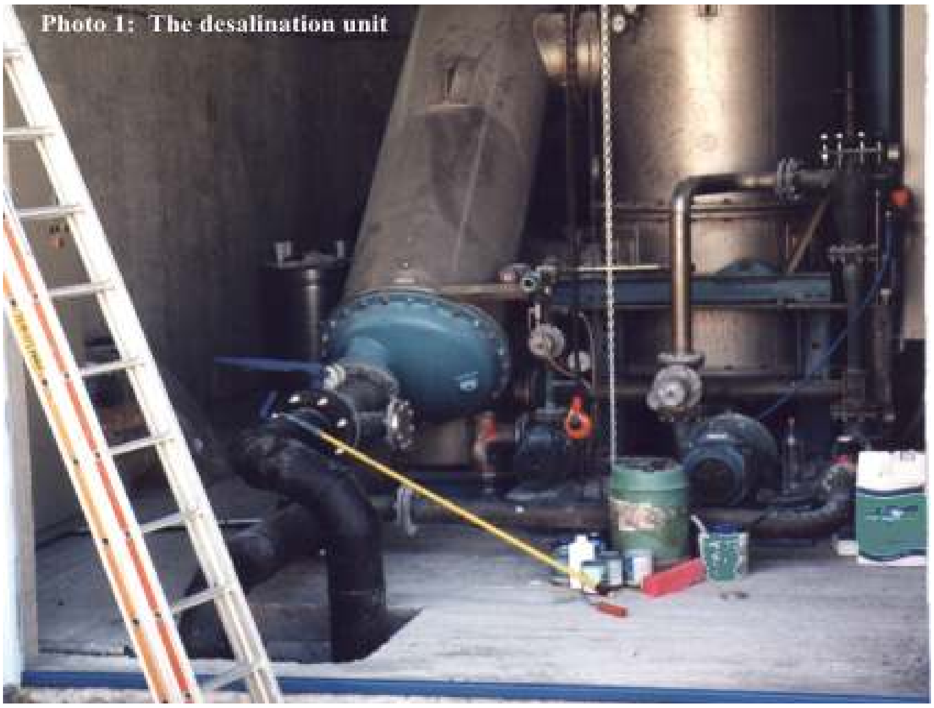
Photo 1: The desalination unit

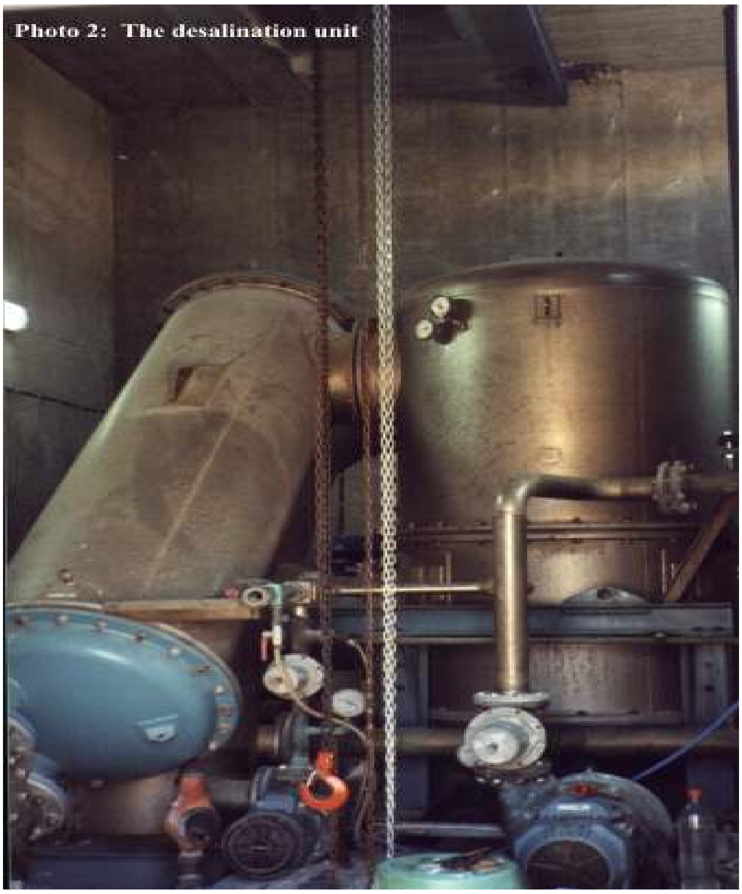
Photo 2: The desalination unit


Photo 3: Well head and geothermal pump at PRASSA 1

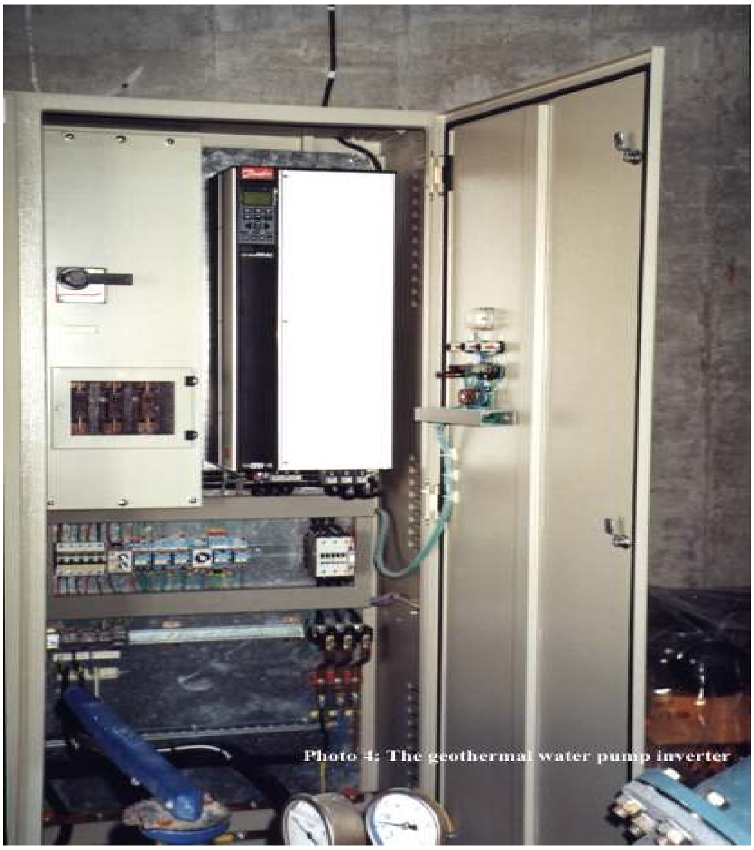
Photo 4: The geothermal water pump inverter

Photo 5: Sea water pump, filter and the head of piping