Opening the Future with New Challenges - DooWon TEG

# Smart MVR Distiller

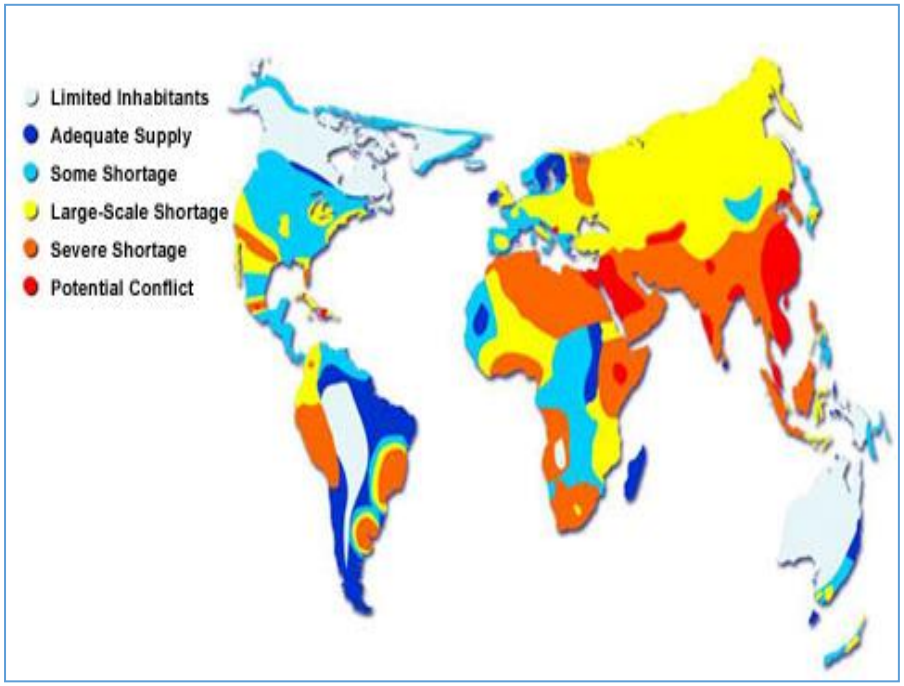
DOOWON TEG Co., Ltd.

www.doowonteg.com

# Ⅰ. Fresh Water Business

## ▣ Future-oriented business to solve water problem with high efficiency SMVR System

- ▶Seawater, river and groundwater are boiled and evaporated without using chemicals and filters to make 100% sterilized water (drinking water). It is an environmentally friendly facility.
- ▶High quality water production is possible (100 PPM or less).
- ▶Seawater is a profitable business because it can produce high-priced edible salt or industrial salt that has been sterilized if the concentrated water is dried.



# Ⅰ-Ⅱ. Purify the Living Sewage

## ▣ Purify the domestic sewage from houses and pass directly them to the river.

▶Urbanization, industrialization, and climate change made water shortage more serious problem, and the **'water reuse technology'** is attracting attention. Water reuse technology refers to the purification of wastewater such as rainwater or domestic sewage so that **it can be reused as domestic water, industrial water, and river water.**

▶With using **SMVR**, purify the domestic sewage and pass it directly to river for **restoring the natural environment (area near river).** Also solve the problem of 'sewage treatment plant' with **minimizing the amount of sewage.**

**Before Improvement**

**After Improvement**

## ▣ Purify the industrial sewage from factories and recycled as industrial water

▶The amount of industrial water usage is increasing. Hereby the amount of industrial wastewater also increases, resulting in many complex environmental problems such as groundwater contamination and treatment cost increase.

▶With using SMVR, purify the industrial sewage from factories and recycled as industrial water.

It will solve environmental problems and the shortage of industrial water.

**Purification efficiency according to concentration of raw water (wastewater)**

| Wastewater Concentration (%) | Concentrated Water (ton) | Distilled Water (ton) | Purification Efficiency | Incoming wastewater volume (ton/day) |
|---|---|---|---|---|
| 0.5 | 5 | 95 | 95% | 100 |
| 1 | 10 | 90 | 90% | |
| 2 | 20 | 80 | 80% | |
| 3 | 30 | 70 | 70% | |
| 4 | 40 | 60 | 60% (Decline Investment Value) | |
| 5 | 50 | 50 | 50% (Decline Investment Value) | |

## ▣ Feature

▶ SMVR is environmentally friendly system that produces 100% sterilized, safe and clean water (drinking water) because it produces water by boiling water such as seawater, ground water, and lime water without using chemicals and filters.

▶ Facilities capable of supplying drinking water to areas lack of potable water.
SMVR is capable of discharging water by reducing waste water discharge to 1/10 with water recycling technology.

▶ Water (potable water) production capacity and efficiency are superior to existing reverse osmosis (RO) type desalination facilities.

▶ The system configuration is simple. The location and cause of the problem appear on the LCD screen in case of trouble, which makes maintenance and repair easy.

▶ The compact size of the equipment makes it easy to install anywhere, regardless of location.

▶ In the case of clean seawater, edible salt can be produced by concentrating abandoned concentrated water. (Attach 1)

## ▣ Core-Tech

### 1. Extensive Experience / Usage

We developed a highly reliable and efficient high-speed turbo blower and steam compressor with a user-friendly automatic controller, after over 20 years of experience in development !
These Turbo systems are suitable for the aeration of sewage and waste water disposal plants that require oil-free compressed air, conveying chemical/cement/crop powders, supplying oxygen in fish farms, incinerator, other industrial use, and specially compressing low pressure steam for a SMVR distiller . (Attach 3)

### 2. Design and Manufacture through Optimization Analysis

Main components of the Turbo system are optimized ; a high-speed impeller using a complete 3 -dimensional aerodynamic flow analysis and 3D(Inventor) modeling, the tilting pad bearings and high-speed gears using vibration and rotor dynamic analysis !

### 3. Compact Turbo system & Simple Repair

One of the typical characteristics of turbo machines is that when the impeller, a major part of the machine, rotates at high speeds, its size reduces in reverse proportion to the speed. It is easy to maintain and repair small components including the impeller, but not everyone can develop high-speed turbo machines. It is pure technological strength that matters ! (Attach 5)

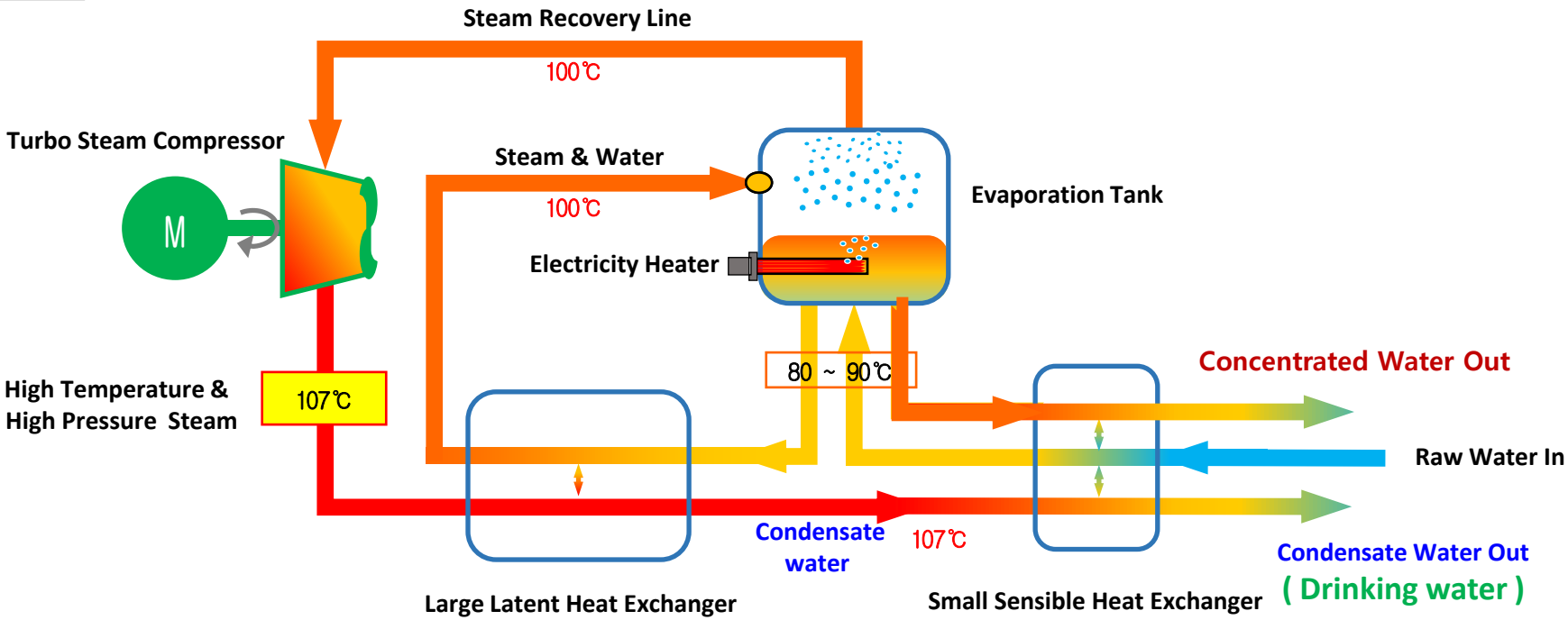
### 4. Convenient Operation

The Turbo system provides a visually operated and easy-to-use true color HMI control panel, which takes user input parameters required for the operation, and displays the status map, the trends of major parameters, alarms and causes of error, and the storage capacity of operational data ! (Attach 4)

### 5. No additional Facilities

The Turbo system generally uses oil to protect the bearings and gears, and it requires cooling water to cool the unit continuously. This requires a cooling tower, large and separate equipment installed on the outside. This is prone to causing problems, such as germ problems inside the tower in the summer and the freezing and bursting of pipes in the winter..
Our Turbo system has applied an air-cooling system to replace this hassling system, minimizing in the process of the cooling load of the gear and bearing oil, and reducing the maintenance and repair items.

## ▣ Principle



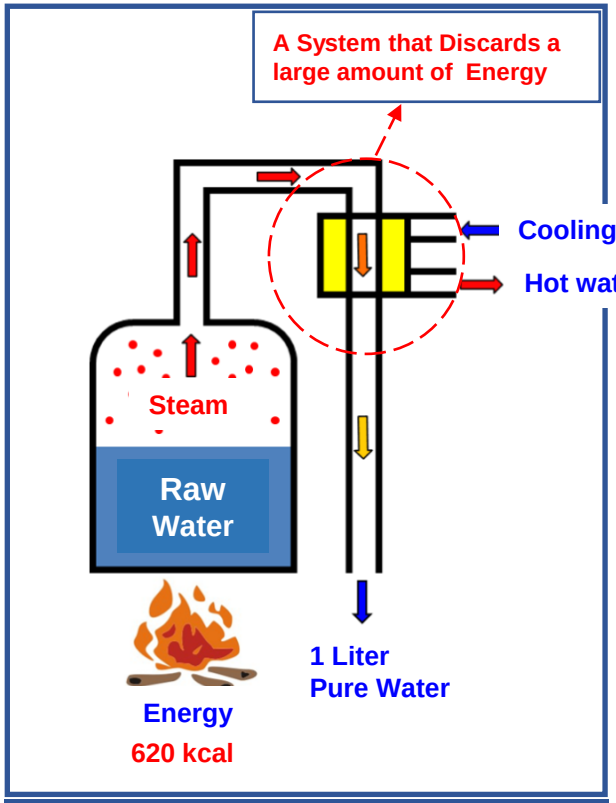

▶ **SMVR – An equipment that produces clean water by distilling raw water (sea water, wastewater, etc.) reusing steam.**

**1) First, use electric heaters to boil the raw-water and generate steam**

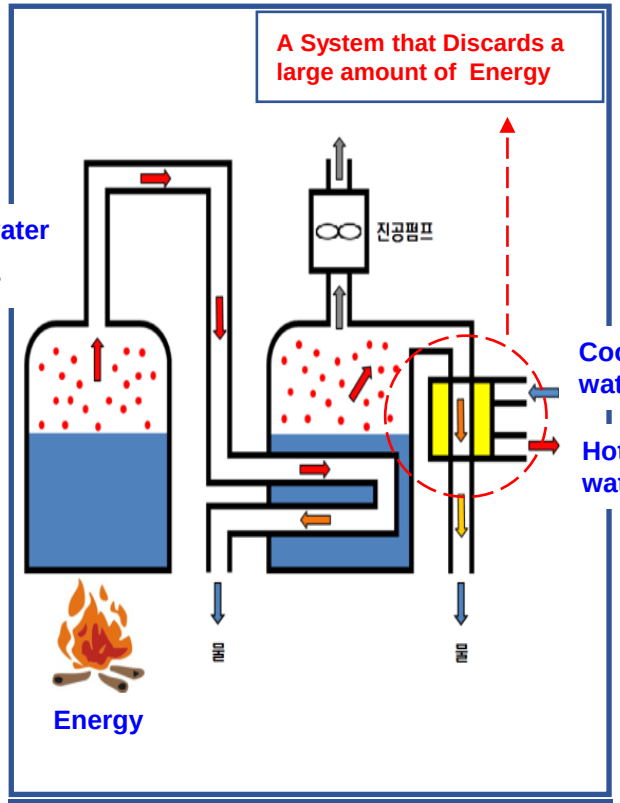
**2) The steam go through a mechanical compressor and become hotter**

**3) The steam exchanges heat with raw-water coming in, and cools down becoming a fresh water**

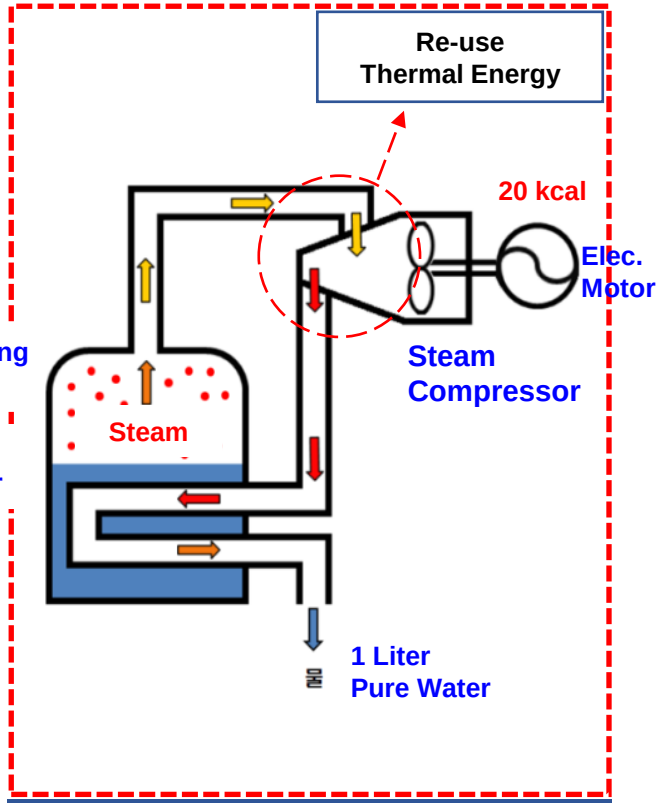
## ▣ Trend of Evaporation System Technology




SE 1 Stage Effect (Simple Heating)




MED Multi Stage Effects Distiller (Vacuum Method)

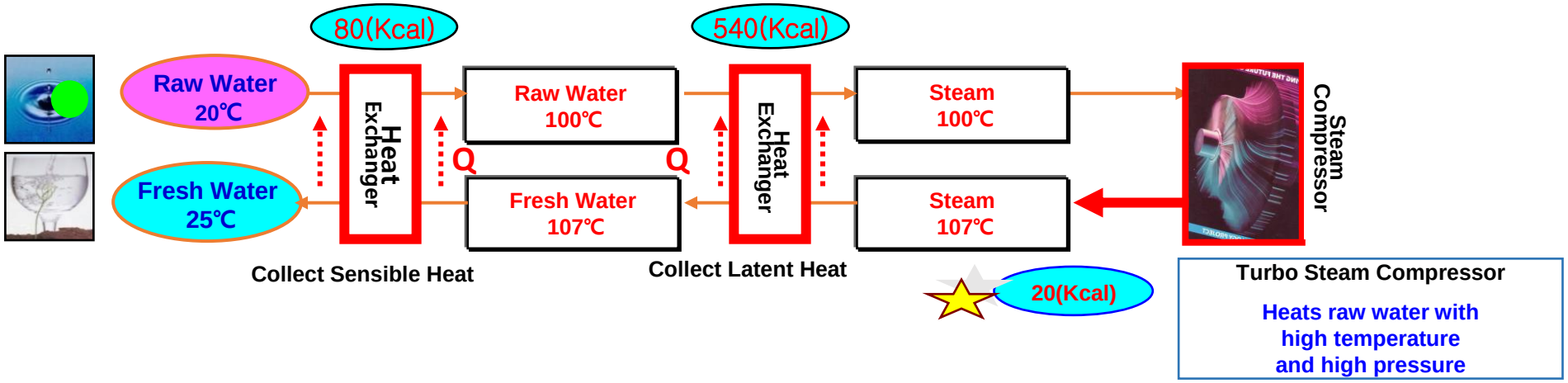


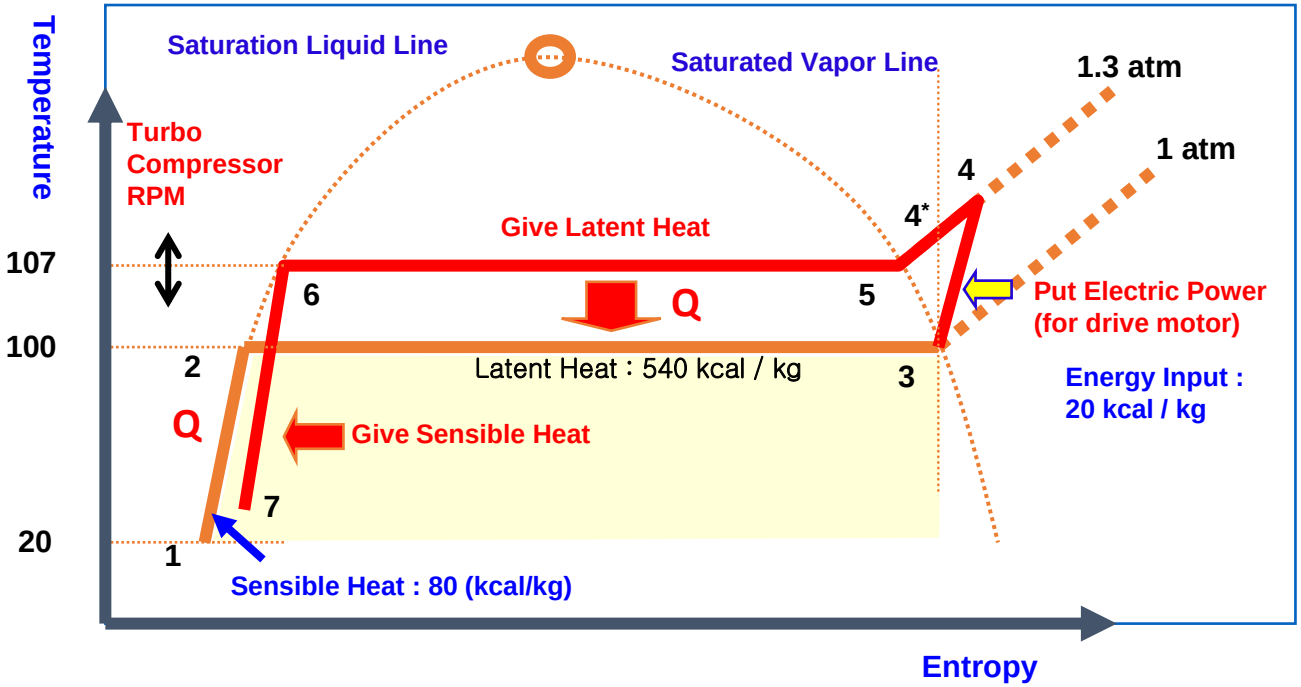

SMVR Mechanical Turbo Vapor Compression Method (Technology utilizing fluid properties)

| Methods | 1 Stage | 2 Stage | ~ | 10 Stage | SMVR |
|---|---|---|---|---|---|
| Input Energy (Kwh/ton) | 720 | 360 | ~ | 72 | 23 |

* Coefficient of Performance (COP) of Heat Pump= $\frac{620\ (kcal)}{20\ (kcal)}$ = 31

## ▣ MVR Energy Balance System



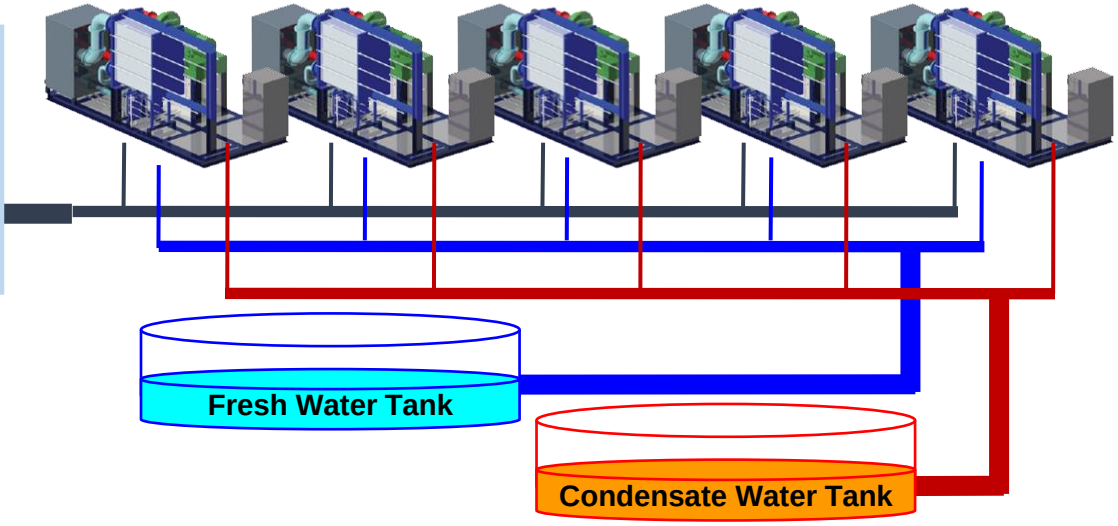
▶ Various small SMVR sizes for niche markets in the world's desalination market
– A standard production model for fresh water facilities

| Model | Producing Ability (ton/day) | Standard (m) | | | Weight ( ton ) | Delivery (month) on FCA | Remarks |
|---|---|---|---|---|---|---|---|
| | | L | W | H | | | |
| SMVR 10 | 10 | 3.5 | 2.5 | 3.0 | 6 | 4 ~ 6 | *Produced in one piece of product with using a frame<br>*All model specification are the same 20ft standard container size |
| SMVR 25 | 25 | 6 | 2.8 | 3.8 | 14 | | |
| SMVR 50 | 50 | 6 | 2.9 | 3.8 | 17 | | |
| SMVR 75 | 75 | 6 | 3.0 | 3.8 | 21 | | |
| SMVR 100 | 100 | 6 | 3.2 | 3.8 | 24 | | |
| SMVR 200 | 200 | 6 | 5.0 | 4.0 | 40 | 6 ~ 8 | -split production in two frame |

▶ Connecting Multiple SMVR-Desalination for Large Capacity

| Model | Producing Ability (ton/day) | Standard (m) | | | Weight (ton x quantity) | Delivery (month) on FCA | Components and Installation |
|---|---|---|---|---|---|---|---|
| | | L | W | H | | | |
| SMVR 300 | 300 | 6 | 3.4 x 3 | 2.9 | 17 x 3 | 6 ~ 8 | Connect 3 to 10 'SMVR 100' |
| SMVR 500 | 500 | 6 | 3.4 x 5 | 2.9 | 17 x 5 | | |
| SMVR 1000 | 1,000 | 6 | 3.4 x 10 | 2.9 | 17 x 10 | | |

[ Multi Stage Model : SMVR 500 ] ➡ [ SMVR 100 ] [ SMVR 100 ] [ SMVR 100 ] [ SMVR 100 ] [ SMVR 100 ]
[ Multi Stage Model : SMVR 1000 ] ➡ [ SMVR 200 ] [ SMVR 200 ] [ SMVR 200 ] [ SMVR 200 ] [ SMVR 200 ]




Supple Raw Water
(Sea water / Salt Water)

- Raw Water Pipe
- Fresh Water Pipe
- Condensate Water Pipe

## Analysis of water treatment cost of SMVR

- ▣ **Electric Energy Required for Water Production: 50 kwh/ton** (Attach 2)
- ▣ **Water Production Cost: 50 kwh/ton x 100 KRW/kwh = 5,000 KRW/ton ($5, KRW1,000/$) ( 1 kwh=100KRW. Korea ) = 5.0 KRW/L**

### Standard

- water production per day :100ton/24hours (100,000 L)
- Daily water consumption per household (4people) :1.2ton(1,200 L)
- Daily water consumption per person : 0.3ton (300 L)

### Estimated number of households that can be supplied water

- 1 day water production 100 tons / per household
- 1 day water consumption 1.2 ton = 83.3 households

### Estimated number of people who can be supplied water

- 1 day water production 100 tons / person
- 1 day water consumption 0.3 tons = 333.3 people
  (When drinking 2 liters per day : 50,000 people)

[ When producing 100 tons of drinking water / 24 hours ]
= 100,000 bottles / 1 L

= 5,000 box / 20 bottles

20 bottles / box

## ▣ Test Results (Malicious Wastewater)

[Proved water efficiency with authorized institution test]

| No. | Item | Measure | Restrictions on malicious wastewater for a specific area in Korea | | | | Request Accredited Institutional Examination of SMVR<br>Test Result<br>Very good ( First Grade) | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Clean Area | "A" Area | "B" Area | Special Area | Influx | Efflux | Ratio (%) |
| 1 | BOD | mg/ℓ | 40 | 80 | 120 | 30 | 79.4 | 9.1 | 88.5 |
| 2 | $COD_{Mn}$ | mg/ℓ | 50 | 90 | 130 | 40 | 484 | 28.3 | 94.2 |
| 3 | SS | mg/ℓ | 40 | 80 | 120 | 30 | 186 | 2.0 | 98.9 |
| 4 | T-N | mg/ℓ | 30 | 60 | 60 | 60 | 504 | 6.01 | 98.8 |
| 5 | T-P | mg/ℓ | 4 | 8 | 8 | 8 | 0.85 | 0.05 | 94.1 |
| 6 | $CN^-$ | mg/ℓ | 0.2 | 1 | 1 | 1 | ND | ND | - |
| 7 | Cr | mg/ℓ | 0.5 | 2 | 2 | 2 | 1.42 | 0.02 | 98.6 |
| 8 | Fe | mg/ℓ | 2 | 10 | 10 | 10 | 62.2 | 0.14 | 99.8 |
| 9 | Zn | mg/ℓ | 1 | 5 | 5 | 5 | 183 | 0.11 | 99.9 |
| 10 | Cu | mg/ℓ | 1 | 3 | 3 | 3 | 0.07 | 0.03 | 57.1 |
| 11 | pH | - | 5.8~8.6 | 5.8~8.6 | 5.8~8.6 | 5.8~8.6 | 5.7 | 6.8 | - |
| 12 | Conductivity | ㎲/㎝ | Reference | | | | 24,700 | 57 | 99.8 |
| 13 | Na | mg/ℓ | Reference | | | | 5,180 | 1.77 | 100.0 |
| 14 | Ni | mg/ℓ | Reference | | | | 1.41 | 0.02 | 98.6 |
| 15 | TDS | mg/ℓ | Reference | | | | 16,300 | 48.0 | 99.7 |

**Before**

Concentration of pigment in seawater : 35,000 ppm

→

**After**

No coliform
No Bacterial
No Salinity
Concentration after purification : 100 ppm.

## ▣ Wastewater Treatment Test Report

**Before**

KOREA TESTING & RESEARCH INSTITUTE

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150-038 서울특별시 영등포구 영등포동 8가 88-2
Tel : 02-2164-0011 Fax : 02-2634-1008

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접수번호 : TAS-017322
대 표 자 : 임종욱
업 체 명 : (주)대봉기계
주 소 : 경남 김해시 생림면 사촌리 609-14

접 수 일 자 : 2008년 05월 08일
시험완료일자 : 2008년 05월 21일

시 료 명 : 도금폐수(원수)

**시 험 결 과**

| 시험항목 | | 단위 | 시료구분 | 결과치 | 시험방법 |
|---|---|---|---|---|---|
| BOD | | mg/L | | 79.4 | 수질오염공정시험방법:2007 |
| COD□ | | mg/L | | 484 | 수질오염공정시험방법:2007 |
| 부유물질 | SS | mg/L | | 186 | 수질오염공정시험방법:2007 |
| 총질소 | TN | mg/L | | 504 | 수질오염공정시험방법:2007 |
| 총인 | TP | mg/L | | 0.85 | 수질오염공정시험방법:2007 |
| CN□ | | mg/L | | 검출안됨 | 수질오염공정시험방법:2007 |
| Cr | | mg/L | | 1.42 | 수질오염공정시험방법:2007 |
| Fe | | mg/L | | 62.2 | 수질오염공정시험방법:2007 |
| Zn | | mg/L | | 183 | 수질오염공정시험방법:2007 |
| Cu | | mg/L | | 0.07 | 수질오염공정시험방법:2007 |
| pH(25℃) | | - | | 5.7 | 수질오염공정시험방법:2007 |
| 전기전도도(25℃) | | mS/cm | | 24.7 | 수질오염공정시험방법:2007 |
| Na | | mg/L | | 5180 | Standard Methods:2005 |
| Ni | | mg/L | | 1.41 | Standard Methods:2005 |
| 암모니아성질소 | | mg/L | | 23.8 | 수질오염공정시험방법:2007 |
| 아질산성질소 | | mg/L | | 0.35 | 수질오염공정시험방법:2007 |
| 질산성질소 | | mg/L | | 344 | 수질오염공정시험방법:2007 |
| 증발잔류물 | | mg/L | | 16300 | KS M 0100:2003 |

용 도 : 품질관리용

비 고 : 1. 이 성적서는 의뢰자가 제시한 시료 및 시료명으로 시험한 결과로서 전체제품에 대한 품질을 보증하지는 않습니다.
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2008년 05월 21일

한국화학시험연구원장

총 1 페이지 중 1 페이지

전자문서본(Electronic Copy)

**After**

KOREA TESTING & RESEARCH INSTITUTE

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|---|---|---|---|---|---|
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| COD□ | | mg/L | | 28.3 | 수질오염공정시험방법:2007 |
| 부유물질 | SS | mg/L | | 2.0 | 수질오염공정시험방법:2007 |
| 총질소 | TN | mg/L | | 6.01 | 수질오염공정시험방법:2007 |
| 총인 | TP | mg/L | | 0.05 | 수질오염공정시험방법:2007 |
| CN□ | | mg/L | | 검출안됨 | 수질오염공정시험방법:2007 |
| Cr | | mg/L | | 0.02 | 수질오염공정시험방법:2007 |
| Fe | | mg/L | | 0.14 | 수질오염공정시험방법:2007 |
| Zn | | mg/L | | 0.11 | 수질오염공정시험방법:2007 |
| Cu | | mg/L | | 0.03 | 수질오염공정시험방법:2007 |
| pH(25℃) | | - | | 6.8 | 수질오염공정시험방법:2007 |
| 전기전도도(25℃) | | μS/cm | | 57.0 | 수질오염공정시험방법:2007 |
| Na | | mg/L | | 1.77 | Standard Methods:2005 |
| Ni | | mg/L | | 0.02 | Standard Methods:2005 |
| 암모니아성질소 | | mg/L | | 5.57 | 수질오염공정시험방법:2007 |
| 아질산성질소 | | mg/L | | 0.01 | 수질오염공정시험방법:2007 |
| 질산성질소 | | mg/L | | 0.02 | 수질오염공정시험방법:2007 |
| 증발잔류물 | | mg/L | | 48.0 | KS M 0100:2003 |

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총 1 페이지 중 1 페이지

전자문서본(Electronic Copy)

## ▣ Sample Inspection Table (Colored Sea water)

Gimhae dae-ro 2401, Gimhae, Gyeongsangnam-do, Rep. of Korea TEL : +82 55-330-4571 / FAX : +82 55-330-4459

Water & Wastewater Establishment Section Chief : Kim Hwa-soo Person in Charge : Kim Kyunh Ae

Web-site : http://gimhae.go.kr / E-mail address : KY04063@gimhae.go.kr

**Document Number** : Distillation 65460 – 5121

**Enforcement Date** : May. 01, 2003

**Recipient** : Doowon TEG Co., Ltd.

**Title** : Report of Water Analysis Test Result

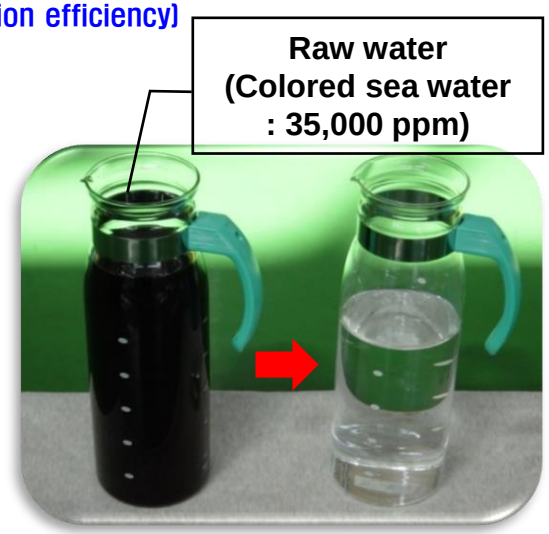
The test results of the samples you have submitted to our establishment are listed below:

| Name of Sample | Drinking Water | | Testing Purpose | Reference |
|---|---|---|---|---|
| Client | Name (Corporate Name) | SamJeong Turbine Co., Ltd. TEL: +82 55-345-6971 | | |
| | Address | 116, Gomo-ro 180 beon-gil, Jillye-myeon, Gimhae-si, Gyeongsangnam-do, Rep. of Korea | | |
| Sampling Place | 116, Gomo-ro 180 beon-gil, Jillye-myeon, Gimhae-si, Gyeongsangnam-do, Rep. of Korea | | Date of Sampling | April. 14, 2003 |
| Date of Receipt | April. 14, 2003 | | Receipt Number | Complaint 515 |

| Test Item | Standard | Test Results | Test Item | Standard | Test Results |
|---|---|---|---|---|---|
| Bacteria | Less than 100CFU/mL | 0 | Benzene | Less than 0.01mg/L | Non-detection |
| Coliform | Non-detection / 100mL | Non-detection | Toluene | Less than 0.7 mg/L | Non-detection |
| Lead | Less than 0.05mg/L | Non-detection | Ethylbenzene | Less than 0.3 mg/L | Non-detection |
| Fluorine | Less than 1.5mg/L | Non-detection | Xylene | Less than 0.5 mg/L | Non-detection |
| Arsenic | Less than 0.05mg/L | Non-detection | Carbon tetrachloride | Less than 0.002 mg/L | Non-detection |
| Selenium | Less than 0.01mg/L | Non-detection | Hardness | Less than 300 mg/L | 22 |
| Mercury | Less than 0.001mg/L | Non-detection | Smell | Odorless | Conformity |
| Hexavalent Chrome | Less than 0.05mg/L | Non-detection | Flavor | Flavorless | Conformity |
| Ammonia Nitrogen | Less than 0.5mg/L | 0.07 | Copper | Less than 1 mg/L | Non-detection |
| Nitrate Nitrogen | Less than 10mg/L | Non-detection | Chromaticity | Less than | 1 |
| Cadmium | Less than 0.005mg/L | Non-detection | Aluminum | Less than 0.2 mg/L | Non-detection |
| Boron | Less than 0.3mg/L | Non-detection | Hydrogen ion concentration | 5.8 ~ 8.5 | 7.1 |
| Phenol | Less than 0.005mg/L | Non-detection | Zinc | Less than 1 mg/L | 0.062 |
| Diazinon | Less than 0.02mg/L | Non-detection | Chlorine ion | Less than 250 mg/L | 3 |
| Parathion | Less than 0.06mg/L | Non-detection | Evaporation residue | Less than 500 mg/L | 126 |
| Fenitrothion | Less than 0.04mg/L | Non-detection | Iron | Less than 0.3 mg/L | Non-detection |
| Carbaryl | Less than 0.07mg/L | Non-detection | Manganese | Less than 0.3 mg/L | Non-detection |
| Trichloroethylene | Less than 0.03mg/L | Non-detection | Turbidity | Less than 1NTU | 0.43 |
| Dichloromethane | Less than 0.02mg/L | Non-detection | Sulfate ion | Less than 200 mg/L | 2 |
| Judgment | Suitable for drinking water quality standards | | | | |

Count of Bacteria
Count of coliform
dichloromethane
Chlorine ion

(Demonstration of water purification efficiency)




**"ZERO" bacterium**
**"ZERO" coliform**

**Residual/Input =126/35,000**
**= 0.36 (%)**
**99.64(%) Eliminated**

## ▣ Attach 1 (Expected amount of salt production per day by each SMVR model

- Seawater Salinity: Over 3 ~ 3.5%.
- Amount of salt production per 1ton of seawater : 10kg (Sea water 100ton -> 1ton salt production)
- Salt retail price : KRW 1000 Won/kg. (Korea selling Price)

* If salt water concentration is high, salt production will increase and the above calculation is estimated amount, which may differ depending on the situation.
* Salt from contaminated seawater should not be used for edible use
* Clean seater is boiled at 100˚ C to produce drinking water, and highly concentrated seawater will be sent to the salt pond, resulting 100% sterilized edible salt

### Salt Production and amount by Model

| Model No. | Daily salt production | Monthly (25 days) Salt production | Monthly (25 days) Amount of salt | Yearly (300 days) Salt production | Yearly (300 days) Amount of salt |
|---|---|---|---|---|---|
| SMVR 25 | 0.25ton (250 Kg) | 6.25ton(6,250 Kg) | ₩ 6,250,000($6.25) | 75ton(75,000 Kg) | ₩ 75,000,000($75,000) |
| SMVR 50 | 0.5ton (500 Kg) | 12.5ton(12.500 Kg) | ₩ 12,500,000($12,500) | 150ton(150,000 Kg) | ₩ 150,000,000($150,000) |
| SMVR 75 | 0.75ton (750 Kg) | 18.75ton(18,750Kg) | ₩ 18,750,000($18,750) | 225ton(225,000 Kg) | ₩ 225,000,000($225,000) |
| SMVR 100 | 1ton (1,000 Kg) | 25ton(25,000 Kg) | ₩ 25,000,000($25,000) | 300ton(300,000 Kg) | ₩ 300,000,000($300,000) |
| SMVR 200 | 2ton (2,000 Kg) | 50ton(50,000 Kg) | ₩ 50,000,000($50,000) | 600ton(600,000 Kg) | ₩ 600,000,000($600,000) |

# SMVR-Distiller Electrical Specifications

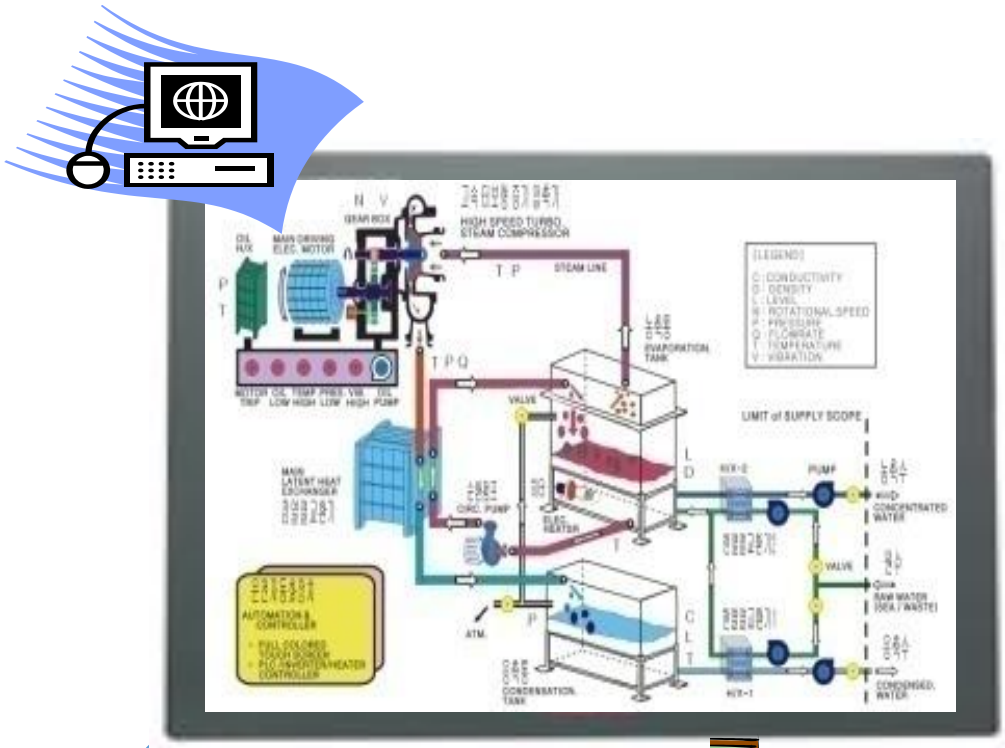
| Model | Amount of distillation per hour (Ton/h) | Performance during evaporative concentration (KWh/Ton) | | Capacity (KW) | | | Power consumption | Moter | |
|---|---|---|---|---|---|---|---|---|---|
| | | During normal operation (average) | Guaranteed Performance at Contract | During normal operation (average) | Guaranteed Performance at Contract | Electrical equipment Ready capacity | Daily average total consumption Power (kWh) | Type | KW |
| SMVR 10 | 0.417 | 75 | 90 | 31 | 38 | 64 | 751 | Screw | 37 |
| SMVR 25 | 1.042 | 50 | 60 | 52 | 63 | 106 | 1,250 | Turbo | 55 |
| SMVR 50 | 2.083 | 50 | 60 | 104 | 125 | 212 | 2,500 | Turbo | 110 |
| SMVR 75 | 3.125 | 50 | 60 | 156 | 188 | 319 | 3,750 | Turbo | 160 |
| SMVR 100 | 4.167 | 50 | 60 | 208 | 250 | 425 | 5,000 | Turbo | 200 |
| SMVR 200 | 8.333 | 50 | 60 | 417 | 500 | 850 | 10,000 | Turbo | 350 |

**Remarks **

*1) Electric equipment preparation capacity (1set) = Guaranteed Performance at Contract (KWh/Ton) x The amount of distillation per hour of equipment (Ton/h) x 1.7(Power peak ratio)
*2) (N units) = Electric equipment preparation capacity (1 unit) + (N-1) * Guarantee performance at contract basis Capacity

Example: For five SMVR100s:
Electric equipment preparation capacity (one) = 60 * (100/24) * 1.7 = 425 (kW)
Electric preparation capacity (5 units) = 425 + (5-1) * 250 = 1,425 (kW)
The average total power consumption per day = 50 (kWh / ton) * 100 (ton / day) = 5,000 (kWh / day)

## ▣ SMVR System Automation Controller




**10 inch Full Color Touch Screen on Windows 7**

### High Performance Control System :

The system is composed of the basic unit made of the high performance programmable logic controller (LS_GM6_PLC), with the special modules(sending & receiving 4-20 mA signal from/to sensors, temperature, pressure, level meter, flow meter, inverters, etc), and the 16,700,000 true color HMI touch screen used for taking and confirming a user's operational commands, displaying status and trends, and storing of data.
It is equipped with RS232, RS485, and Ethernet communication ports to communicate with other equipment, and it is programmed to enable remote operation with an existing other system, and also to control a number of SMVR distillers efficiently and individually.

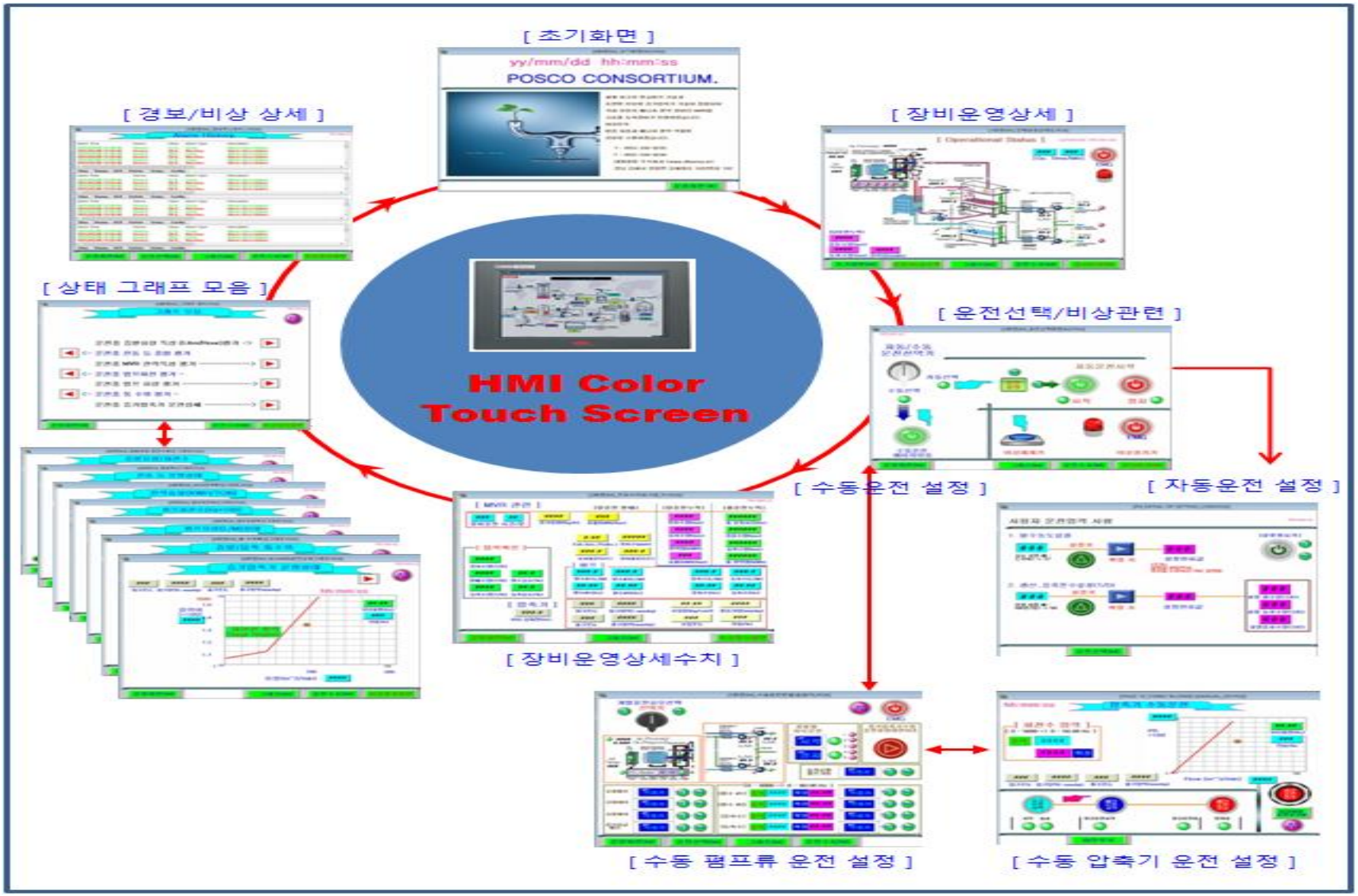
### Visible & Easy Operation on Human-Machine-Interface System with Full Colored Touch Screen helps your reliable and easy operation :

The visually and easy-to-use HMI touch screen panel takes the user input parameters required for operation, shows the status map, the trends of the major parameters, alarms, and the causes of any errors, as well as the storage capacity of the operational data. Following the directions on the touch screen, you first push the start button, and simply watch the operational status. If there are any problems with the equipment, it shows where, why, and when the problems began at a glance, automatically saving the data and stopping the equipment safely. In other words, you can become a professional operator without any special training.

▣ Attach 4

( Configuration history of LCD screen )

SMVR-Desalination The operation status can be observed and checked through the LCD screen.



# Ⅵ. Technology & Quality Competitiveness

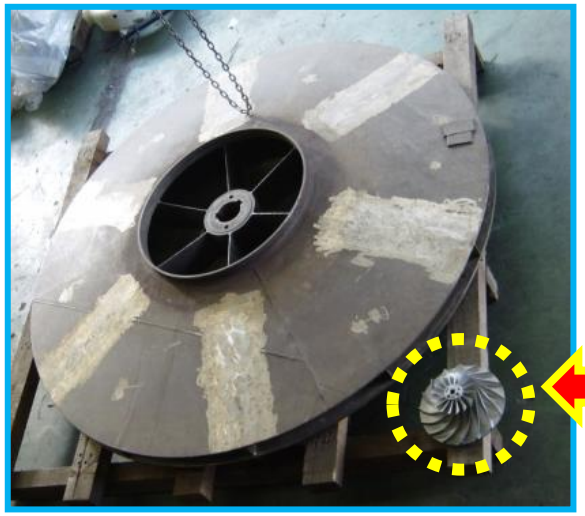
## ▣ Comparative analysis of domestic and overseas competitors

| Evaluation Criteria | SMVR | RO | Other<br>MVR | Others |
|---|---|---|---|---|
| Environmental pollution caused by the discharged water | No effect (eco – friendly) | Effect on the environment | No effect (eco – friendly) | |
| Chemical input | Needless | Absolutely needed | Needless | |
| Additional Steriliizing | Needless | Absolutely needed | Needless | |
| Pre-treatment facility | Needless | Absolutely needed | Needless | |
| Post-treatment facility | Needless | Absolutely needed | Needless | |
| Quality of Water | Superlative degree water | Good water | High class water | Korea Standard : |
| | (TDS<100ppm) | (100<TDS<500ppm) | (TDS<100ppm) | TDS<500 PPM |
| Maintenance item | Low pressure pump seal parts | High pressure pump and parts | Common pump and parts | |
| | | Filters | | |
| System Components & Maintenance | Very easy and simple | Very complicated and hard | Very complicated and hard | |
| | Technician not needed | Specialized manpower needed | Specialized manpower needed | |
| Brine filtering | 100% desalination | Cat not desalinate 100% | 100% desalination | |
| Filtering efficiency | Constant and high efficiency | Love and erratic | Constant, but not as high as SMVR | |
| Periodical part replacing | None (semi permanent) | Periodic Filter replacement | None | General items such as pump and motor excluded |
| Water production cost per ton (USD) | 4 USD( Low cost ) | 7 USD( High cost ) | 6 USD | |
| Initial investment cost | High ( @ 1.2 Mil USD ) | Low ( @ 0.7 Mil USD ) | Very High (@1.8~2 Mil USD) | |
| Contaminated sea water desalination | Possible | Impossible | Possible | |
| Level of technology and quality | Very High | Low | High | |
| Availability in Ships and Offshore plants | Most suitable (Compact size) | Suitable (Currently used) | Not suitable (too large) | |

## ▣ Comparison of Evaporation System

| Items | SMVR | TVR | MED | MSF | Others |
|---|---|---|---|---|---|
| ▶ Relative Efficiency | 25 | 5 | 2 | 1 | Heat recovery steps |
| ▶ Relative Size | Very Low | Low | Medium | Large | Based on the Same Capacity |
| ▶ Required Energy | Electric | Fuel + Electric + Steam | Fuel or Electric + Steam | Electric + Steam | TVR, MED, MSF desalination plants require a lot of energy |
| ▶ Capacity | Low | Medium | Large | Large | - |
| ▶ Technology Level | Very High | High | Medium | Low | SMVR need high technology |
| ▶ Rep. Companies | DOOWON TEG (Korea)<br>Sasakura (Japan)<br>IDE (Israel) | Sasakura (Japan)<br>Korean Companies | Doosan<br>Hyundai | Doosan<br>Hyundai | - |
| ▶ Required Conditions | Electric Heater + Turbo Steam Compressor | High Pressure Steam System + Chemical Processing System | TVC (High Pressure Steam System) + High-Capacity Electrical System +Chemical Processing System | Steam Turbine or Heat Recovery Boiler + High-Capacity Electrical System +Chemical Processing System | TVR, MED and MSF facilities are very complicated structure and water purification method, so they can not be operated without professional manpower. |

## ▣ Size comparison



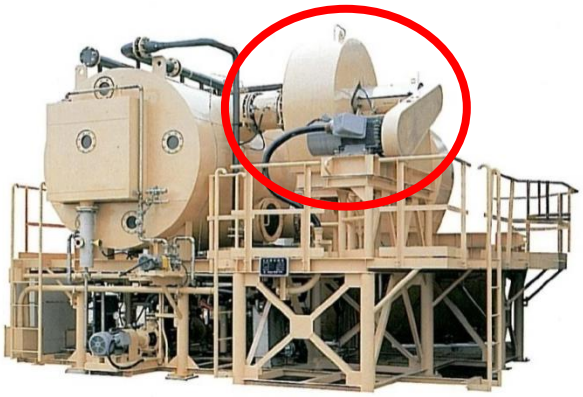
### ◈ Size of compressor impeller ◈

- ➤ Extremely large : Diameter over 2,000 (mm) – Other company 2
- ➤ Large : Diameter 1,500 - 2,000 (mm) – Other company 1
- ➤ Small : Diameter 200 - 400 (mm) – DOOWON TEG

DOOWON

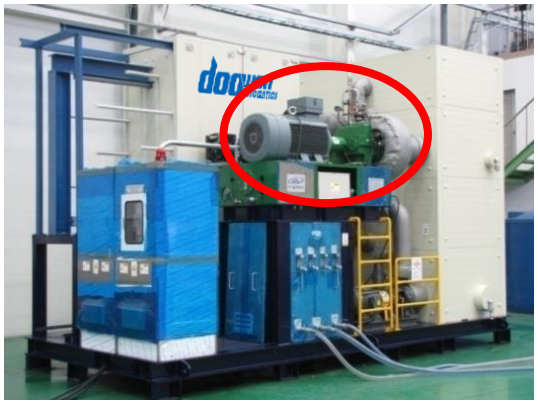
Doo Won SMVR – Distiller A/S and Maintenance Very Easy !

Other company 1



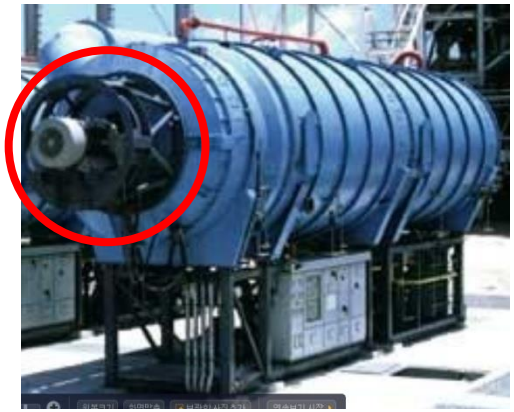
Q=150(T/D), L:6,000, W:6,000, H:5,000

DOOWON (Korea)



Q=100(T/D), L:6,000,W:2,500,H:2,900

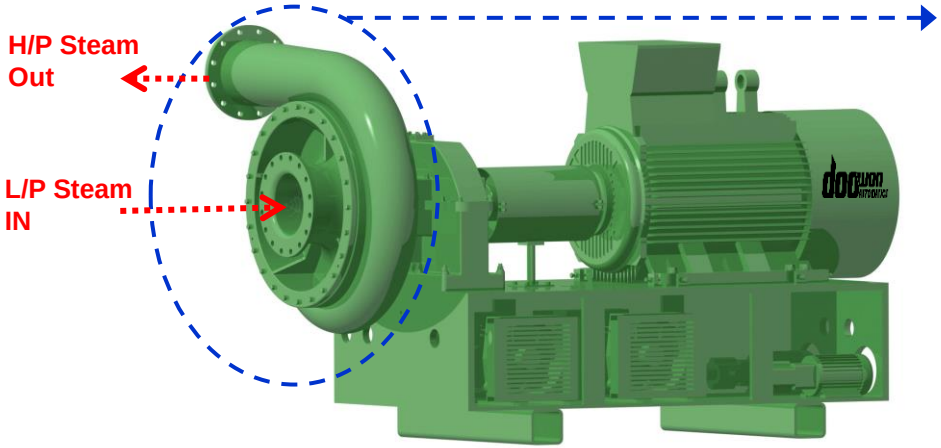
Other company 2

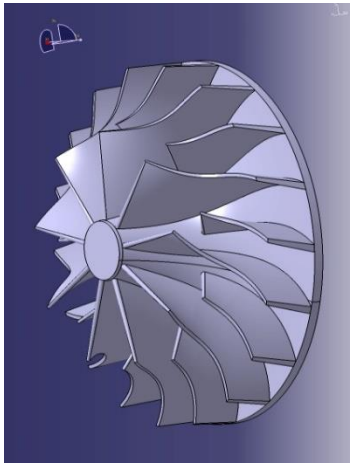


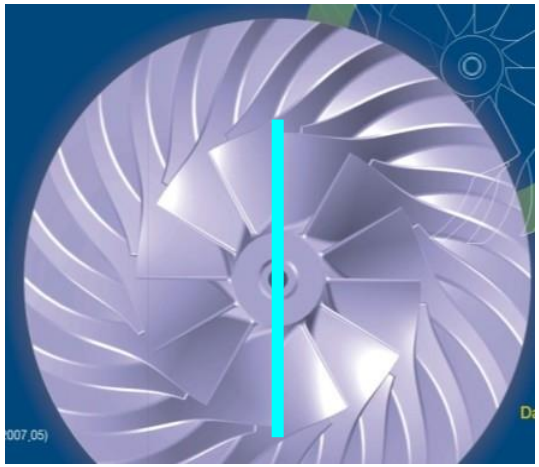
Q=100-250(T/D), L:9,500,W:4,500,H:6,100

## ▣ Aerodynamic Design of Turbo Steam Compressor(Core Technology of Doowon)

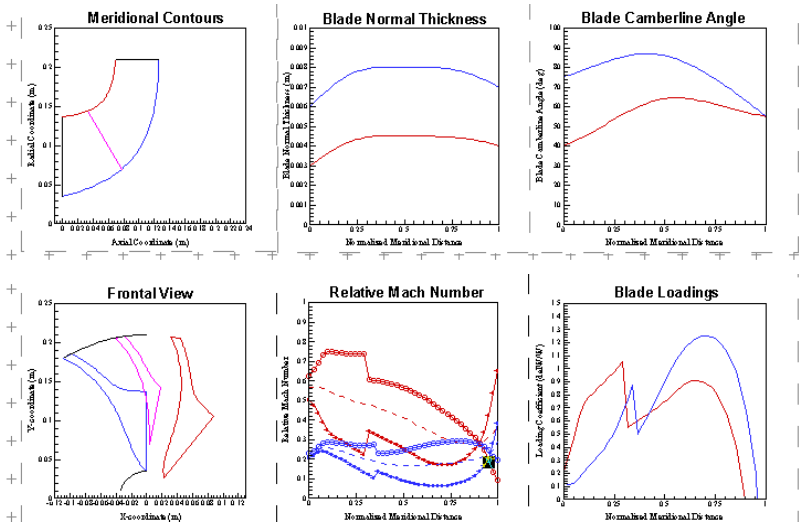
**Design Rot. Speed= Max. 22,500 (rpm)**



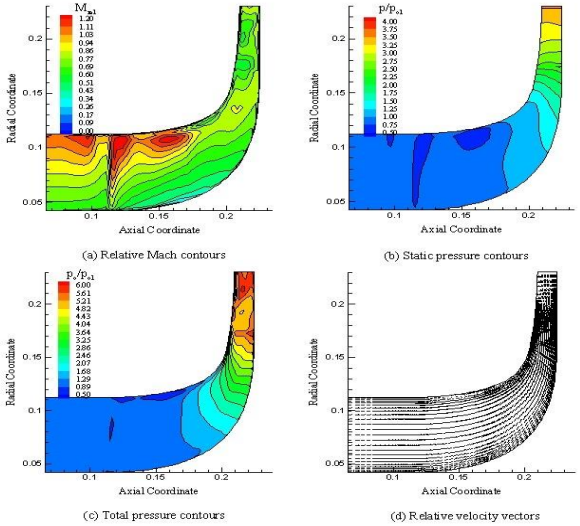





### Aerodynamic Analysis & Design

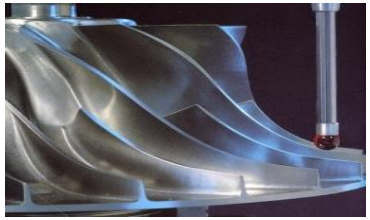


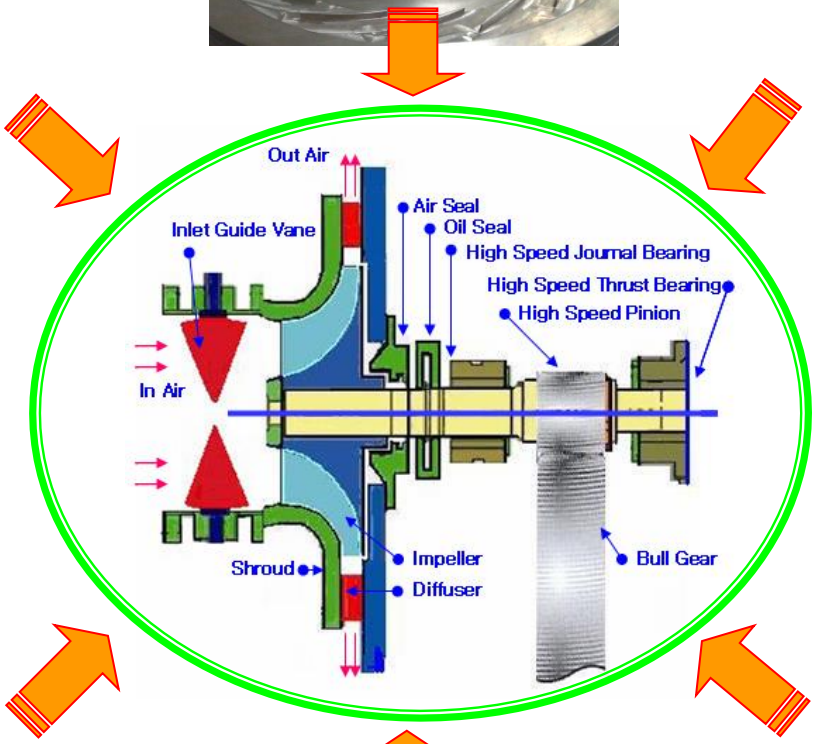

Q3D F3D

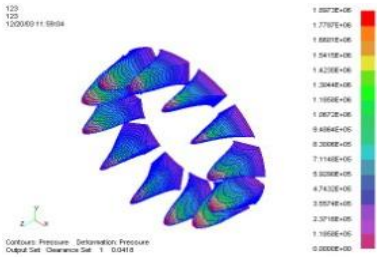


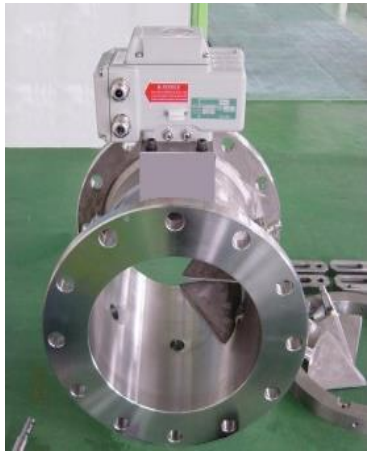
## Attach 5

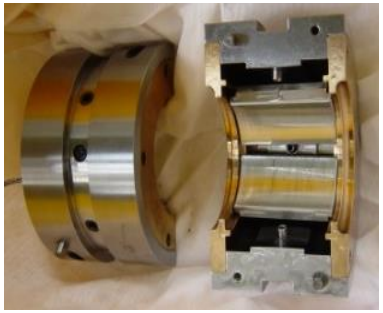
### Essential Items of Turbo Compressor











DOOWON T E G
Co., Ltd.

Thank you