Desalination MSF Unit
Jiddah Refinery

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17-19/10/2017

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About the presenter

Professional Chemical Engineer (PEC & SCE)
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Present Assignment:
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About
Desalination MSF Unit Presentation

What’s expected

The audience will be able to know about:

- Jiddah Refinery MSF Unit
- Operational Challenges
- Best Practices adopted
- Sharing experience

Outline

- Introduction
- Process Overview
- Major Equipment
- Common Problems
- MSF Unit Problems & Challenges
- Performance & Troubleshooting
- Benefits Realized
- Best Practices & Lesson Learned

Introduction

Process Overview

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Introduction

Purpose of Desalination

To convert seawater into freshwater.

Principle of MSF (Multistage-Flash Unit)

Evaporation at a temperature higher than the saturation temperature is referred to as *Flash Evaporation*.

Introduction

Jeddah Refinery Desalination

- Own seawater pump house supply
- two units (MSF & MED)
- Used for Boilers, Process, Potable, Domestic Users

MSF Unit Design

- Capacity = 5040 m^3/day
- Steam Consumption = 26 T/h (1.1 bar saturated steam)
- Water Quality < 10 μS/cm

Process Overview

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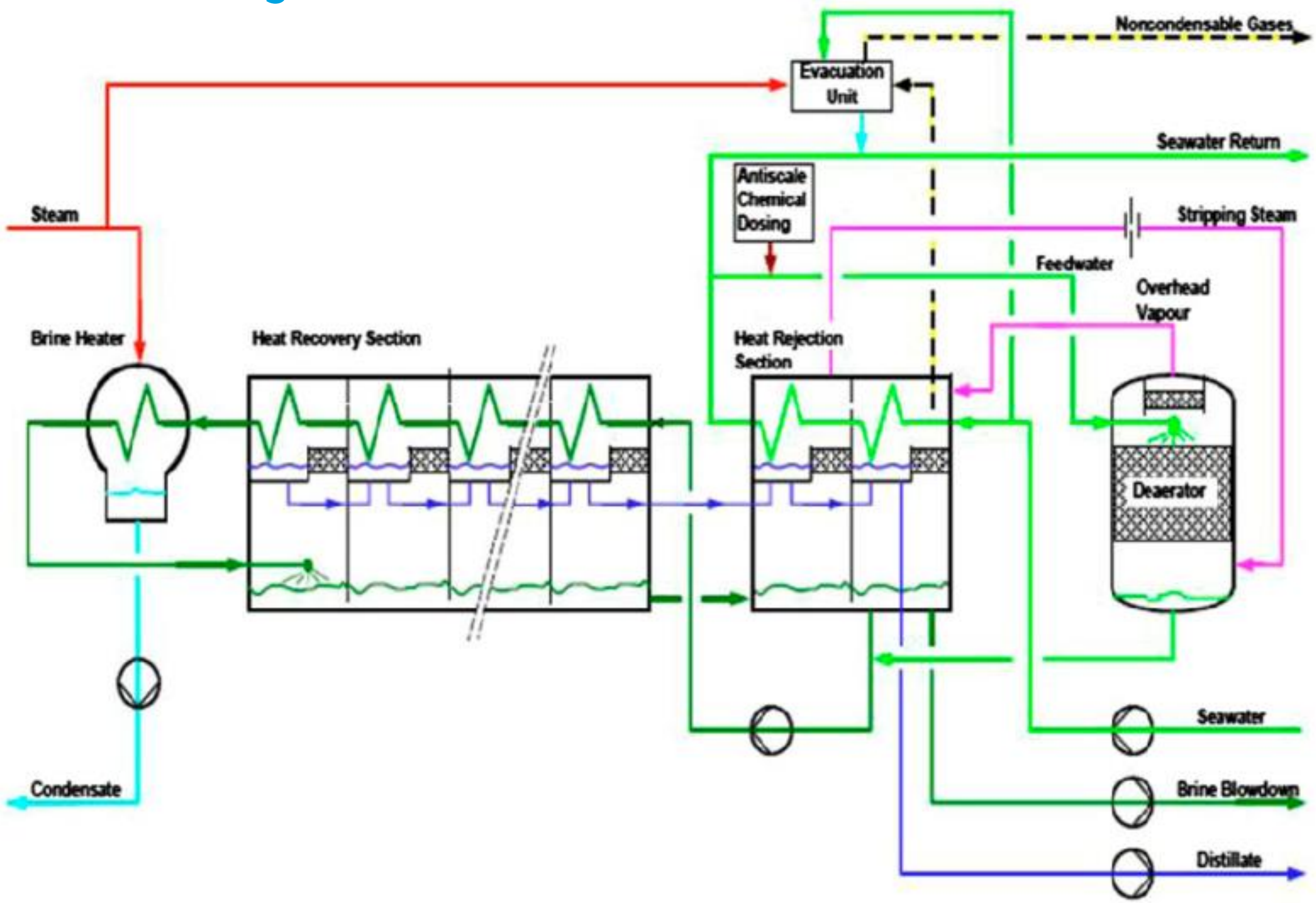
Process Overview

Simple Process Diagram



Major Equipment

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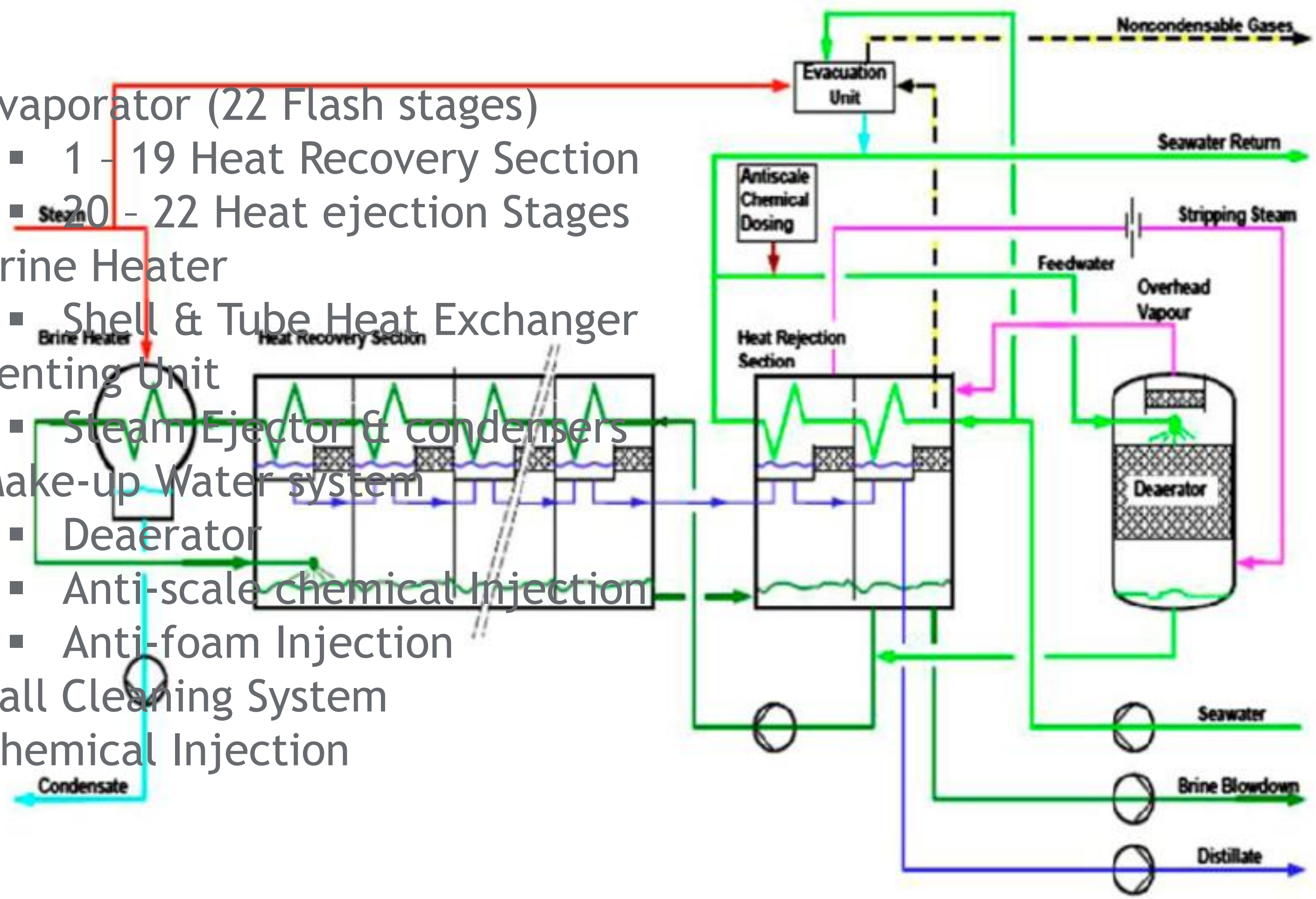
Major Equipment

- Evaporator (22 Flash stages)
  - 1 – 19 Heat Recovery Section
  - 20 – 22 Heat ejection Stages
- Brine Heater
  - Shell & Tube Heat Exchanger
- Venting Unit
  - Steam Ejector & condensers
- Make-up Water system
  - Deaerator
  - Anti-scale chemical Injection
  - Anti-foam Injection
- Ball Cleaning System
- Chemical Injection



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Common Problems

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Common Problems

- Poor Vacuum
  - Air leaks in Evaporator Shell, deaerator, vent/ejecter condenser
  - Low steam pressure
  - Plugging of ejector nozzles
  - Low cooling water flow
- Low Distillate Production
  - Low brine recirculating flow
  - Poor Vacuum in stages
  - Scaling in brine heater and Evaporator tubes
- Impure Distillate
  - Brine level
  - Foaming in stages
  - Demister improper setting
  - Impure condensate return

MSF Unit Problems & Challenges

Jiddah Refinery

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MSF Unit Problems & Challenges
Major Issues

- Low Brine Circulation
- Low Distillate Production
- Poor Brine Heater Performance
- Higher Distillate conductivity
- Leaks in Evaporator tubes
- Vacuum issues

MSF Unit Problems & Challenges
Main Challenges

- Major Source of Distilled water
- Quality of water <10 µS/cm
- Aging of the equipment
- Pumps performance
- Leakage during operation
- Steam Balance

Challenges of MSF Unit
Some Examples

Performance & Troubleshooting

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Performance & Troubleshooting
MSF Unit Performance

Process Parameter, Units	2/16/2017 10:36	2/16/2017 8:30	2/16/2017 13:27	2/16/2017 15:21	2/19/2017 1:30
	95% Load	85% Load	75% Load	60% Load	50% Load
Brine recirculation pumps G-001 A/B, flow, m^3/hr	1770	1600	1510	1314	1221
SW supply pressure, Kg/cm^2	2.65	2.65	2.65	2.65	2.7
SW discharge m^3/hr	1490	1488	1487	1490	1451
Make up flow, m^3/hr	325	320	322	326	300
Brine heater E-002 Inlet temp °C	91.4	87.8	85	79.7	80
Brine Heater Outlet temp. °C	100.8	96.3	93	86.5	86.5
Brine blowdown flow G-002 A/B	237	352	315	324	347.5
Vent Condensate temp. °C	-	26	-	-	25.6
Distilled pumps G-003 A/B, m^3/hr	200	179	160	127.5	114
Condensate flow G-004 A/B, m^3/hr	23.5	19.4	17.9	12	11.3
Last stage vapor pressure, mmHg	-789	793	-795.5	-797	-797.9
Brine Level, %	52	52	52	49	52
Anti-foam Flow & Strokes%	60	60	60	60	60
Anti-scale (BELGARD) flow & Strokes%	60	60	60	60	60
Distillate conductivity, μS/cm	14	11.9	7.13	6.25	5.5
Evaporators Tray Level, %	45.4	41.6	51.2	48	5.2
Brine to Recovery pH	8.8	8.79	8.96	8.8	8.63
High Pressure Steam valve Pressure & Opening, %	0.817	0.863	0.8		1.149
Brine heater E-002 temp °C	115		103.5		

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Performance & Troubleshooting
Successful Troubleshooting

- Blowdown & Brine Circulation
  - Improved with pumps performance
- Cleaning and Fixing Leaks in Evaporator tube
  - Stages 1-4 tubes hydro-jetting (90/10 Cu/Ni)
  - Stage 7 & 8 total re-tubing
- Suitable Chemicals Injection
- Brine Heater Efficiency Improvement
  - Leaks repair
  - Scale removal with special techniques
- Improved Vacuum (After Mar 2017 T&I)
  - Ejectors performance
  - Vent & Ejector condenser performance

Performance & Troubleshooting
Example

Benefits Realized

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Benefits Realized

- Distillate Production increased
  - 140 to 200 Tons/hr
- Brine Heater Efficiency Improved
  - Heater outlet temperature 104 → 91°C
- Better Quality distillate
  - Conductivity improved from 15 → 3 µS/cm
- Vacuum improved
  - From condenser repair 560 → 740 mmHg

Best Practices & Lesson Learned

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Lesson Learned
Best Practices adopted

- Ball Cleaning System
  - Run after every 72 hrs.
- Avoid acid with better chemical replacement
  - To avoid tube leaks
  - HSE concern (Handling issues)
- Monitoring of the Unit
  - Key parameters
  - Maintain Brine circulation Ratio
- Good plan for Turnaround and Inspection
- Special techniques used to remove scaling *(Aqua milling)* at Brine Heater tubes
- Tubes leaks and repair should be done properly

“Science is simply common sense at its best”

-Thomas Huxley

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