# High Temperature Multi Effect Desalination 95°C demonstration in DTRI pilot plant

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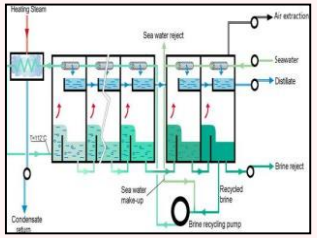
# Overview

- Introduction
- Methodology
- Results
- Conclusion

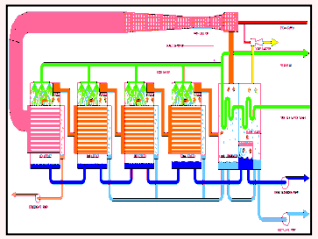
# Introduction

High [Reliability]

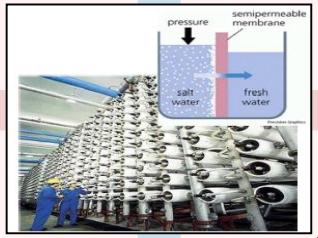
MSF



MED TVC

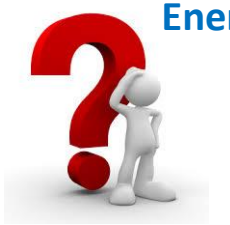


RO




Current Technologies

High Reliability & Energy Efficiency

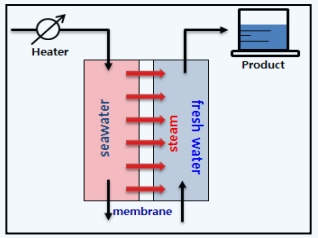


[Energy Efficiency]

Low

High

MD

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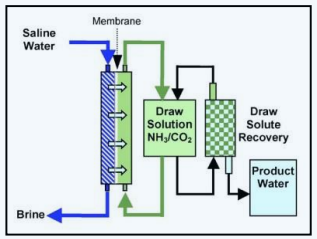
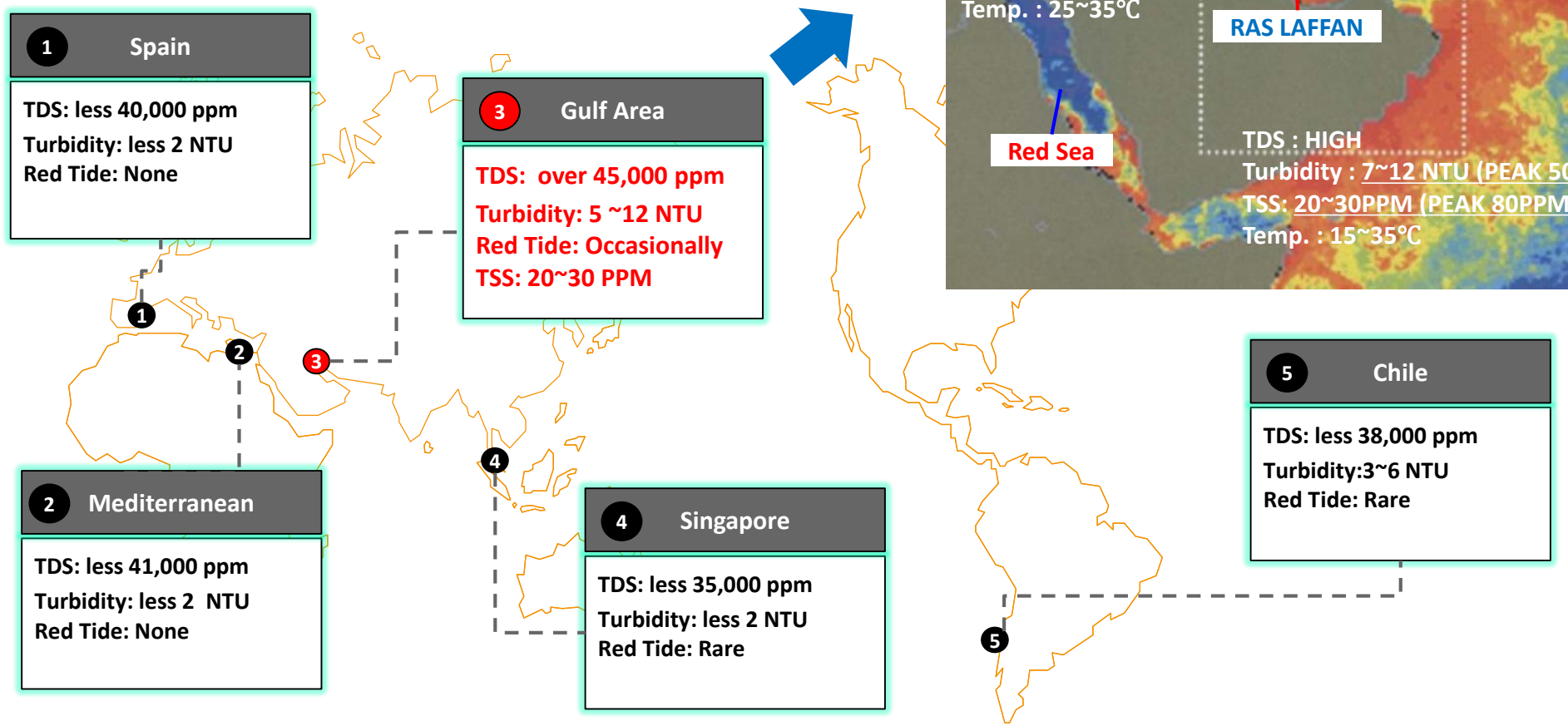



Low

Future Technologies

## Comparison FOR Seawater Condition

*Seawater condition in Gulf area is much worse than any other region.*



## Difficulties For SWRO IN GULF AREA

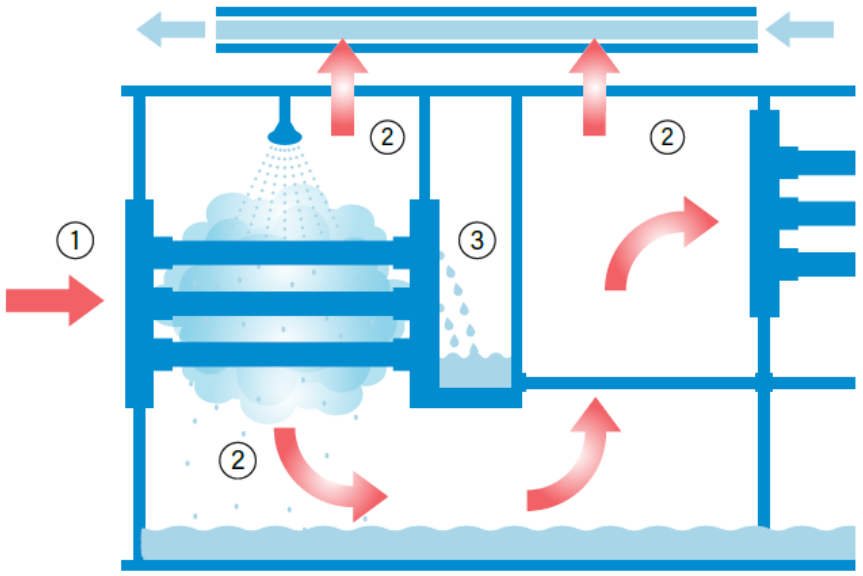
| | Gulf Area | Difficulty |
|---|---|---|
| Salinity (TDS, ppm) | • Highest salinity in the world (45,000ppm) | • Recovery ratio to be decreased<br>• Shorten life time of membrane |
| Turbidity (NTU) | • 5~12 NTU<br>• Peak 50 NTU | • Conservative pretreatment design to be required (2~3 stage) |
| TSS (Total suspended Solid, ppm) | • 20~30 ppm<br>• Peak 80 ppm | • Conservative pretreatment design to be required (< 5ppm) |
| Red Tide | • Occasionally | • Reliability to be decreased sharply<br>• DAF is essential system<br>• Beach well can be required. |

- ✓ High CAPEX for sufficient pretreatment
- ✓ Low recovery ratio
- ✓ Low reliability
- ✓ High O&M Cost

## MED Technology

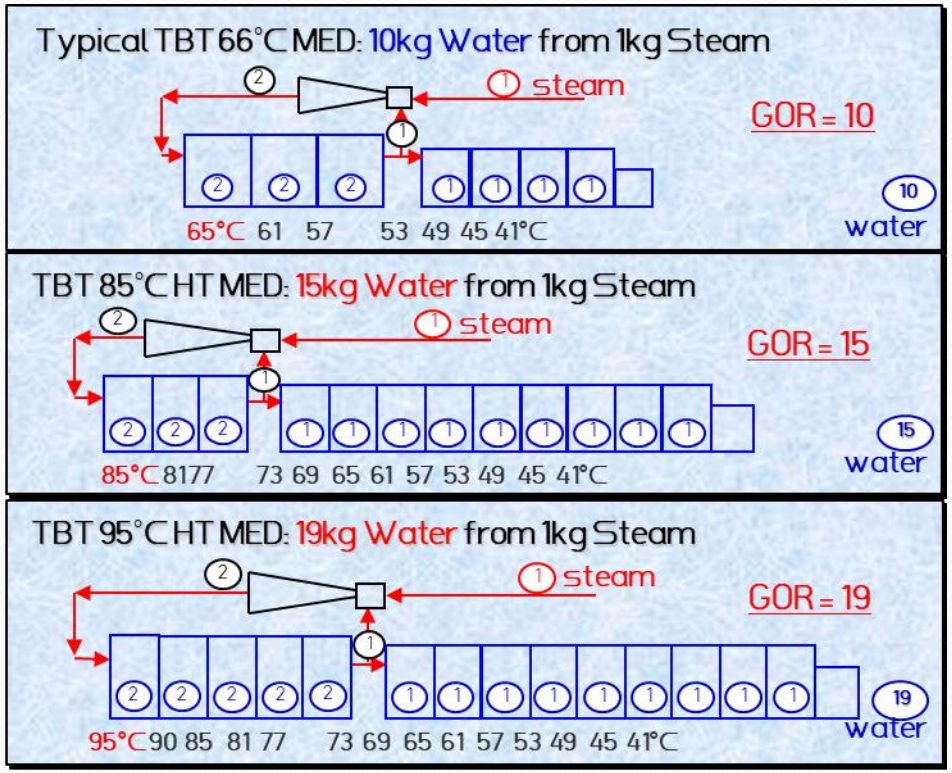
**Multi-Effect Distillation (MED) is an advanced form of thermal desalination now playing a major role in large-scale desalination projects with the higher efficiency.**

### How It Works




1. Steam passes through the inside of the tubes
2. Seawater is sprayed onto the outside of tube, generating vapor which is moved to next effect to be used as the heat source
3. Vapor condenses inside of the tube and is collected as fresh water

**Increasing TBT 65 → 85° → 95 C allows 90% increase in MED efficiency (GOR* & PR**).**
**= ~33% Steam Saving to produce the same amount of water**





**33% less energy**
**to produce same water**

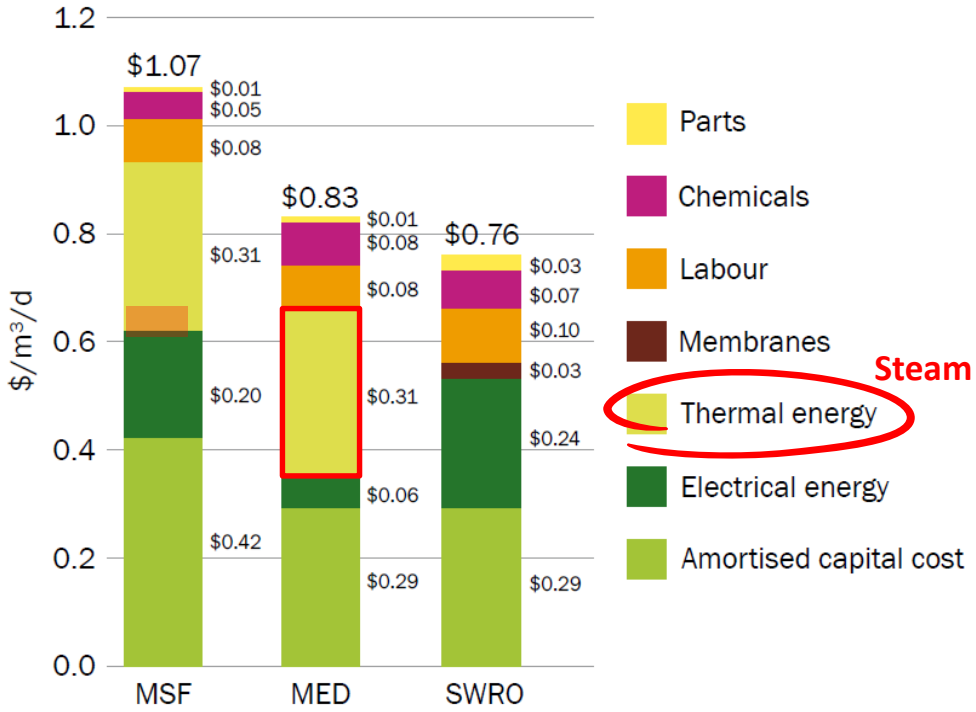
**40% less energy**
**to produce same water**

* GOR: Gain Output Ratio = product water [kg] / steam consumption [kg]
** PR: Performance Ratio = product water [kg] x 2,326 [kJ/kg] / energy input by steam [kJ]

## Benefits OF Advanced HT-MED

**Energy cost is a huge portion in desalting seawater.**
**Saving steam consumption in HT-MED reduces the water production cost of MED.**

Relative operating costs of the main desalination process

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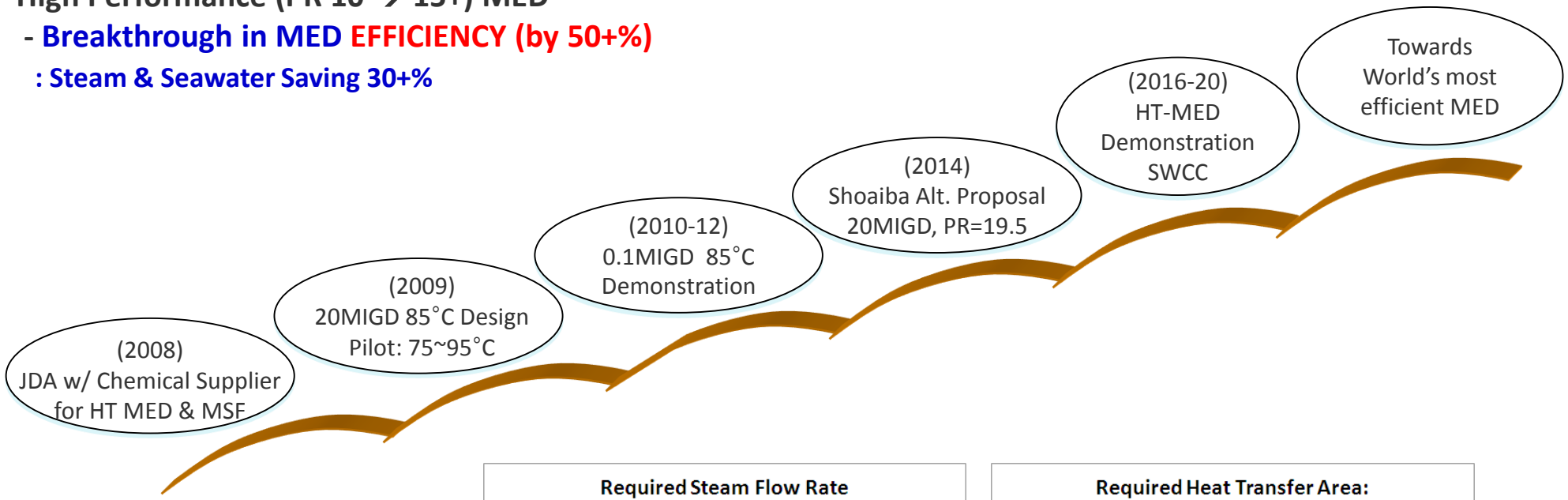
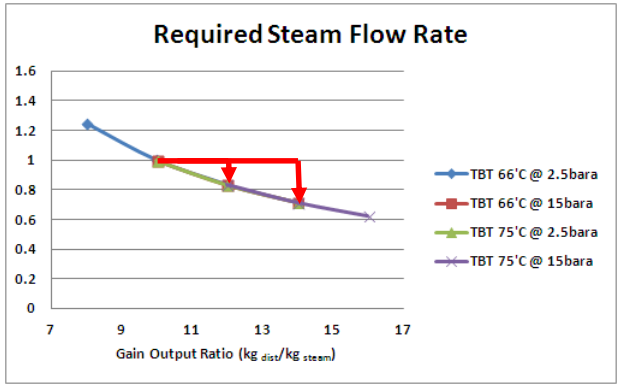
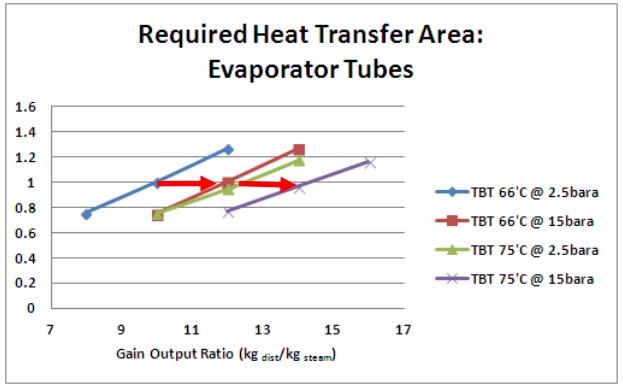
## Benefits OF Advanced HT-MED

**High Performance (PR 10 → 15+) MED**

- **Breakthrough in MED EFFICIENCY (by 50+%)**
  - **: Steam & Seawater Saving 30+%**

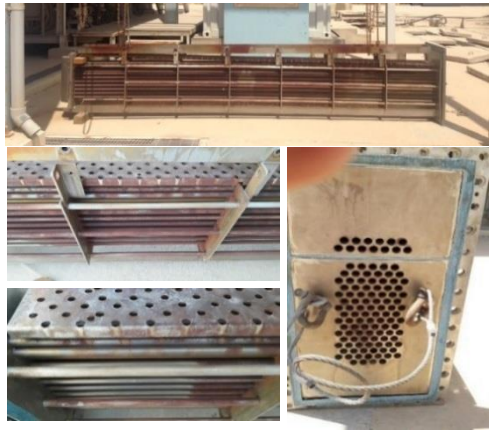


## Methodology: Demonstration Pilot plant

- **DTRI MED Pilot**



DTRI MED Pilot
- Location: DTRI in Jubail
- Capacity: 1.3 ton/hr
- Type: Brine Recirculation MED-TVC
- No. of Effect: 4
- Tube Material: Titanium
- No. of Pass: 2
- Feed Type: Tray + Perforated plate

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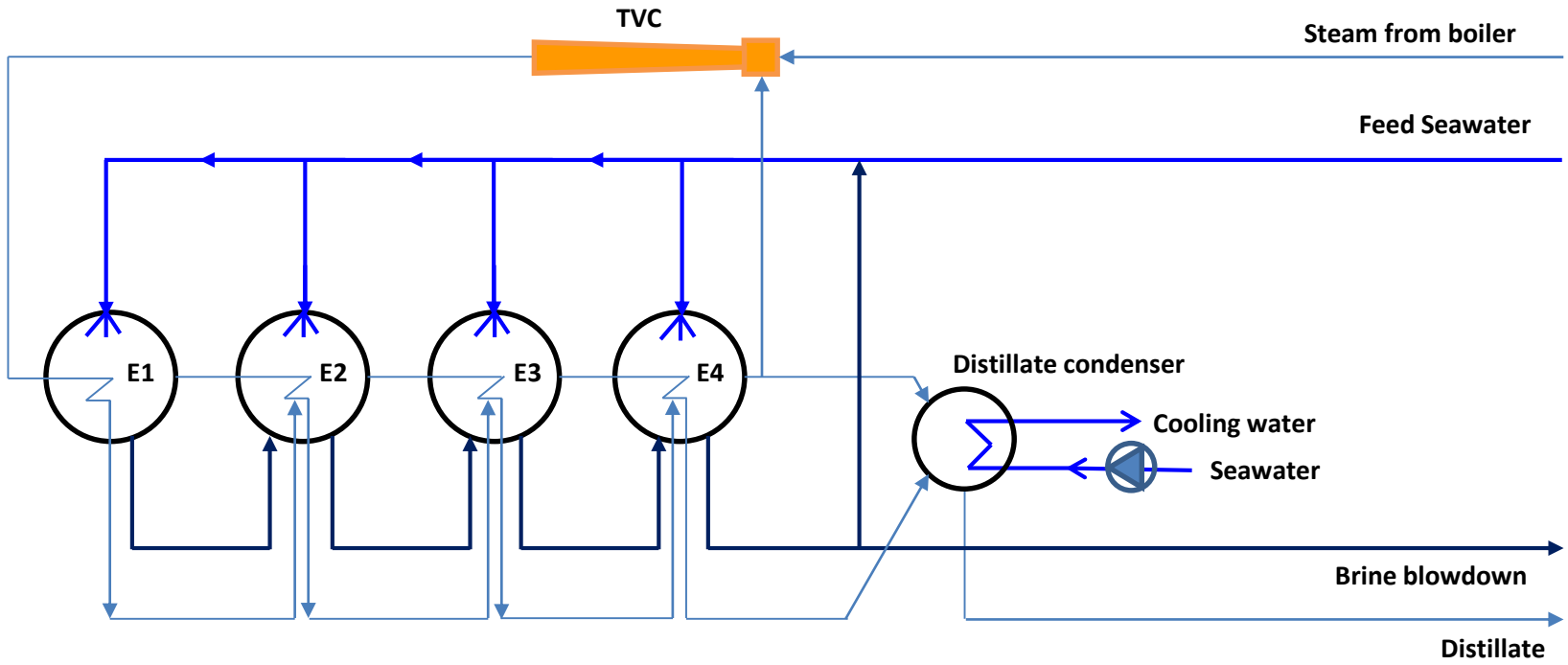
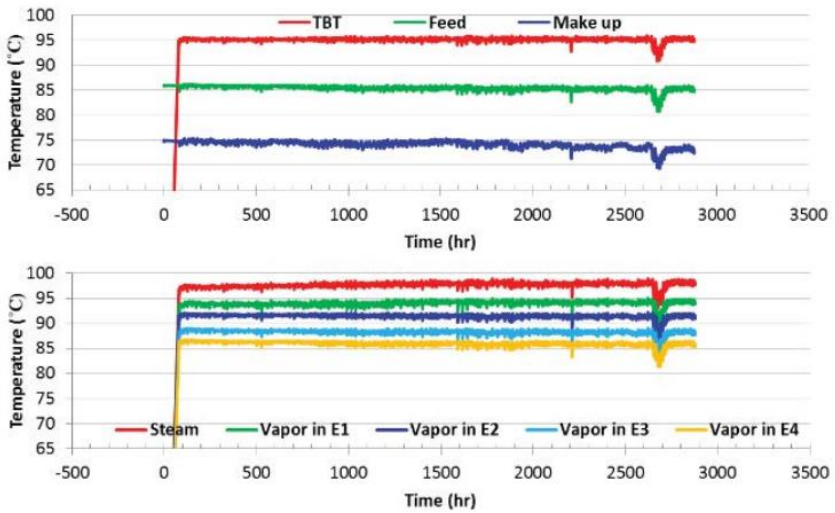
- **Operating Condition of 4 Months Scale Test**
  - Top Brine Temperature: 95 ˚C
  - Bottom Brine Temperature: 88˚C
  - Total feed water supply: 35 ton/hr, 60,000~63,000 ppm
  - Distillate production: 1 ton/hr

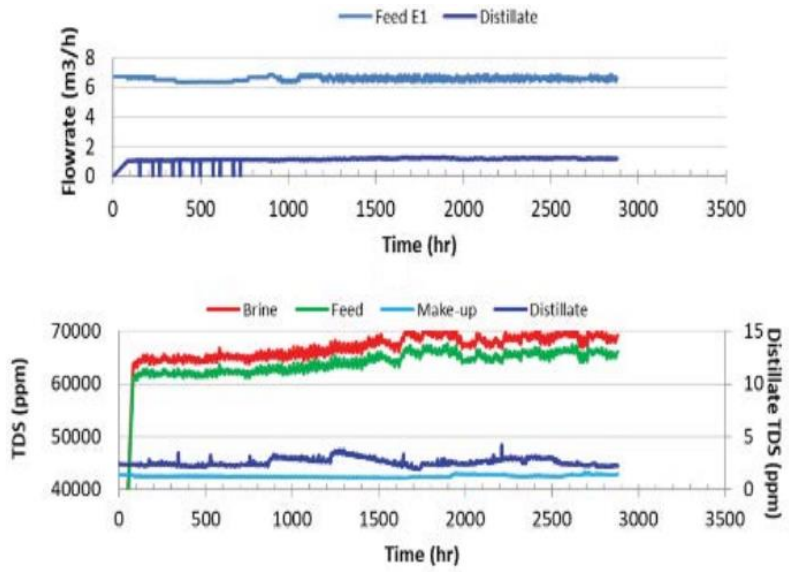



**MED Pilot Schematic Diagram**

## Temperature Profile

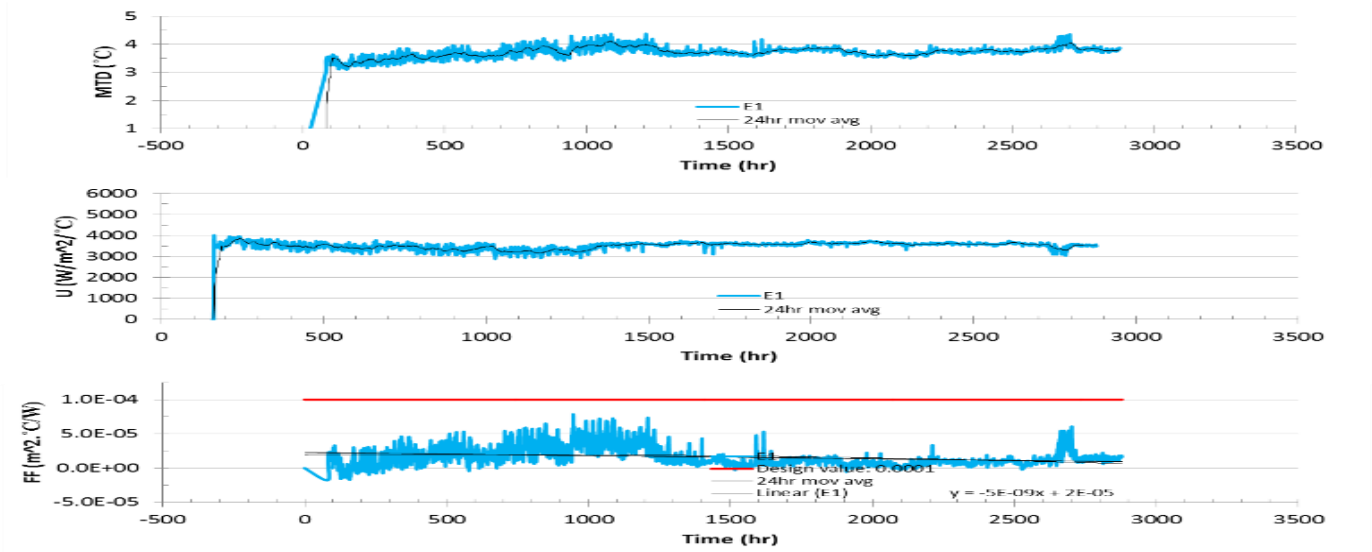
**Stable Operation**



## Fouling Factor Analysis: htc* & ff** profile

Stable Operation

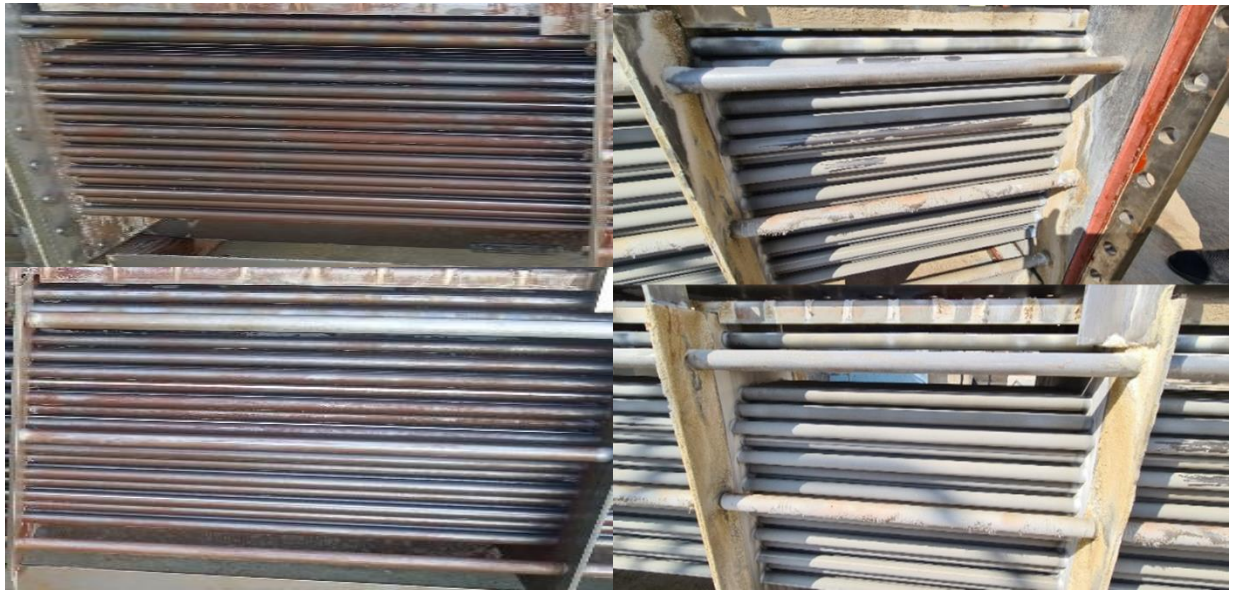



*HTC, Heat transfer coefficient

**FF, Fouling factor

## Visual Inspection Result

Cont., Results

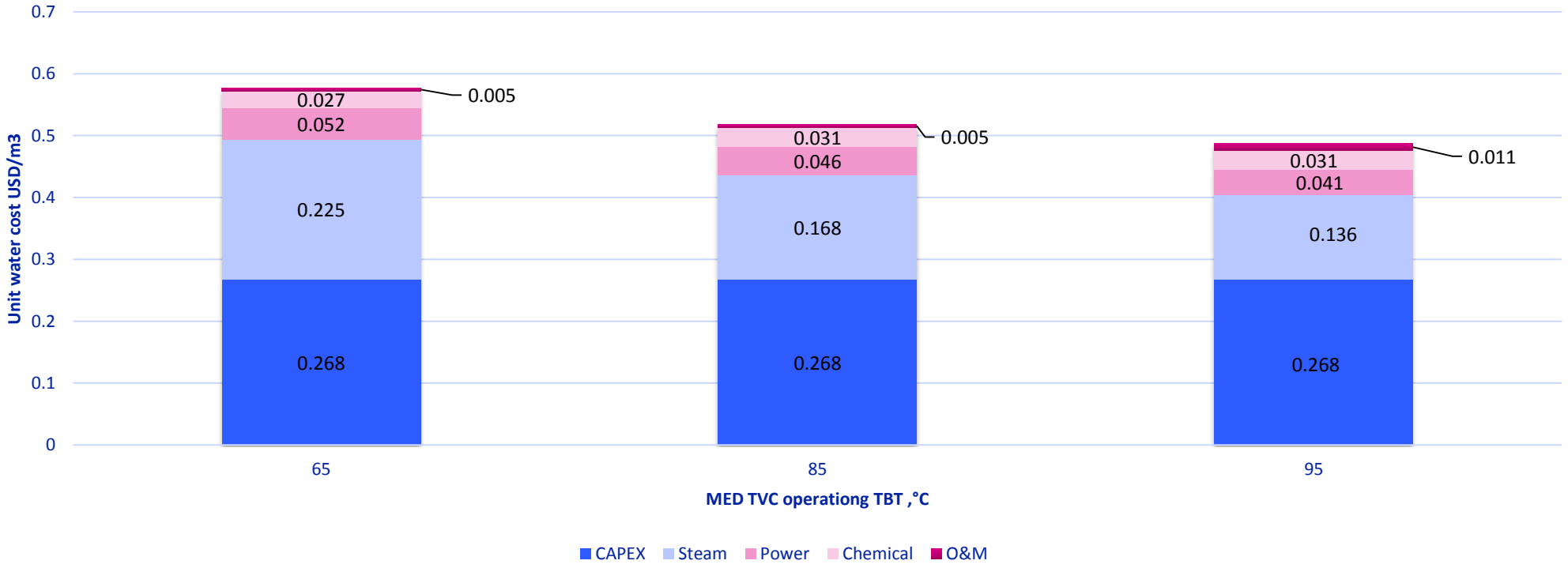



After 4-month test, very thin film layer of soft scale was formed on the tube.

# TECHNO-ECONOMIC ANALYSIS

Cont., Results

- **Comparing to conventional MED-TVC (PR 11.5), High TBT MED-TVC plant (PR 18.3) has significant improvement in HTC and reduction in OPEX**
  - **Steam consumption reduction: Over 30%**




***LCOW, Levelized cost of Water**

- Based on Fuel Cost of 24 USD/bbl

## CONCLUSIONS

- **Based on technical and experimental studies (2008~2012), high TBT (85˚C) MED-TVC is a competitive technology.**
  - ✓ **PR is increased from 9-11 to 16-19 kg distillate/2,326kJ**
  - ✓ **40% Less Steam Consumption**

- **SWCC Demonstration verified the High TBT (95˚C) MED-TVC technology under Jubail seawater condition.**
  - ✓ **HTC & FF monitoring: Consistent HTC and FF trend show high TBT (95˚C) MED-TVC operation can be achieved.**
  - ✓ **Visual inspection: Only thin film soft scale appeared on the tube surface, which can be easily removed by water flushing**

- **Based on demonstration test, it is proved that HT MED-TVC is technologically viable in Gulf Area.**