Decentralized Desalination System using Solar Energy/Waste Heat Multiple Effect Humidfication (MEH)

1000 LPD Demonstration system – OMAN
Winner of 3rd Prize - Water Globe 2002

Total Pages -19.

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1. Introduction:

Water is essential for life. Clean and healthy drinking water is the one resource displaying the highest demand growth rates worldwide when compared to any other basic foodstuffs. This is an proven fact and includes drinking water, domestic water, industrial water, service water and irrigation water.

But why is demand exploding? The main reason is a rapidly growing world population coinciding with dwindling resources – mainly in developing countries. Further reasons are: growing demands on convenience and availability in industrialized countries, but also within the rising middle classes of emerging countries such as China and India.

Already, about one third of the world's population has no direct access to clean, potable drinking water; that's roughly 2 Billion people! In numerous developing countries, "fetching drinking water" is the one and only daily, all-consuming task for women and children. In a time where many public infrastructures are overloading and breaking down, daily drinking water supply is even becoming a hot button issue in developed nations.

Solution strategies for the upcoming drinking water squeeze are complex and few, but the main components will be:

1. Water management – e.g. increased prudence in water consumption
2. The exploration of new sources of water supply – one of them being the desalination of abundant saltwater supplies.

In the Millennium Declaration dated September 18th, 2000, the **United Nations** resolved to **cut by one half**, the number of people who are unable to access or to afford safe drinking water by the year 2015.

We at the Gerindtec Group intend to support this endeavor to the best of our ability.

2.0 Brief History of the Gerindtec Group

The Gerindtec Group sees itself as a solution-provider for the de-centralized safe drinking water supply to locations where salt- and/or brackish water are the only water resources available. With offices and core activities based in Germany, India and ANZ, the Company commands years of system integration efforts and experience in thermal desalination, going all the way back into the early 2000s.

It was in 2003, that the process of multiple effect humidification (MEH) was first put into commercial use by Gerindtec´s partner for system integration. Since then, this process has garnered benchmark status in the solar thermal desalination industry. It was in 2005 that the first plants were built, yielding 5000 Liters of pure drinking water per day from salt water.

The Gerindtec Group prides itself in being willing and able to offer system integrated solutions for specification-based engineering. System layout and implementation are organized and put into practice using the assistance of local installation partners (local content aspect). Gerindtec´s German system integration partner has completed a number of projects worldwide and is a recognized force in the global quest for renewable energy driven– desalination generated drinking water.

3.0 History of Development of Desalination System

3.1 Titanium Oxide - Highly selective absorber coatings

Solar Thermal Panels have been in the forefront for of the harnessing of solar energy directly and extensively used in Solar Domestic Hot Water systems (HWS).

Thermal Panels used for DHWS are made out of thin copper substrate on which a coating of nickel and black chrome are applied. The copper substrate is then ultrasonically welded to Copper tubes and fabricated into solar Thermal Panels.

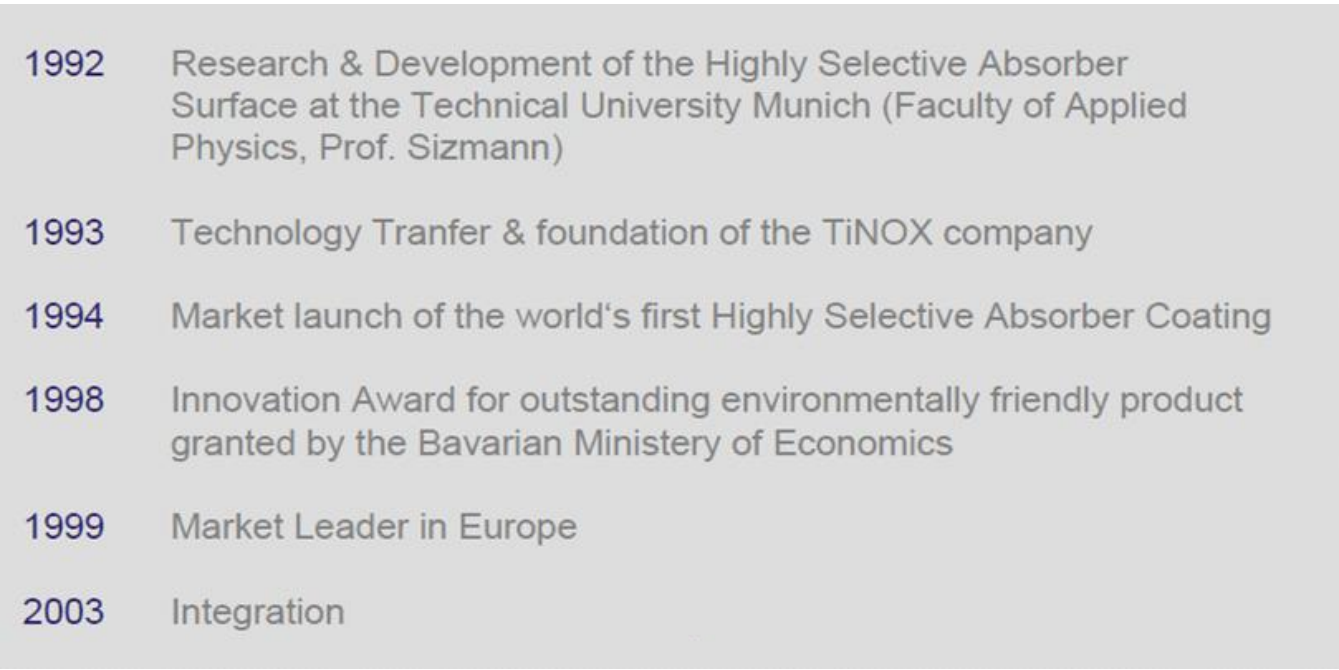
The limitation of Thermal coatings used for DHWS is characterized by lower levels of energy efficiency as they are deployed to heat water typically through a ΔT of 30 to 50 °K with respect to the ambient temperature.

Higher range applications such as solar cooling, industrial heating and desalination called for higher thermal efficiency which the conventional black chrome coatings - found difficult to achieve.

To address the demand for a more energy efficient, - highly selective solar absorber coatings, our German cooperation partners, in association with the University of Munich, developed and subsequently patented a special process using nano-particles of Titanium coated onto a thin copper substrate in the presence of Nitrogen and Oxygen and a protective layer of Quartz Glass.

The resulting PATENTED - TiNOX highly selective absorber coatings were proven to be offer a much higher energy efficiency and were effectively able to address the higher level applications.

The **patented** TiNOX-highly selective absorber coatings became a bench mark and have remained a market leader in Europe and other parts of the world, since 1999.



Time line - TiNOX highly selective absorber Coatings

To prove the long lasting performance of TiNOX absorbers, the "task X"-test (ISO draft proposal CD 12 952.2) was developed in cooperation with renowned research institutes. It simulates a long-term collector usage and its environmental effects on the selective coating such as temperature and humidity. Coatings examined by "task X" guarantee an efficiency of 95 % of the new condition after a simulated time period of 25 years.

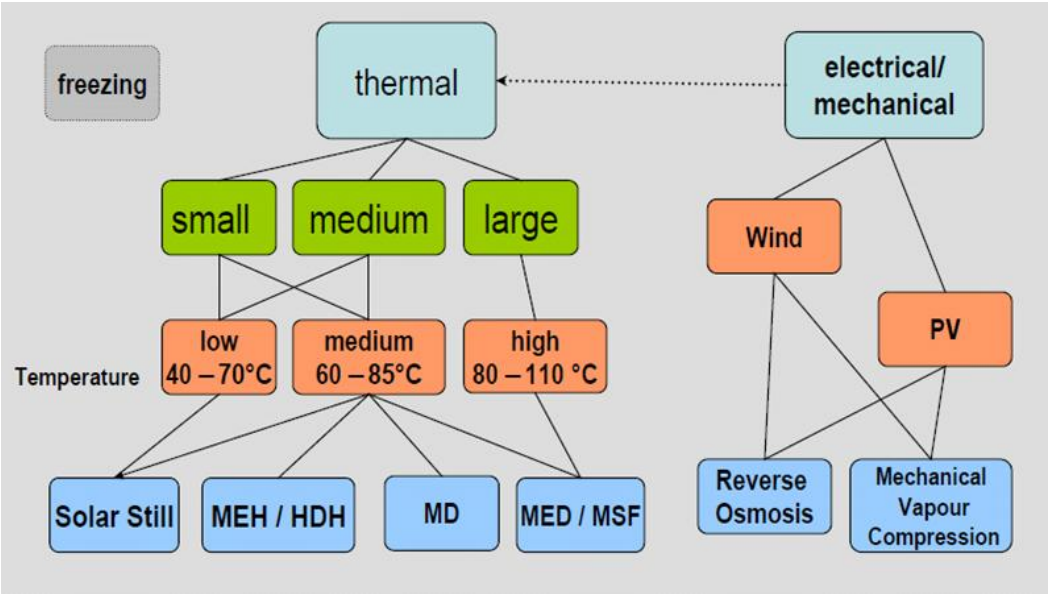
TiNOX is certified "task X" by the SPF in Rapperswil (CH), the "Frauenhofer ISE" institute in Freiburg and the Swedish National Testing and Research Institute.

3.2 Solar based Modular Desalination System

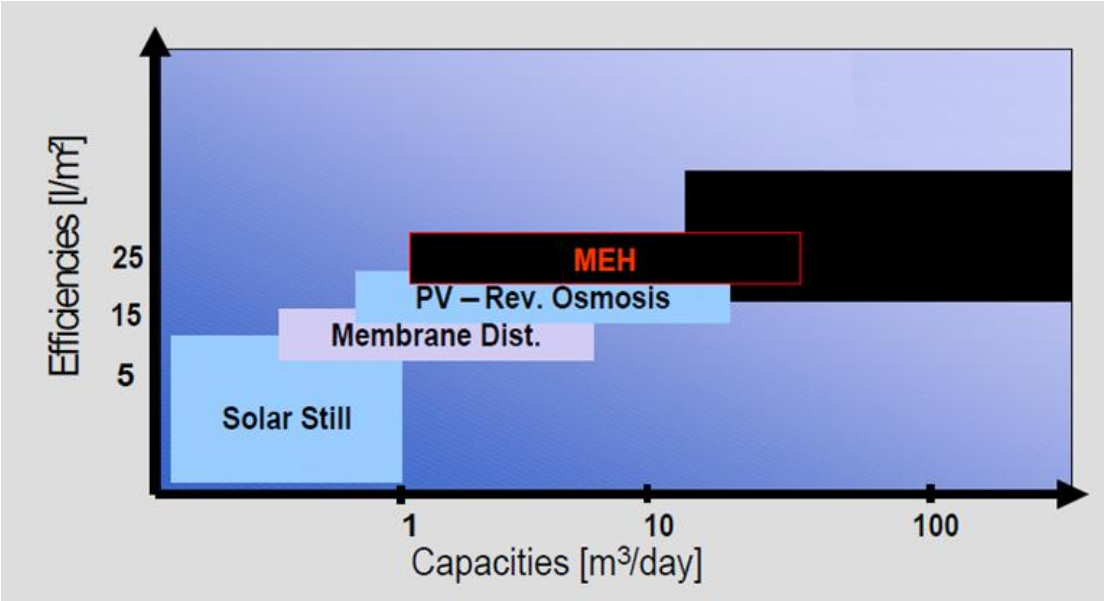
Sea water Desalination has been recognized by one and all, as the ultimate solution to meet the world's ever growing water needs.

Along with successful development and launch of the TiNOX highly selective absorber coatings, other business partners realized the need for the development of a Modular Decentralized and ***most energy efficient solution*** for Sea water Desalination to meet drinking water needs in remote and highly challenging locations.

Current Approaches to Sea Water Desalination have been made through the following methodologies:-



Our German partners decided to develop a Desalination system using TiNOX highly selective absorbent Technology, adopting Multiple Effect Humidification (MEH)– as this simulates the natural water cycle and the distillate would be in its purest form.



Development work for the Desalination system started alongside TiNOX Technology for highly selective absorber Coatings

1990`s	R&D University Munich; Physics Department for applied Thermodynamics, Prof. Dr. R. Sizmann
1995	Product Development (TAS GmbH, ZAE),First experimental installations
2001	Technology transfer (TiNOX GmbH)
2002	Award of Oman Demonstration Installation (3rd prize Water Globe 2002)
2005	Start of industrial production

Time line- Development of TiNOX Desalination Technology

The resulting product of this pioneering R&D effort produced a system that is very low on energy demand through the most efficient re-use of heat generated by the production of condensation.

Compared to a conventional solar distiller where *solar energy* demand is in the order of 500 Kwh/m³ of distillate, the energy demand of the MEH system is only of the order of 120 KwH/ m³.

In comparison, the most efficient of solar distillers developed to date, can only produce distillate of max. 6 liters/m² area of collector surface.

Our MEH system, in conjunction with the TiNOX highly selective absorber coatings, are designed to produce an unmatched-**25 liters/m²** of solar collector surface.

The MEH Desalination system has been installed in many locations and the design has been optimized- to offer solutions for safe drinking water in modular units with capacities of 1000, 5000, 10000, & 50000 LPD.

3.3 Summary of Objectives

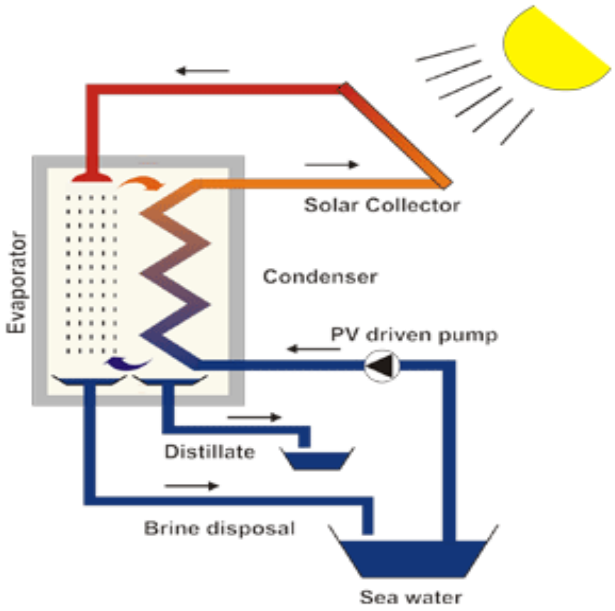
The Main Objective of the Development of our MEH Desalination Technology is,

- To decentralize and reduce the costs of production and distribution of safe drinking water.
- To provide a sustainable solution for the provision of safe drinking water to small under-privileged communities in remote locations.
- To overcome the limitations of the Technologies available, at present.
- Use of Renewable Energy and/or waste heat.

3.4 Salient Features

- Produces safe drinking water to **WHO standards** using solar/waste heat.
- Highly Energy Efficient and Eco friendly Design concept.
- Considerably **less power demand** - Can be configured to operate even in the most remote places (using 100% Solar Energy) - where Electrical power is not available.
- **Minimal maintenance** with no requirement for skilled man power**.**
- Can treat any quality of input water (Sea water, Brackish water, Polluted Water from wells & bores)
- **No pre-treatment** required for input water - as is the case in Reverse Osmosis- (RO) systems.
- Modular design – Easy to Install & Operate - Provides pure safe drinking water - from any type of input water quality - capacities 1000 LPD, 5000 LPD, & 10000 LPD & 50000 LPD complying with WHO specifications.
- Fully Solar panel based system using solar Thermal panels with highly Efficient TINOX highly selective absorber coatings.
- 24 hours of water production of safe drinking water through the use of the heat storage system.
- With Solar based systems the Maintenance and operation costs are at the very minimum when compared with other Technologies.
- The system can produce pure drinking water using waste heat from Electrical generators or any other waste heat producing industrial processes.
- Minimal Wastage : Up to 70 % Conversion of Sea water and 90% Conversion of Brackish water possible.

4.0 Brief Summary of Equipment & Process



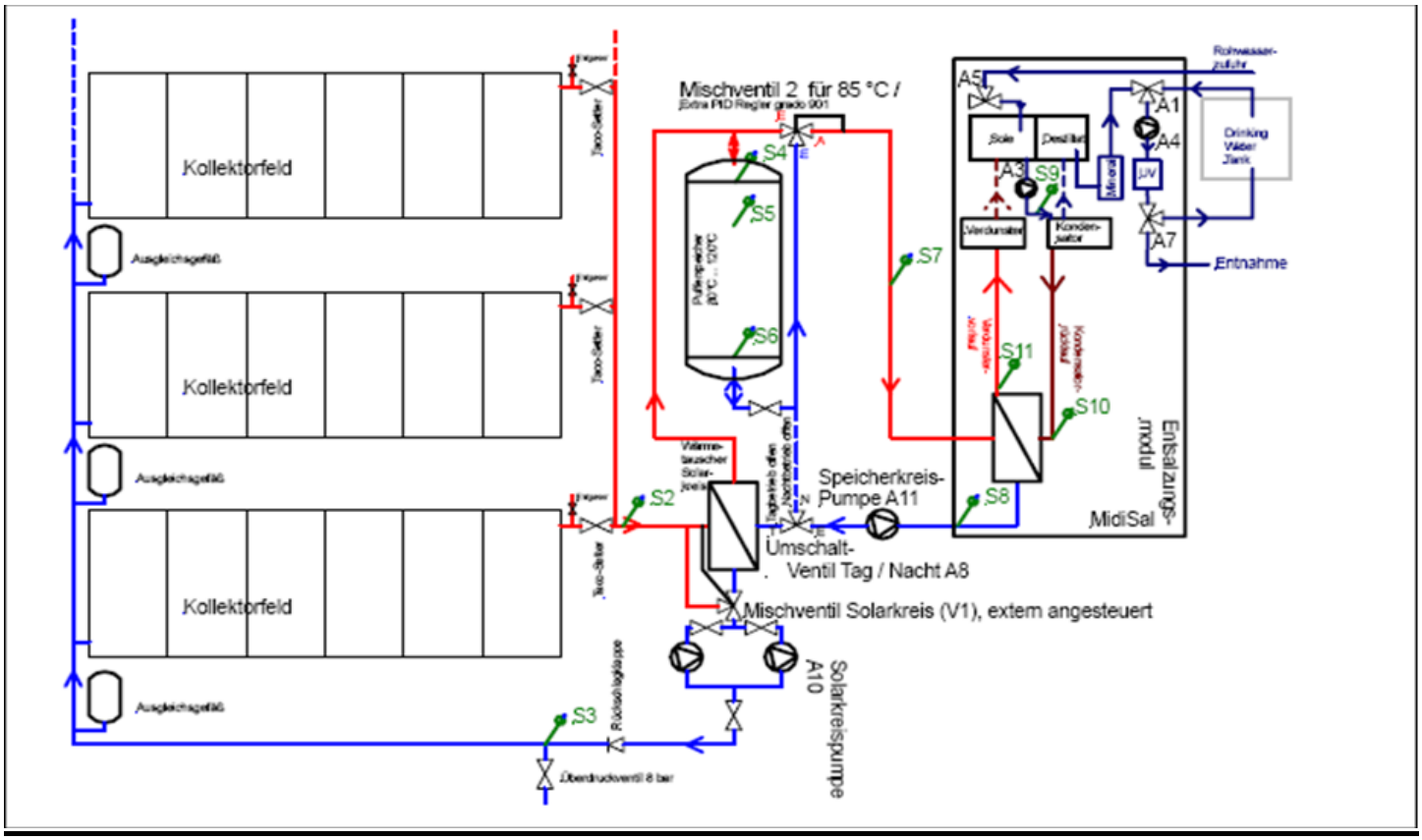
The original TiNOX / MEH Water Management desalination process is based on the evaporation of salt water and the subsequent condensation of the generated steam. In literature, this proprietary process is referred to as Multiple-Effect-Humidification (MEH).

The produced vapors are virtually clear, and do not carry any solvents. Following the condensation process, one can collect clear, salt-free and healthy fresh water.

In the process, sea water or other salty water (salt lakes, fossil brackish water) is heated by the sun or by use of waste heat. The heat would be supplied via highly corrosion-protected heat exchangers. The heated salty water enters an evaporation chamber produced from corrosion free materials – an imperative for reliable long term operation. Here the salty water evaporates from efficient antibacterial textile surfaces. The produced steam is transported to the condenser in a second step – completely without any additional energy demand.

As in nature, natural convection enables the best performance in the water production process - optimized by the **well engineered geometric collocation** of surfaces within the module. During condensation, the main part of the energy used for evaporation is regained, through the application of materials with extremely low heat flux resistance.

4.1 System Lay out



5.0 Technical Data of Equipment

5.1 Capacity – 1000 LPD

Technical Data Sheet MiniSal 1000 System Desalination Systems	
Autonomously operating Multi-Effect-Humidification unit. Capacity (nominal) 1000 Litres per day. Includes our patented, cleverly designed arrangement of corrosion free condensation and evaporation subunits enhancing best energy recovery ratios. All components in contact with salt water are made from corrosion free materials. Condensers/Evaporators are made of taste-free, beverage-conforming Poly Propylene material. Casing of the humidification chamber and collection basins are made of highly graded stainless steel.	
Casing of Desalination unit Dimensions:	Dismantled isolation box, set up on site requested Base area: central unit 1.08 m x 2.37 m, attached controller box 0.5 m x 0.9 m, Height 2.70 m
Weight Transportation Operation	480 kg 650 kg
Connection Raw Water supply Flange 4 holes, 1" d 32 DIN 2501	Required capacity supplied to the system, pressure 0.2 bar: a) min. 0.5 m^3/h, if system operates without add. cooling tower b) 0.1 m^3/h using additional external cooling tower*
Specification of Raw Water quality	Any not turbid raw water from nearly any source such as: Sea water, brackish water, water from polluted wells
TDS Conductivity Turbidity	Max. 100 000 ppm Max. 120 000 µS/cm No suspended substances (mechanical filtration at 50 Micron)
Connection for Heating Power Flange 4 holes 1" d32 DIN 2501	Nominal power: 4.5 $kW_{thermal}$ Temperature: Supply line 85 °C (185 °F) / Return 75 °C (167 °F)
a) Heating Supply by Solar Collectors	e.g. 35…45 m^2 highly efficient Solar Thermal Collectors (solar water heaters),
b) Heating Supply by waste heat	Using waste heat from primary cooling circuit of Diesel or Gas Motor - Corresponding minimum el. nominal power 10 $kW_{electrical}$
c) Heating supply by gas burner	5.5 $kW_{thermal}$ bulk load
Connection for electrical energy supply	Electrical grid connection 230 V AC, 50/60 Hz, 10A, nominal power 200 Watt
Alternative Photovoltaic set	**1.2 kW_{peak}** Photovoltaic system including 24 hours storage, inverters, controllers*
Specification of product water Salinity (TDS) Conductivity Temperature Max. Bacteria (Colony count 36°C)	 < 50 ppm < 20 µS/cm max. 40°C < 30/ml directly after production (permanent 5/ml with add. UV-disinfection system*)

Note: Re-mineralization of produced distillate can be done using additional (optional)– drinking water supply unit	
Specification of disposed brine Temperature TDS	Free flux without tailback needed, 2.3 m^3/h without or 0.3 m^3/h with cooling tower* Max. 45°C Max. concentration 150 000 ppm TDS

5.2 Capacity - 5000 LPD

Technical Data Sheet MidiSal 5000 System Desalination Systems	
Autonomously operating Multi-Effect-Humidification unit. Capacity (nominal) 5000 Litres per day. Includes our patented, cleverly designed arrangement of corrosion free condensation and evaporation subunits enhancing best energy recovery ratios. All components in contact with salt water are made from corrosion free materials. Condensers/Evaporators are made of taste-free, beverage-conforming Polypropylene material. Casing of the humidification chamber and collection basins are made of highly graded stainless steel.	
Casing of Desalination unit Dimensions:	20" CSC container Base area: 2.44 m x 6.06 m, Overall height Transportation 2.59 m Set Up 3.09 m
Weight Transportation Operation	5300 kg 6100 kg
Connection Raw Water supply Flange 4 holes, 1.5" d 40 DIN 2501	Required capacity supplied to the system, pressure 0.2 bar: a) min. 2.5 m^3/h, if system operates without add. cooling tower b) 0.5 m^3/h using additional external cooling tower*
Specification of Raw Water quality	Any not turbid raw water from nearly any source such as: Sea water, brackish water, water from polluted wells
TDS Conductivity Turbidity	Max. 100 000 ppm Max. 120 000 µS/cm No suspended substances (mechanical filtration at 50 Micron)
Connection for Heating Power Flange 4 holes 1" d32 DIN 2501	Nominal power: 20 $kW_{thermal}$ Temperature: Supply line 85 °C (185 °F) / Return 75 °C (167 °F)
a) Heating Supply by Solar Collectors	e.g. 140…200 m^2 highly efficient Solar Thermal Collectors (solar water heaters),
b) Heating Supply by waste heat	Using waste heat from primary cooling circuit of Diesel or Gas Motor - Corresponding el. nominal power 30 $kW_{electrical}$
c) Heating supply by gas burner	25 $kW_{thermal}$ bulk load
Connection for electrical energy supply	Electrical grid connection 230 V AC, 50/60 Hz, 10A, nominal power 450 Watt
Alternative Photovoltaic set	**3.5 kW_{peak}** Photovoltaic system including 24 hours storage, inverters, controllers*

Specification of product water Salinity (TDS) Conductivity Temperature Max. Bacteria (Colony count 36°C)	 < 50 ppm < 20 µS/cm max. 40°C < 30/ml directly after production (permanent 5/ml with add. UV-disinfection system*)
Note : Re-mineralization of produced distillate can be done using additional. (optional) drinking water supply unit*	
Specification of disposed brine Temperature TDS	Free flux without tailback needed, 2.3 m^3/h without or 0.3 m^3/h with cooling tower* Max. 45°C Max. concentration 150 000 ppm TDS

5.3 Capacity 10000 LPD

Technical Data Sheet MegaSal 10000 System Desalination Systems	
Autonomously operating Multi-Effect-Humidification unit. Capacity (nominal) 10000 Litres per day. Includes our patented, cleverly designed arrangement of corrosion free condensation and evaporation subunits enhancing best energy recovery ratios. All components in contact with salt water are made from corrosion free materials. Condensers/Evaporators are made of taste-free, beverage-conforming Polypropylene material. Casing of the humidification chamber and collection basins are made of highly graded stainless steel.	
Casing of Desalination unit Dimensions:	40" CSC container Base area: 2.44 m x 12.1 m, Overall height: Transportation 2.59 m, Set Up 3.09 m
Weight Transportation Operation	app. 9800 kg app. 11400 kg
Connection Raw Water supply Flange 4 holes, 1.5" d 40 DIN 2501	Required capacity supplied to the system, pressure 0.2 bar: a) min. 5.0 m^3/h, if system operates without add. cooling tower b) 1.0 m^3/h using additional external cooling tower*
Specification of Raw Water quality	Any not turbid raw water from nearly any source such as: Sea water, brackish water, water from polluted wells
TDS Conductivity Turbidity	Max. 100 000 ppm Max. 120 000 µS/cm No suspended substances (mechanical filtration at 50 Micron)
Connection for Heating Power Flange 4 holes 1.5" d40 DIN 2501	Nominal power: 40 $kW_{thermal}$ Temperature: Supply line 85 °C (185 °F) / Return 75 °C (167 °F)

a) Heating Supply by Solar Collectors	e.g. 320…380 m^2 highly efficient Solar Thermal Collectors (solar water heaters),
b) Heating Supply by waste heat	Using waste heat from primary cooling circuit of Diesel or Gas Motor - Corresponding el. nominal power 60 $kW_{electrical}$
c) Heating supply by gas burner	50 $kW_{thermal}$ nominal power
Connection for electrical energy supply	Electrical grid connection 220-240 V AC, 50/60 Hz, 10A, nominal power 850 Watt
Alternative Photovoltaic set	**5.5 kW_{peak}** Photovoltaic system including 24 hours storage, inverters, controllers*
Specification of product water Salinity (TDS) Conductivity Temperature Max. Bacteria (Colony count 36°C)	 < 50 ppm < 20 µS/cm max. 40°C < 30/ml directly after production (permanent 5/ml with add. UV-disinfection system*)
Note: Re-mineralization of produced distillate using additional (optional) drinking water supply unit*	
Specification of disposed brine Temperature TDS	Free flux without tailback needed, 2.3 m^3/h without or 0.3 m^3/h with cooling tower* Max. 45°C Max. concentration 150 000 ppm TDS

6.0 References

Location	System size	Operation time	Raw water
Frontier Lifeline Mediville, Chennai India	1 x 1000 liter/day	from 2010	Brackish Water
Fuerteventura, Spain. Aguas Verdes Holiday Resort, drinking water supply	2 x 500 liters/d	from 1992	Brackish Water / Sea Water
Tunisia, Sfax, Al Matar Farm irrigation and drinking water supply	1x 500 liters/d	from 1994	Brackish Water
Pozo Izqerdo, Gran Canaria	1x 1000	from 2000	Sea water

SODESA Project; CIEA-Research Institute for Water and Energy	litres/d		
Sultan Qaboos University Desalination Test Center Muscat, Sultanate of Oman	1x 1000 litres/d	from 2001	Sea water beach well
Bavarian Center for applied Energy Research	500 l/d	1994-2001	Sea Water, industrial waste water (Galvanisation effluents)
AHC-Oberflächentechnik GmbH & Co. KG Kerpen, Germany	1000 l/d	from 1996	Galvanisation effluent
Sami Rock Company Jeddah, Kingdom of Saudi Arabia Drinking Water supply	MidiSal, 5000 liters per day	from December 2005	Brackish / Sea Water
Solar Farm Bin Ladin Jeddah, Kingdom of Saudi Arabia Drinking Water supply	MidiSal, 5000 liters per day	from June 2006	Brackish / Sea Water
Geroskipou, Cyprus Public Swimming pool Drinking + HC Water supply	MiniSal, 1000 liters per day	from December 2007	Sea Water
Jeddah Aviation Club Jeddah, Kingdom of Saudi Arabia Drinking Water supply	MidiSal, 5000 liters per day	from May 2008	Brackish / Sea Water
South of Dubai Desert Resort UAE	MidiSal, 5000 liters per day	from July 2008	High salinity fossile ground water

7.0 Images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1 Heat Source Inlet
2 Heat Source Outlet
3 Distillate Outlet
4 Raw Water Inlet
5 Brine Disposal
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2
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MiniSal™5000 System

- Commissioned 2006
- Water Production from salty ground water

- Wind for pumping of ground water
- 140 m² Solar thermal collectors
- 10 m³ thermal storage tank

MiniSal™5000 System

- 140 m² thermal collectors
- Use of water is for human consumption, replacing daily truck delivery

Utilization of solar collector field as shading for car parking

Solar Thermal Water distillation plant installed at Frontier Mediville , Elavur Chennai.

The system is being introduced in India by GERINDTEC a systems integration company based in Germany, Australia, and India.

The model MINI SAL100O installed at Frontier Mediville , is a pilot plant with the capacity to distill and deliver 1000 Litres of pure water per day. The water can be any type of raw water - Sea water, Brackish water, or contaminated ground water - using Solar Energy or waste heat from other sources.