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NEW WW TREATMENT OPTIONS FOR REFINERY WASTEWATER

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Problem

- 💧 ***New Environmental Requirements***
- 💧 ***Low Energy Costs - High Maintenance Sensitivity***
- 💧 ***Highly Abnormal Refinery Wastewater***
 - ***High Temp (> 50 C) – Bio Difficult***
 - ***High TDS (ave. 18,000 mg/L)***
 - ***High Ammonia (80 mg/L)***
 - ***High Phenol (>60 mg/L)***
 - ***V. High Variability (TDS From 8 – 35,000 mg/L)***
 - ***Frequent Flow interruptions***
- 💧 ***High Removal Efficiencies Required***
 - ***Phenol -> 0.1 mg/L (99.8% Removal)***
 - ***Ammonia -> 1 mg/L (98.7% Removal)***



Problem

Upstream Process Modifications

Unfeasible

Treat Wastewater As Is

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Process Targets

Meet Effluent Requirements

Reliable & Cost Effective

Easy to Use

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Treatment Options

💧 Oil/Water Separation & Conventional Biological

- *Traditional Treatment Methods*
- *Low Cost*

--- HOWEVER ---

- *High Removal Efficiencies Required*
- *Operational Considerations*
 - *Conventional Biosystem Sensitivities*
 - *Solids Settling Requirements*
- *Challenging Operating Conditions*
 - *Feed Modification Very Expensive*
- *Unpopular Technology*



Treatment Options

Traditional Treatment

--- DECISION ---

Alternatives:

💧 *Physical/Chemical Treatment*

💧 *MBR*

💧 *PACT MBR*

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Treatment Options

💧 Physical / Chemical Treatment

- Non Traditional - Unproven*
- Higher Cost*
- More Treatment Steps*

--- HOWEVER ---

- Adaptable to Varying Operating Conditions*
- High Removal Efficiencies Possible*
- Better Start-up / Shut-down*
- Easier to Operate*



Treatment Options

MBR

- ▶ *New Technology – Relatively Unproven*
- ▶ *Potentially Higher Cost*
- ▶ *May Not Achieve Treatment Requirements*
- ▶ *Potential for Fouling*

--- HOWEVER ---

- ▶ *More Adaptable to Feed Variations*
- ▶ *High Removal Efficiencies Possible*
- ▶ *Better Start-up / Shut-down*
- ▶ *Easier to Operate*



Treatment Options

PACT MBR

- ▶ *New Technology – Development Stage*
- ▶ *Potentially Higher Cost*
- ▶ *More Complex*

--- HOWEVER ---

- ▶ *More Adaptable to Feed Variations*
- ▶ *Higher Removal Efficiencies Possible*
- ▶ *Less Fouling*
- ▶ *Better Start-up / Shut-down*
- ▶ *Easier to Operate*



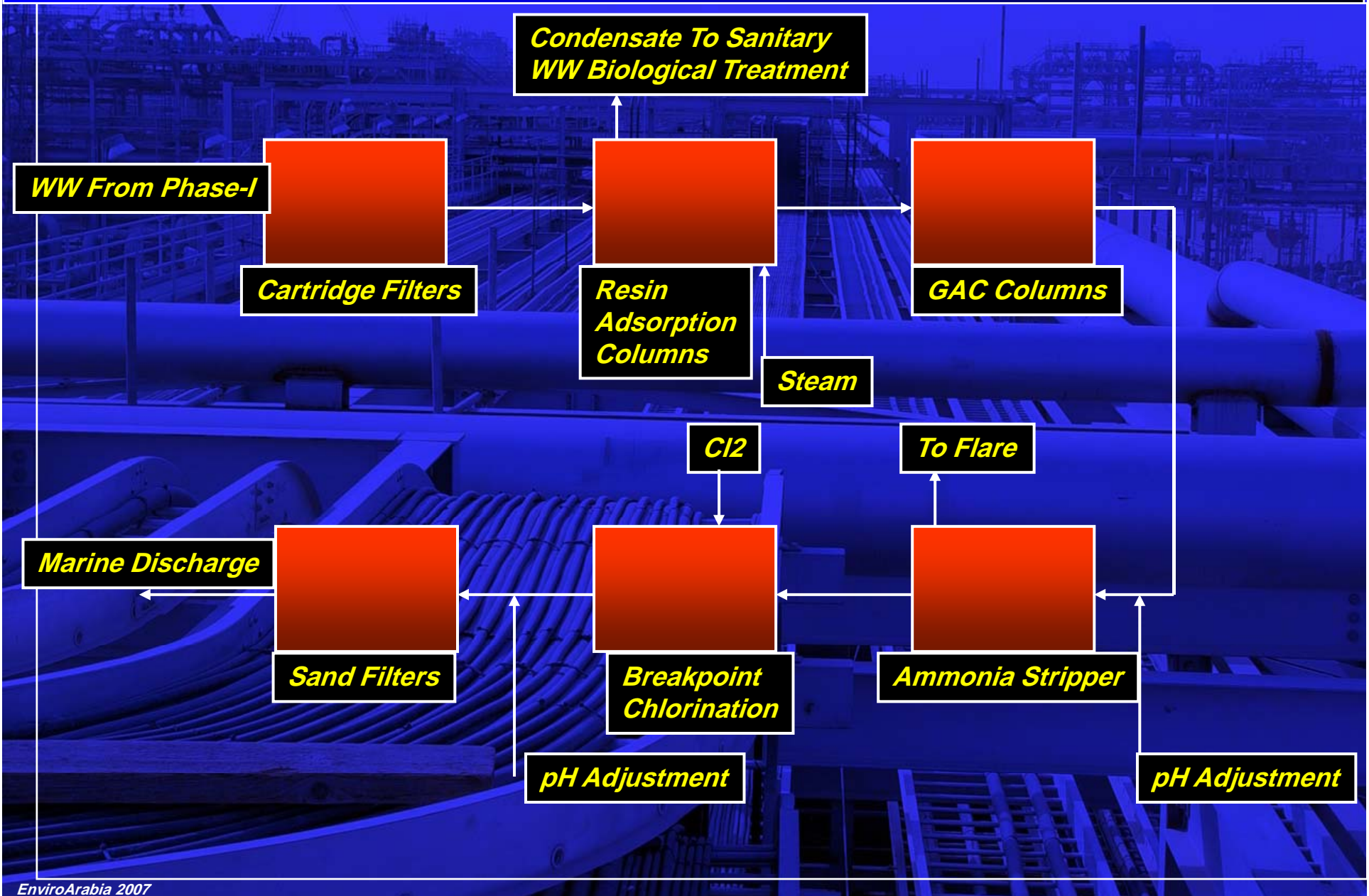
Design Development - Physical / Chemical

💧 Engaged Siemens

- Develop Technologies*
- Bench Scale Testing*
- Field Pilot Testing*
- Equipment Design – Economic Evaluation*
 - Conventional Biological*



Physical/Chemical Process Design



Physical / Chemical Pilot Plant Testing – Conclusions

💧 Physical / Chemical Tests Demonstrated:

- PME Compliance Capability*
- Easy Startup*
- Robust System*
 - Accommodates Process / Operator Problems*

--- However ---

- Higher Cost Than Traditional STP (Unmodified)*
- Many Process Operations*



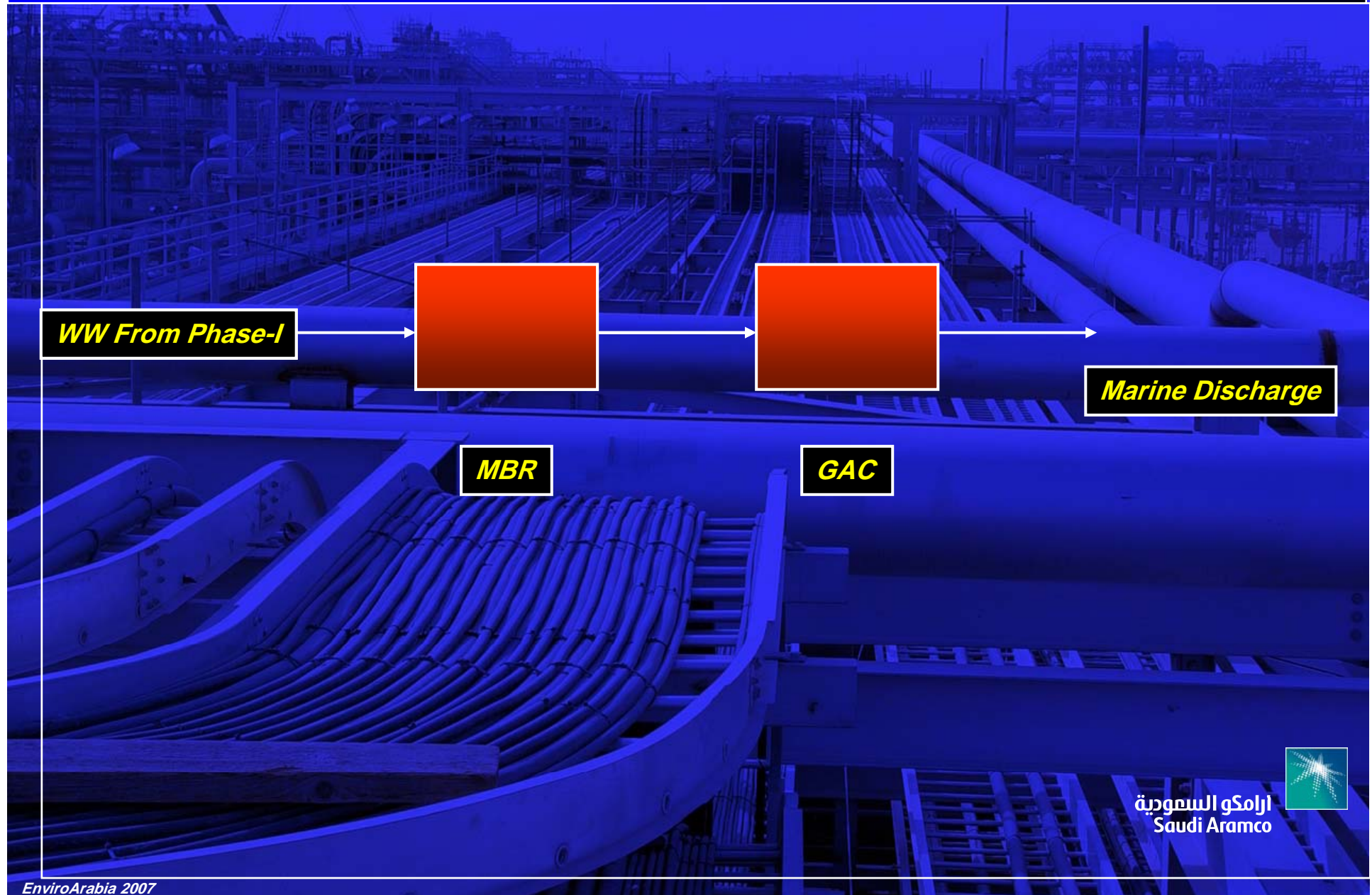
Design Development MBR / PACT MBR

💧 Engaged Siemens

- Bench Scale MBR Testing*
- Side-by-Side PACT MBR Testing*
- Equipment Design – Economic Evaluation*
 - MBR*
 - PACT MBR*
 - Physical/Chemical*



MBR Process Design



MBR / PACT MBR Testing - Results

MBR

- ▶ Fouling Problems*
- ▶ Compliance Problems*
 - Require GAC Polishing*
- ▶ Difficult to Operate*
 - Very Frequent Back flush & Chemical Cleaning*
 - Very Slow Acclimation*
 - 4 – 6 Weeks*
 - F/M ~ 5 for MLSS Growth*
 - Very Sensitive Biomass*



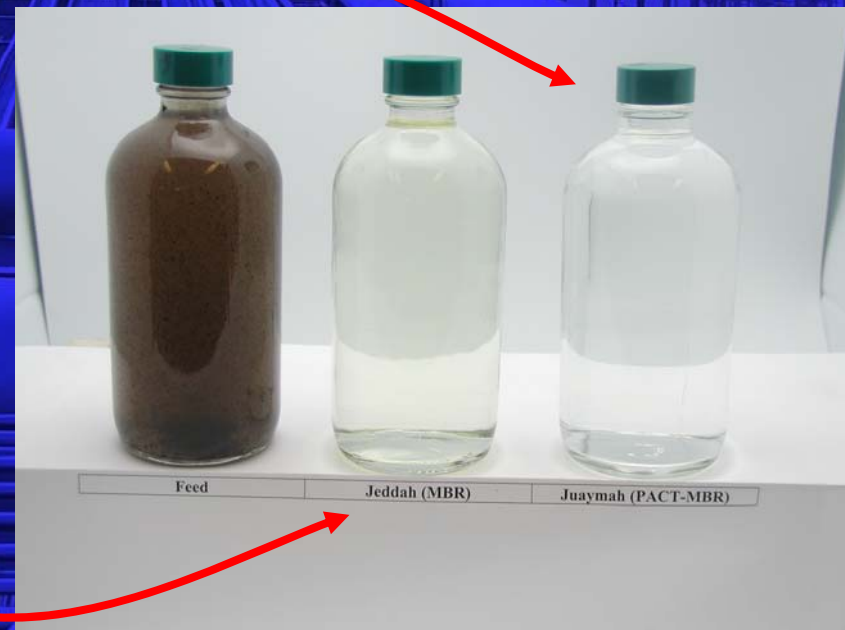
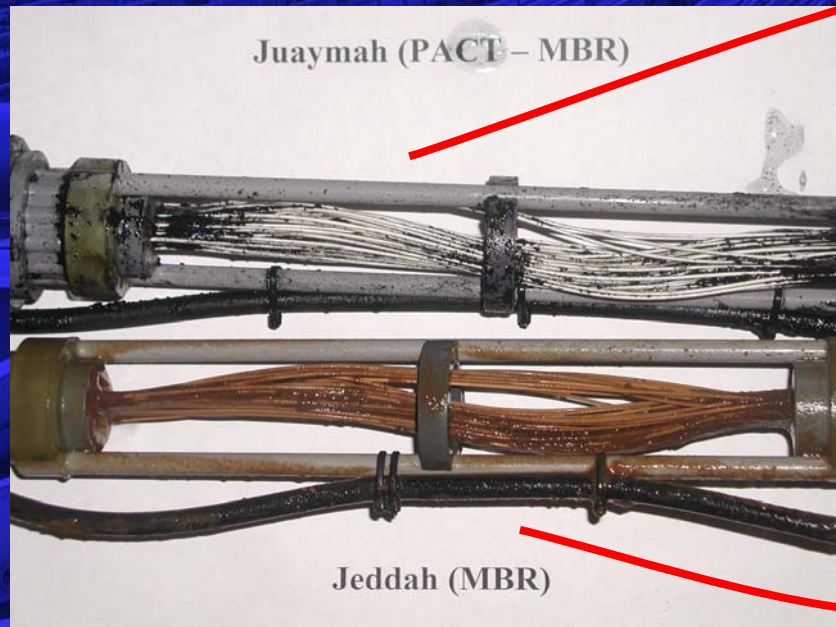
MBR / PACT MBR Testing - Results

💧 PACT MBR

- No Fouling Problems***
- Fully Compliant Effluent - Immediately***
- Easy to Operate***
 - No Chemical Cleaning***
- Robust – Easy to Start-up***
- Economical***
 - Lower Capital Cost vs. MBR & PAC or Physical Chemical***
 - Lower Operating Costs***



MBR to PACT/MBR Comparison



PACT MBR Process Design

WW From Phase-I



Marine Discharge

PACT MBR

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Decision

Two Options Confirmed

Physical / Chemical & PACT MBR

Cost Analysis

PACT MBR

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Conclusions

💧 *Identified & Demonstrated Feasibility of:*

- *Physical / Chemical Treatment*
- *MBR & GAC*
- *PACT MBR*

💧 *Evaluated Project Life Cycle Costs*

- *PACT MBR*
 - *Lower Capital Cost*
 - *Lower Operating Cost*
 - *More Reliable & Easier To Operate*





Thank You

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