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Saudi Aramco



EcoRight™ *MBR Reuse Technology*

Water Arabia Conference
Khobar, Saudi Arabia.



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Outline

Oily WW Treatment Challenges

Treatment Options

- *Biological IWWTP & GAC Columns*
- *PACT WWTP*
- *MBR & GAC Columns*
- *PAC MBR (Carbon Enhanced MBR)*
- *GAC MBR*

Conclusion / Summary



Challenges

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- **Refinery / Oil Processing Wastewater**
 - **High Temp ($> 50\text{ C}$) – Bio Difficult**
 - **High Chlorides ($\rightarrow 1,000\text{ mg/L}$)**
 - **V. High TDS ($5,000 +\text{ mg/L}$)**
 - **V. High Feed Conc. Changes**
 - **High Ammonia/Phenol Concentrations**
 - **Frequent Flow interruptions**
 - **Refractory Organics**
- **High Maintenance Sensitivity**
- **Water Conservation Important**



Main Concern

Refractory Organics

- *Conventional WWTP – Not Feasible*
- *Carbon Adsorption Required*



Treatment Options

- *Oil/Water Sep. & Conventional IWWTP*
 - *Conventional IWWTP & GAC Columns*
 - *PACT IWWTP*

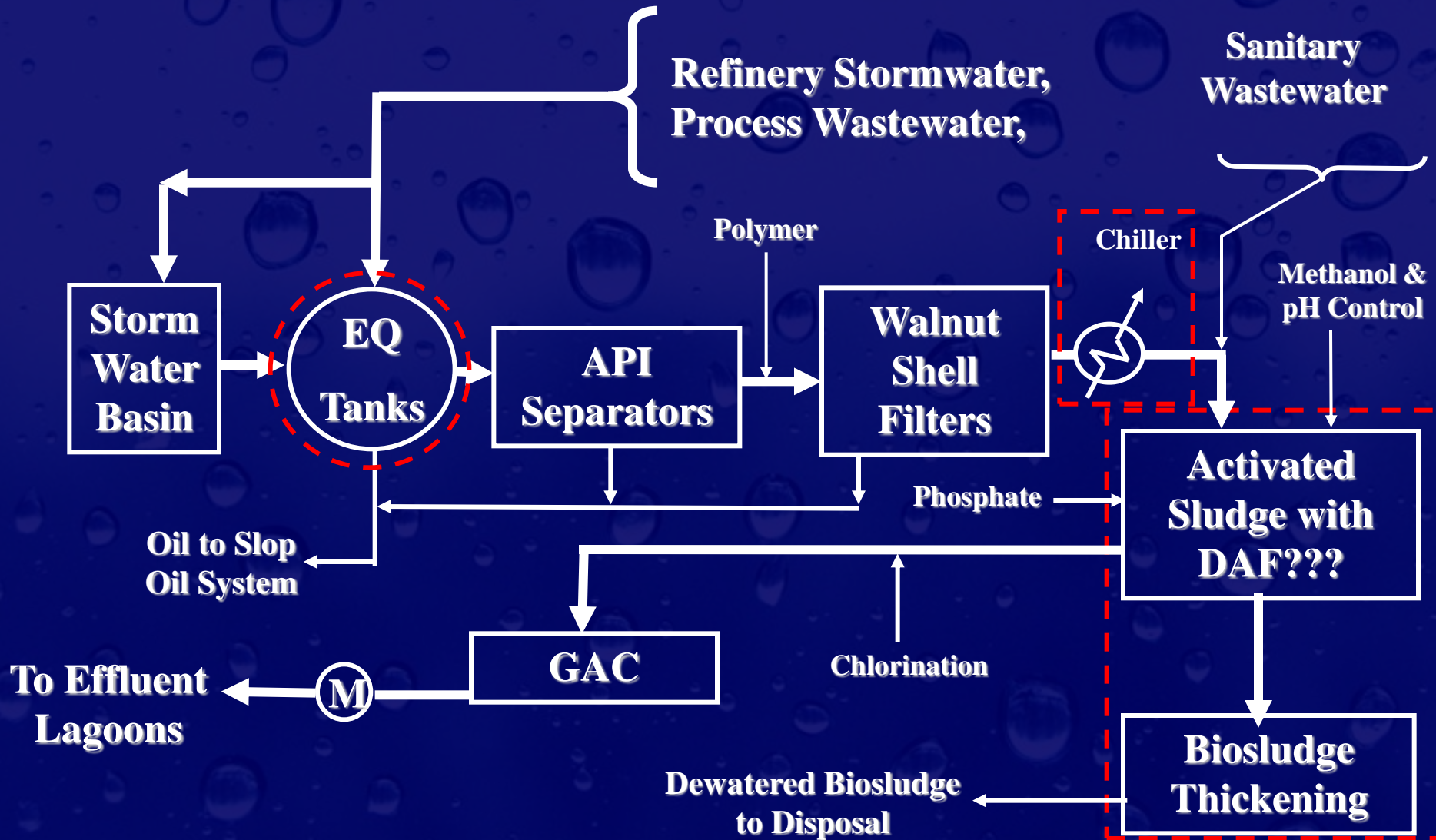
- *Oil/Water Separation & MBR*
 - *MBR & GAC Columns*
 - *PAC MBR (Carbon Enhanced)*
 - *GAC MBR – EcoRight MBR*





Conventional Biological Treatment & GAC Columns

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A small image in the top left corner showing a globe of the Earth resting on a cracked, metallic surface, symbolizing environmental impact or resource scarcity.

Conventional Biological Treatment Advantages / Disadvantages

Advantages:

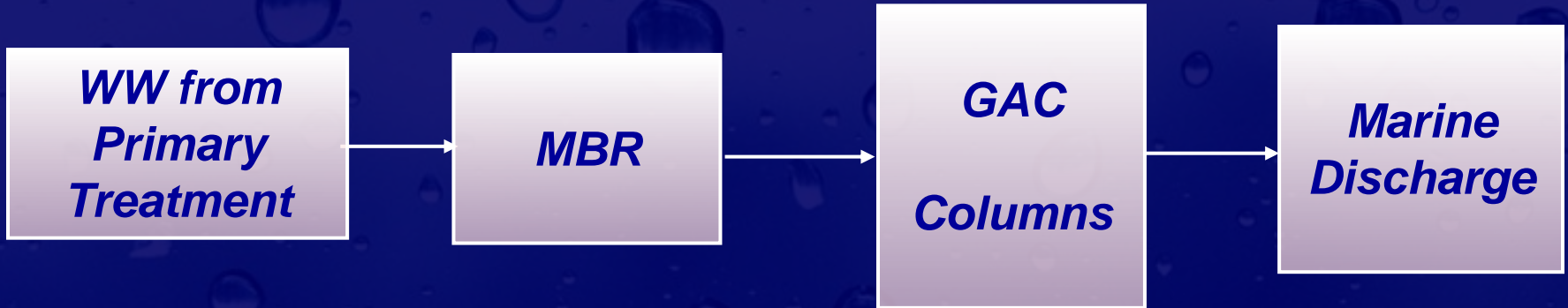
- *Most common system*

Disadvantages

- *Biomass unstable – feed fluctuations = upsets*
- *Solids won't settle in Clarifier*
- *Can't meet effluent requirements w/o GAC*
- *Ammonia may be toxic*
- *Extensive plot area required to accommodate equipment – Space Limitations*



MBR & GAC Column Design



A small image in the top left corner showing a globe of the Earth resting on a silver plate with a cracked surface, symbolizing environmental impact or water scarcity.

MBR & GAC Columns Advantages / Disadvantages

Advantages:

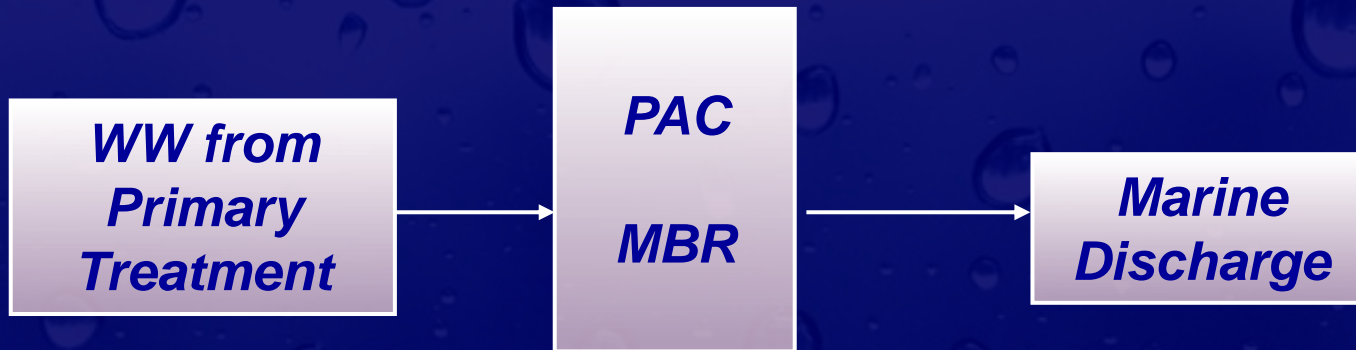
- *No Clarifier = No Settling Problems*
- *Smaller Footprint*
- *More Stable Biomass*

Disadvantages

- *Membrane Fouling*
- *High Cost for GAC Replacement / Regeneration*

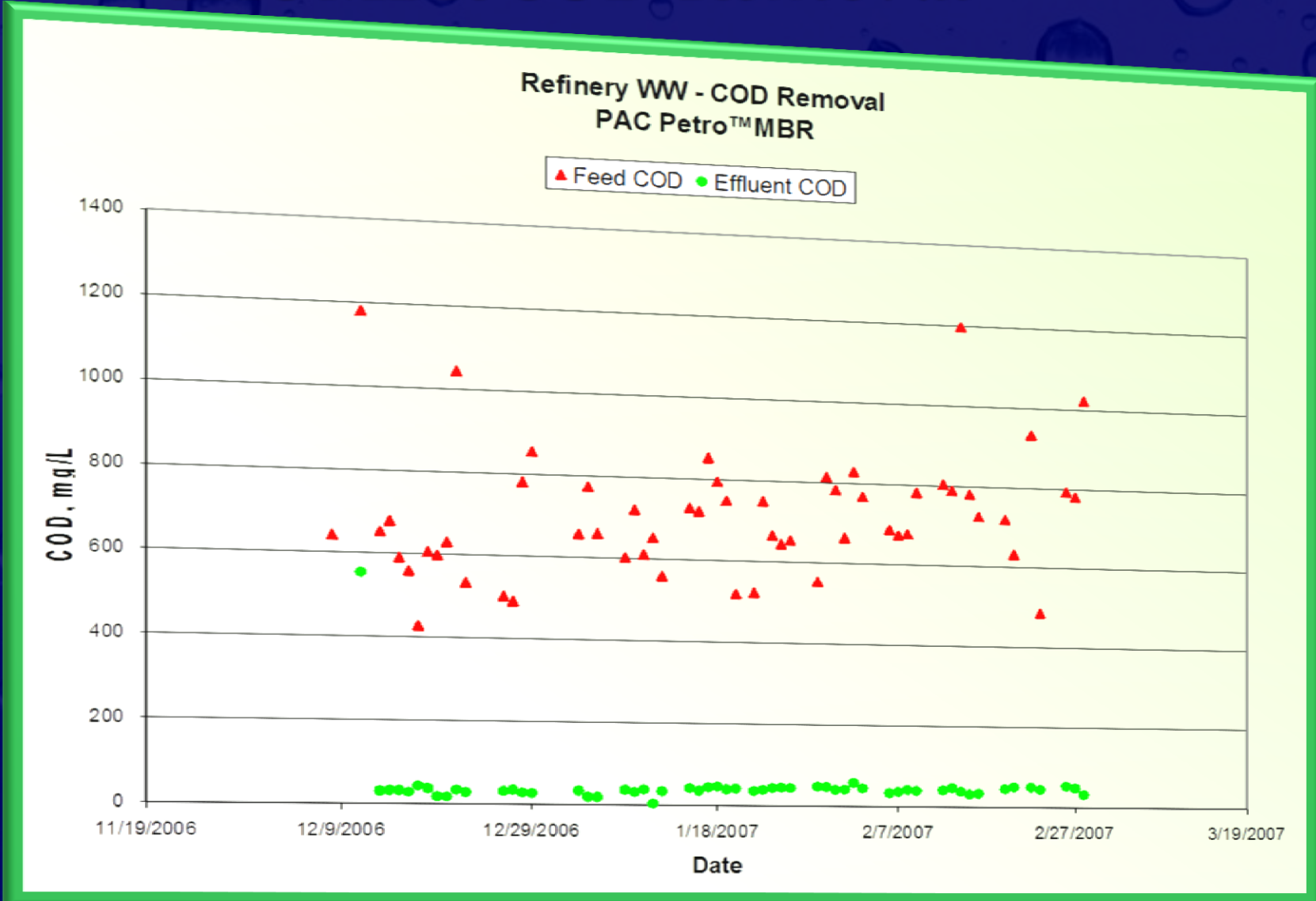


PAC MBR Process Design





PAC MBR COD Removal





MBR & PAC MBR Comparison

	<i>Feed</i>	<i>MBR Removal %</i>	<i>PAC MBR Removal %</i>
<i>BOD</i>	~400 mg/L	(~4 mg/L) 99%	(~5 mg/L) 99%
<i>COD</i>	~750 mg/L	(151 mg/L) 81%	(46 mg/l) 92%
<i>TOC</i>	~200 mg/L	(27 mg/L) 86%	(11 mg/L) 94%



Effluent Comparison

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Petro(tm)MBR Effluent



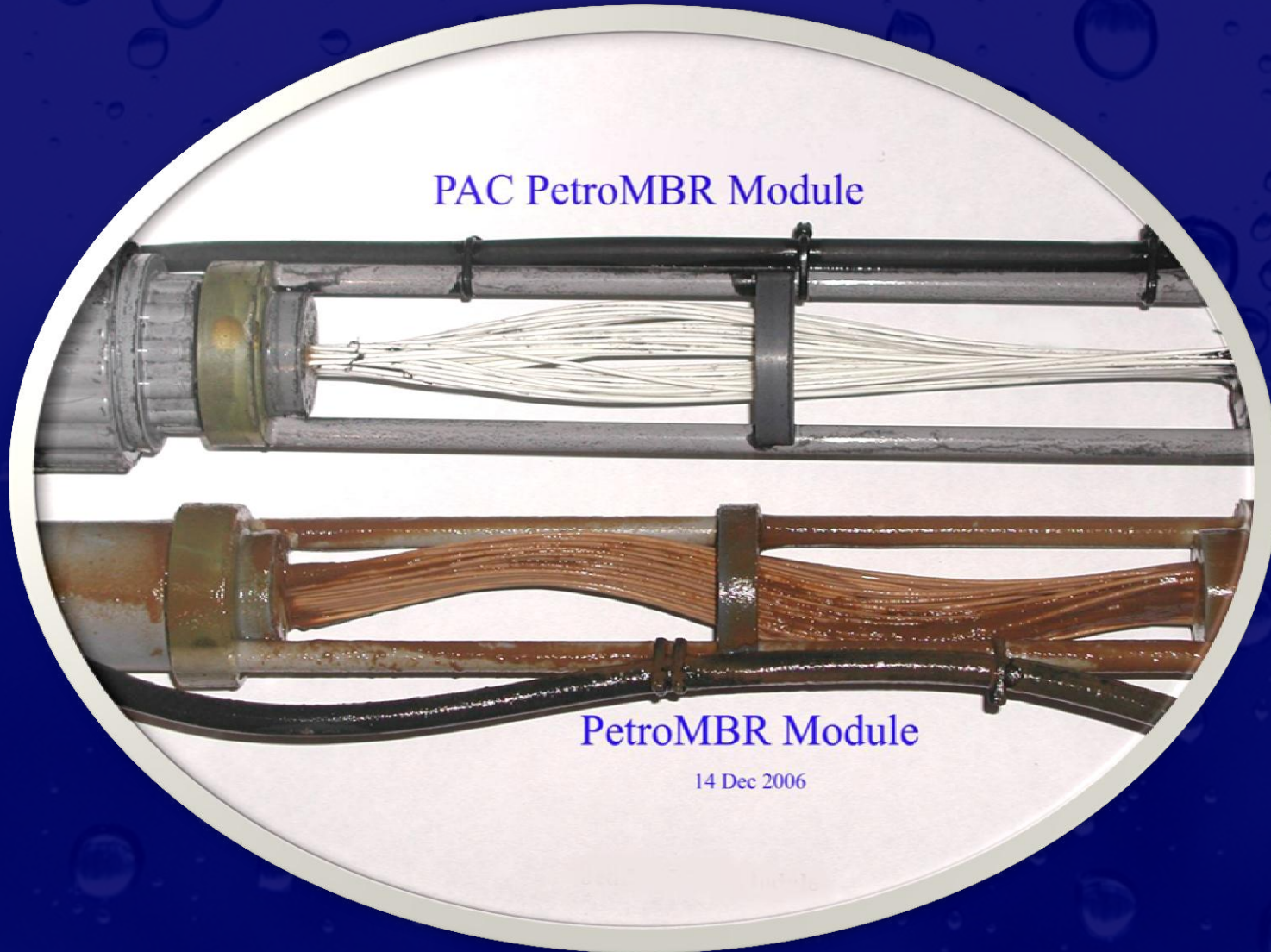
PAC Petro(tm)MBR Effluent

Refinery Wastewater Blend MBR Effluent



Membrane Comparison

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PAC PetroMBR Module

PetroMBR Module

14 Dec 2006



MBR – PAC MBR RO Comparison

	<i>MBR</i>	<i>PAC MBR</i>
<i>Silica - Total</i>	1.1 mg/L	<0.2 mg/L
<i>Turbidity</i>	0.43 NTU	<0.18 NTU
<i>Total Dissolved Solids</i>	238 mg/L	27 mg/L



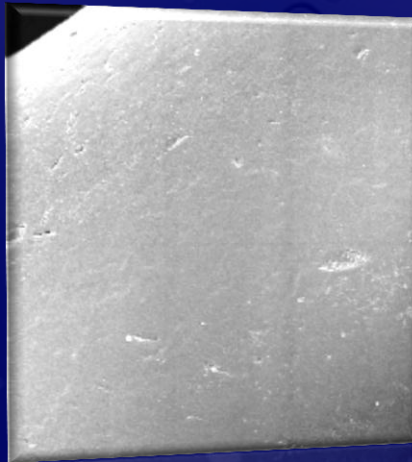


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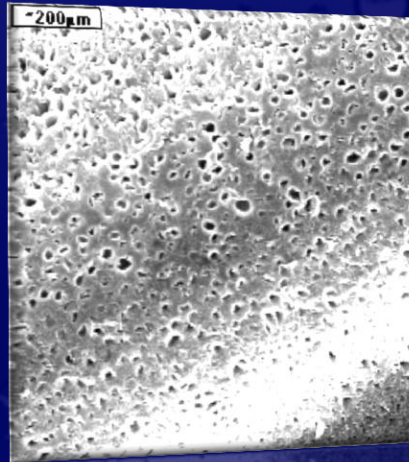


Membrane Abrasion

New

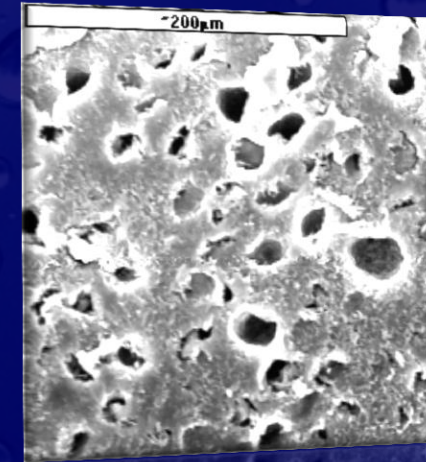


30 days



125X

30 days



500X



PAC MBR (Carbon Enhanced)

Advantages:

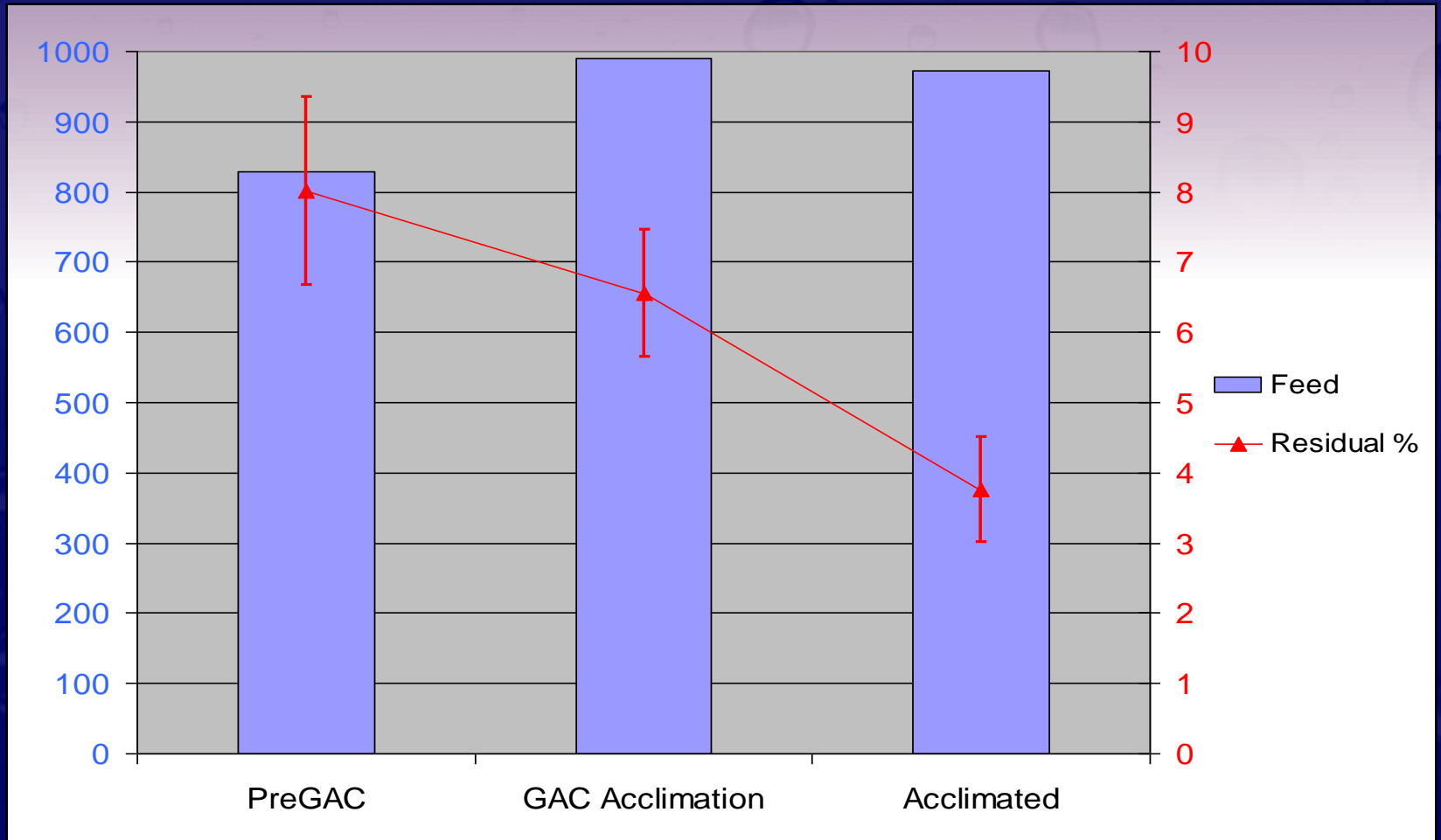
- *No Clarifier = No Settling Problems*
- *Smaller Footprint*
- *More Stable Biomass*
- *Lower Cost for Carbon*
- *No Fouling*
- *Reuse Possible*

Disadvantages

- *Membrane Abrasion*



GAC MBR Bench Results





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EcoRight™ MBR Pilot Unit



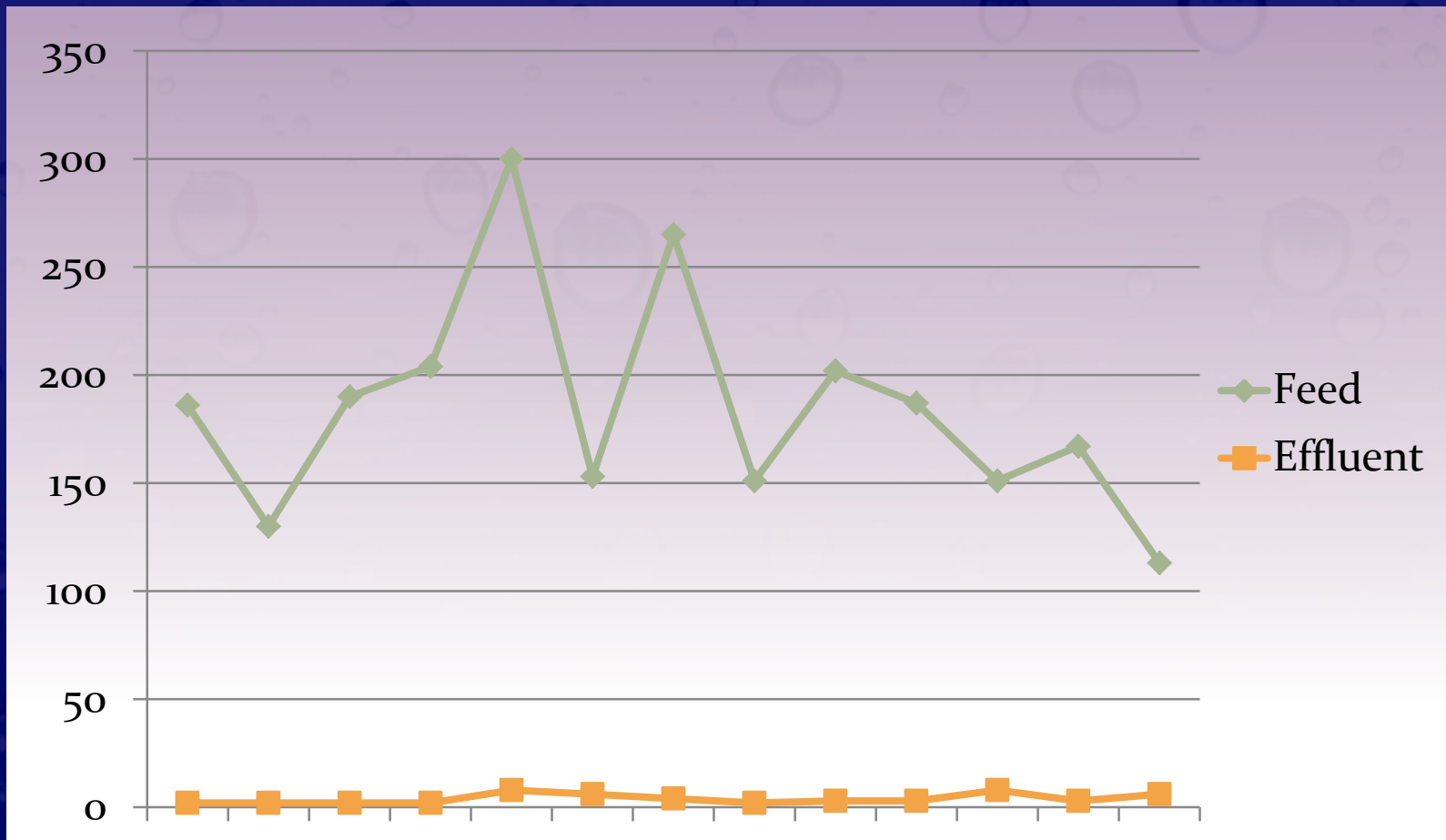


GAC-MBR Testing

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Field Pilot Plant Test Results



BOD (mg/L)

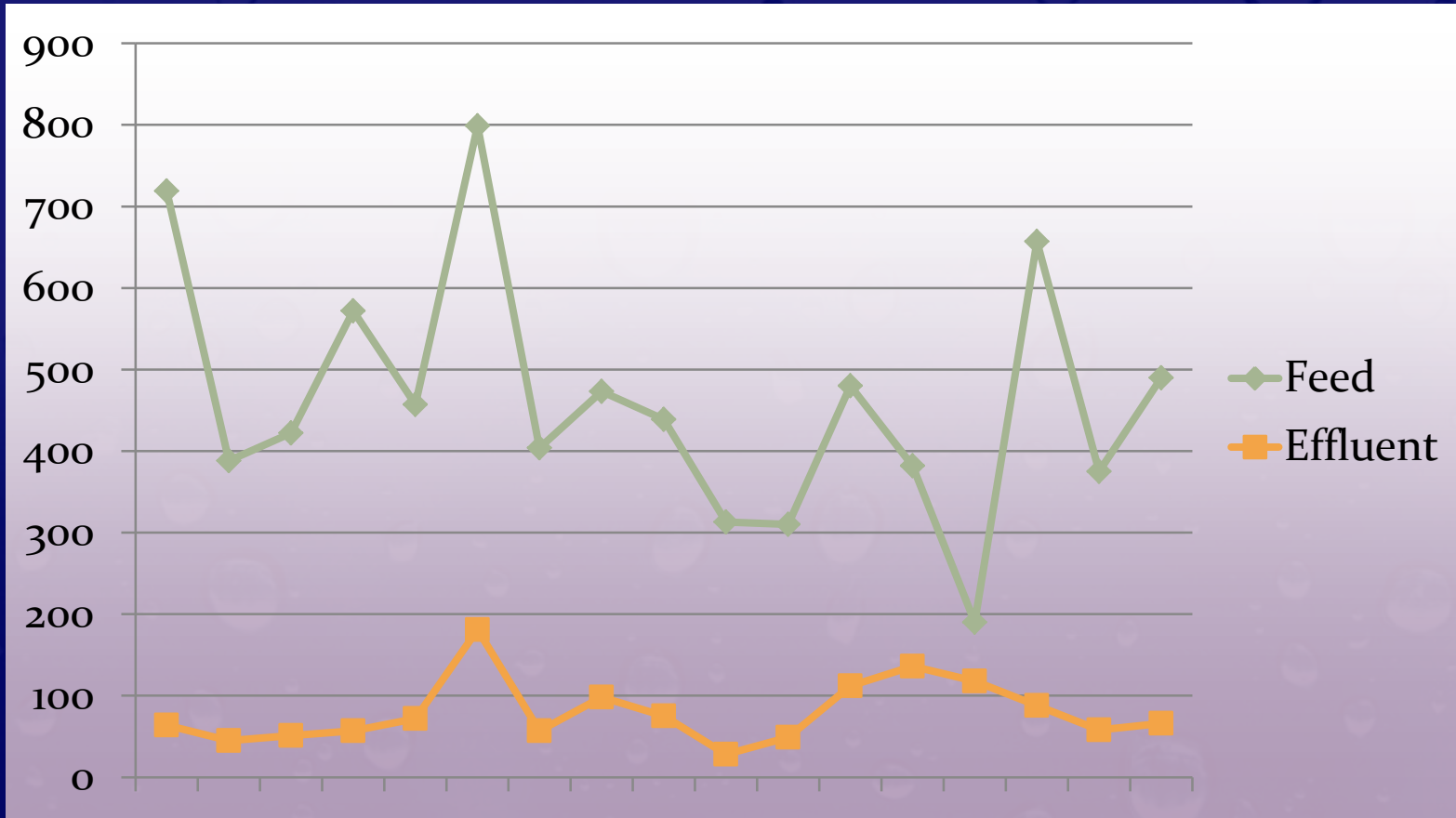


GAC-MBR Testing

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Field Pilot Plant Test Results



Chemical Oxygen Demand (mg/L)



Conclusions from RTR Pilot

GAC MBR Technology:

- *Very Tolerant of Upsets*
- *High Removal Efficiencies Possible*
- *Allows Reuse – RO Not Affected by Discharge*

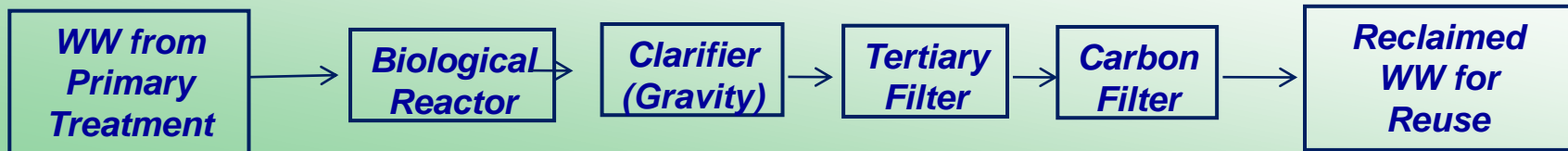
Testing Demonstrated:

- *GAC Regeneration – Equilibrium Established*
- *Suspension Patents Effective*
- *GAC Not Damaged by Aeration*
- *System Not Sensitive to High [Oil]*
- *Nitrification Temperature Sensitive – Cooling Req'd*
- *GAC Lasts > 6 Months*
- *COD Analytical Problems – Chlorides / Carbonates??*



Next-Generation MBR Technology - Theory

CONVENTIONAL ACTIVATED SLUDGE PROCESS



CONVENTIONAL MEMBRANE BIOREACTOR PROCESS



- Lower capital, operating & maintenance costs

GAC MEMBRANE BIOREACTOR PROCESS





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Thank You

