INTERNATIONAL DESALINATION ASSOCIATION
IDA and Its WORLDWIDE AFFILIATES
Presents at
MEXICO WORLD WATER FORUM

DESALINATION THE SUSTAINABLE SOLUTION
and
HOPE FOR THE FUTURE GENERATION

by
LEON AWERBUCH, CHAIRMAN IDA PROGRAMS
President, Leading Edge Technologies
Desalination has decisively proven during the last 30 years its reliability to deliver large quantities of fresh water from the sea, from brackish resources and through water reuse.

- Fresh water is no longer the infinitely renewable resource.
- Unlike oil, fresh water has no viable substitute.
- The sea is the unlimited source from which we can create new fresh water through desalination.
Status of Desalination

The IDA Worldwide Desalination Inventory Report includes a total of 17,348 desalting units with a total capacity of 37,750,000 m³/d or 8.3 billion imperial gallons per day have been installed or contracted.

• Desalination is already used in 125 countries around the world.
Desalination Experience

- Plants are providing reliable desalinated water for tourism, industry, municipal use, agriculture in all parts of the World
- Caribbean Islands
- Spain
- Malta
- Cyprus
- Middle East
- Singapore
- India
- China
- Australia
- Europe
MARKET DRIVERS for DESALINATION and POWER

• The desalination market is driven by growing demand for water and rising marginal costs of supply.

• Falling costs of desalination have dramatically increased the size of the potential market.

• Decreasing unit costs of desalination through technology improvement

• Lack of alternatives to desalination
• Environmental constraints increasing the cost of traditional water resources

• Imbalance between water and power demand

• Water can be stored, whereas electricity cannot resources
The desalination market 2005 - 2015 will be $95 billion,
-Additional capacity of 31 million m³ per day is expected to be commissioned during the period.
-The largest market will continue to be the Arabic Gulf area, it will require doubling of the total capacity.

- The largest growth market will be the Mediterranean Rim, where Algeria, Libya, and Israel capacity increases in excess of 300%. with Spain the total increase in capacity in the Mediterranean region will be 179%. 
- The US market will make the break-through into large scale municipal desalination (it is currently predominantly a brackish water desalination).
- China and India are also set to enter the large-scale seawater desalination market. The 650,000m3/d additional capacity these two countries are expected to bring on line by 2015 could be the start of a massive move into desalination in the longer run.
Desalination Technologies

- Multi-Stage-Flash Distillation (MSF)
- Multi-Effect-Distillation (MED)
- Reverse Osmosis (RO)
- Vapour Compression Distillation (VCD)
- MSF well established reliable technology
- with Performance Ratio (PR) of PR 8-9,
- internal power consumption of 3.5 kWhr / ton of water,
- capacity capital cost $4.50-$8.00 per gallon per day installed (GPD).
THE UNITS SIZE INCREASE

<table>
<thead>
<tr>
<th>Period</th>
<th>MSF</th>
<th>MED</th>
<th>RO</th>
<th>VC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ante 1990</td>
<td>5</td>
<td>0.3</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>1990-95</td>
<td>8</td>
<td>1</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>1995-2000</td>
<td>12.5</td>
<td>3.3</td>
<td>1.8</td>
<td></td>
</tr>
<tr>
<td>2000-2005</td>
<td>16.7</td>
<td>5</td>
<td>1.9</td>
<td></td>
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</tbody>
</table>
THE JEBEL ALI K2 INSTALLATION

40 MIGD + 800 MW

3 * 13.33 MIGD
PR 8.0 - 8.5 kg/ 2326 kJ
THE SHUWEI HAT INSTALLATION

100 MIGD + 1500 MW

6 * 16.7 MIGD
PR 9.0 kg/ 2326 kJ
THE JEBEL ALI L1 INSTALLATION

70 MIGD + 750 MW

5 * 14 MIGD
PR 9.0 kg/ 2326 kJ
AI-TAWEELAH A2 MSF 4x12.5 MIGD

Unit on Barge
- MED with wide range of performance ratios from PR-8 to PR-16,
- internal power consumption of 1.8 kWhr/ ton
- capital cost of MED plants vary from $4.00-$7.00 per GPD.
- MED unit Thermocompression (MED-TC) are similar in characteristic to MED. They are designed where 2 to 10 atm steam is available, for water vapour to be thermocompressed across several effects.
Current status of MED technology

- Taweelah A1 desalination plant: 53 MIGD MED-TVC

- Availability > 98%
- Performances > guarantee
Current status of MED technology

> A 8 MIGD MED-TVC unit is under erection for SEWA
> A second one has been ordered in January 2006

GOR 8,4 @16 bar
44 m x 24 m x 8 m
Seawater RO has become a mature technology with high degree of reliability. It is using electric energy to operate and with energy recovery devices.

As a result the total plant energy requirements can vary from 3.5 to 7.4 kWhr per ton of product.

The capital cost of the RO plant vary from $3.50-$6.50.00 per GPD.
Fujeirah Plant - SWRO Racks and Feed Pump/ER Turbine Arrangement
The future of water demands creative solutions. It requires effective innovations and integration of energy resources to generate power and to economically create and store desalinated water.

Confronting the water challenge is essential to a country’s sustainable development and to the security of its communities.
Desalination is the only realistic hope to create new water resources in the midst of water crisis and water pollution.

We in desalination industry do not feel that the job is done. It requires that all of us continue the search for better technical and economical solutions to make desalination and water reuse available to all the people of the global village.
• The day will come soon when the cost for desalinated water will dropped to below 50 ¢/m³.

• Our goal is to make desalinated water available for global community at affordable cost.

• Desalination has made tremendous progress, but the momentum must continue.
The following Organizations are committed to
LOCAL ACTIONS TO ACHIEVE Those Goals:

- International Desalination Association IDA
- American Membrane Technology Association (AMTA)
- Australian Desalination Association (ADA)
- Asociacion Espanola de Desalacion y Reutilizacion (AEDyR)
- European Desalination Society (EDS)
- Japan Desalination Association (J DA)
- Chinese Desalination Association (CDA)
- Indian Desalination Association (InDA)
- Pakistan Desalination Association (PakDA)
- Water Science and Technology Association (WSTA)
Energy is Power
Power is Water
Water is Life
INTEGRATION OF ENERGY
POWER
WATER DESALINATION and
SECURITY

by
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## Energy Requirements

### (Steam/Electricity)

<table>
<thead>
<tr>
<th>Process Live Steam (ton product/ton steam)</th>
<th>Electricity kwh/ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multi Stage Flash</td>
<td>8</td>
</tr>
<tr>
<td>Vapour Compression</td>
<td>n/a</td>
</tr>
<tr>
<td>Multi Effect Distillation</td>
<td>12</td>
</tr>
<tr>
<td>Reverse Osmosis:</td>
<td></td>
</tr>
<tr>
<td>with energy recovery</td>
<td>n/a</td>
</tr>
<tr>
<td>without energy recovery</td>
<td>n/a</td>
</tr>
</tbody>
</table>
# Typical Power to Water Ratios for Different Technologies

<table>
<thead>
<tr>
<th>Technology</th>
<th>PWR = MW required/Million Imperial Gallons per day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steam Turbine BTG - MSF</td>
<td>PWR = 5.0</td>
</tr>
<tr>
<td>Steam Turbine EST - MED</td>
<td>PWR = 7.0</td>
</tr>
<tr>
<td>Steam Turbine EST - MSF</td>
<td>PWR = 10.0</td>
</tr>
<tr>
<td>Gas Turbine GT - HRSG - MED</td>
<td>PWR = 6.0</td>
</tr>
<tr>
<td>Gas Turbine GT - HRSF - MSF</td>
<td>PWR = 8.0</td>
</tr>
<tr>
<td>Combined Cycle BTG - MED</td>
<td>PWR = 10.0</td>
</tr>
<tr>
<td>Combined Cycle BTG - MSF</td>
<td>PWR = 16.0</td>
</tr>
<tr>
<td>Combined Cycle EST - MED</td>
<td>PWR = 12.0</td>
</tr>
<tr>
<td>Combined Cycle EST - MSF</td>
<td>PWR = 19.0</td>
</tr>
<tr>
<td>Reverse Osmosis RO</td>
<td>PWR = 0.8-1.5</td>
</tr>
</tbody>
</table>
New Hybrid Power Desalination

Combined Cycle Steam & Power

Power for Sale

Power to Desal

Lost Power Revenue Opportunity

Steam to Desal

Multi Stage Flash Distillation

Reverse Osmosis

Nanofiltration

Product Water
Opportunities for optimisation

Annual power and water requirements

- Power (MW) and Water (10xMIGD)

- X-axis: Weeks

- Y-axis: Power (MW) and Water (10xMIGD)
Past Simple hybrid

- Product waters from the RO and Distillation plants are blended to obtain suitable product.
- Power to water ratio can be significantly reduced.

GOING TO THE NEXT STEP

- Product from the RO and MSF plants are blended to allow higher temperature of distillate.
- A single stage RO process can be used.
- Higher Recovery lower pretreatment
Integrated hybrid

- Blending distillate with membrane permeate will reduce requirements on Boron removal by RO.
- A common, smaller seawater intake & outfall.
- The RO and NF membrane life can be extended. (12 years)
We need to innovate and integrate energy, power, and water. We have to look for new ideas on hybridization, energy recovery, and more effective materials and chemicals. We have to learn how to extend the life of existing plants and upgrade existing desalination facilities.
The feedwater temp. to the RO plant is optimized using cooling water from the heat-reject section of the MSF/ MED or power plant condenser. Constant feed temperature

The low-pressure steam from the MSF/ MED plant is used to de-aerate or use de-aerated brine as a feedwater to the RO plant to minimize corrosion and reduce residual chlorine.
An integrated seawater pretreatment and post-treatment is used for the product water from both plants.

The nanofiltration as softening membrane for feed of distillation plants MSF and MED leads to DRAMATIC improvement in productivity.

MSF-MED HYBRID
Schematic Configuration

MSF Desalination Process

- Seawater
- Makeup softening
- Nanofiltration
- Soft feed
- Reject
- Deaeration Pre-treatment
- Recycle softening
- Recovery section
- Blowdown
- Brine Heater
- Condensate
- Steel
- Distillate
- Recycle
- Cooling water out
- Reject section
THE SEWA CASE of INTEGRATED HYBRID

- INCREASE 44% THE CAPACITY OF EXISTING MSF FROM 5 MI GD to 7.2 MI GD
- MINIMUM FOOTPRINT, NO ROOM FOR NEW DESALINATION PLANTS
- REDUCE OPERATING COST
- NO CHANGES TO INTAKE STRUCTURE
- NO INCREASE IN POWER FACILITIES
- CUTTING MSF CAPITAL COST FOR ADDITIONAL CAPACITY BY 40%