



Oily Wastewater Reuse Technologies

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Oily Wastewater Reuse Technologies

- *Agenda*
 - *Background/Need*
 - *Testing*
 - *Benefits*
 - *Conclusions*

Oily Wastewater Reuse Technologies

- ***Background***
 - ***Industrial/Oily WW***
 - ***Hard-to-treat***
 - ***Bio-refractory organics***
 - ***Not suitable for most reuse applications***
 - ***WW discharge regulations tightening***
 - ***Water shortages***
 - ***Existing technology not reliable/too costly***

Oily Wastewater Reuse Technologies

- ***Need for:***
 - ***Reliable, small footprint IWWT***
 - ***Increased removal of contaminants***
 - ***Existing or stricter discharge standards***
 - ***Reuse of wastewater due to:***
 - ***Water shortages***
 - ***Cost of fresh water***

Oily Wastewater Reuse Technologies

- ***Applications:***
 - ***Petroleum Refining***
 - ***Petrochemicals***
 - ***Produced Water from Oil/Gas Production***
 - ***Landfill Leachate***

Oily Wastewater Reuse Technologies

- ***BAC MBR Advantages***
 - ***Small footprint***
 - ***High COD and TOC removal efficiency***
 - ***Bio-refractory organics removal***
 - ***No gravity clarification***
 - ***More stable – less upsets***
 - ***Wastewater reuse potential***
 - ***Lower capital, operating & maintenance costs***

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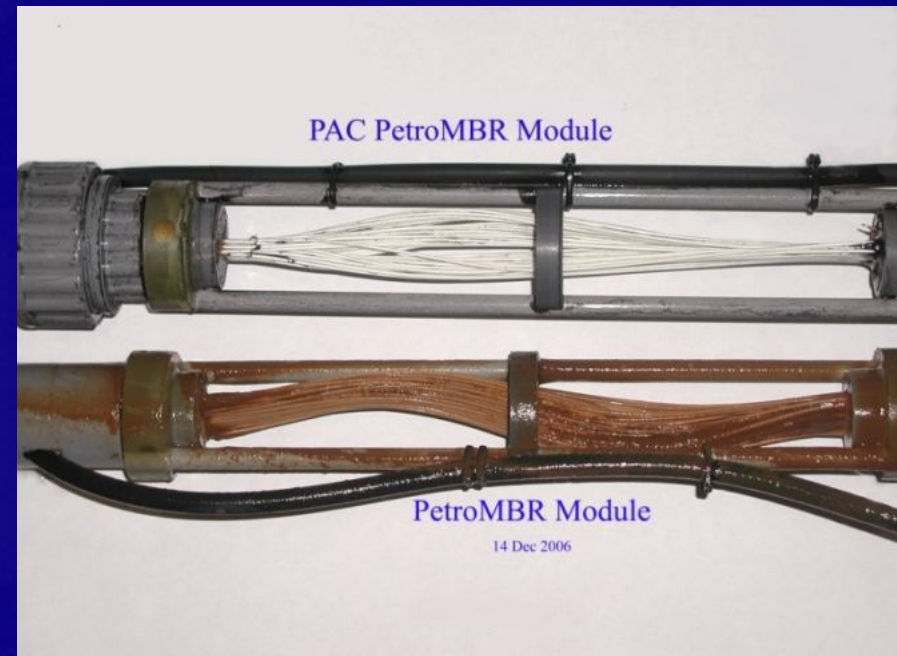
- ***Saudi Aramco PAC MBR Testing***
 - ***Complex refinery WW***
 - ***Highly variable***
 - ***High concentrations of refractory organics***
 - ***Effluent compliance difficult***
 - ***Side-by-side test with MBR***

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PAC MBR Pilot Test Unit

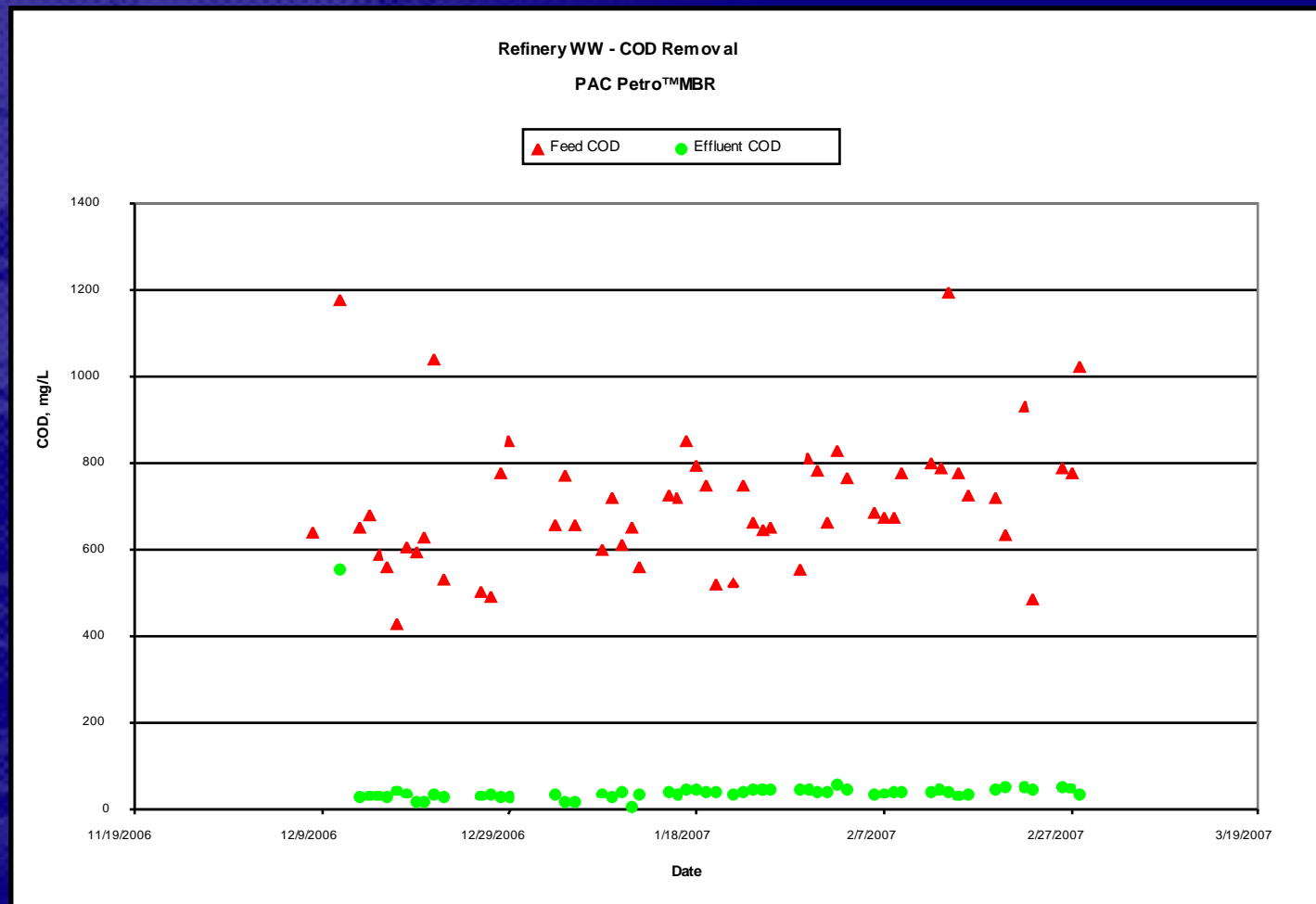


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COD – Inf. & Eff.



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Test Results

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

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RO Test Results

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

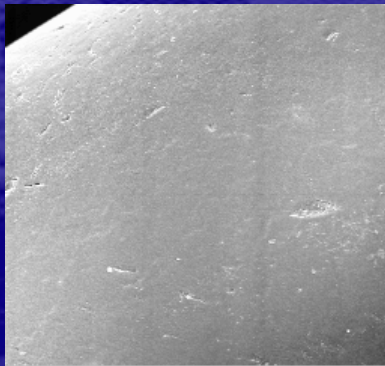
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- ***PAC MBR Results – Summary***
 - *Excellent refractory removal*
 - *Excellent effluent quality – feed to an RO*
 - *Very stable*
 - *No fouling*
 - ***Significant abrasion***
 - *Up to 40% reduction in life expectancy*
 - ***Continuous PAC replacement***
 - *More sludge*
 - *PAC replacement costs*

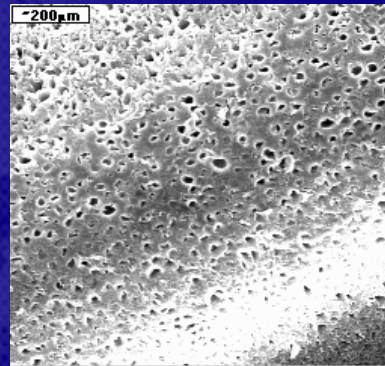
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Membrane Abrasion

New

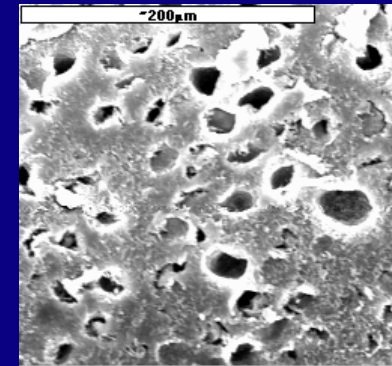


30 days



125X

30 days



500X

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*Saudi Aramco developed & patented **GAC MBR***

- *All advantages of PAC MBR*
- *Solves the problems*
 - *GAC vs. PAC*
 - *GAC can be screened / separated from MOS tank – No membrane abrasion from carbon contact*
 - *GAC not wasted with RAS – less carbon use & less sludge generated*

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GAC Pilot Unit



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- ***GAC MBR testing***
 - *Refractory organic feed*
 - ***Same operational advantages as PAC MBR***
 - *MBR – no clarifier*
 - *Improved refractory removal efficiency*
 - *Stable – carbon improves system recovery*
 - *Lower EPS concentrations*
 - *Biological regeneration of the GAC*
 - ***Green technology***

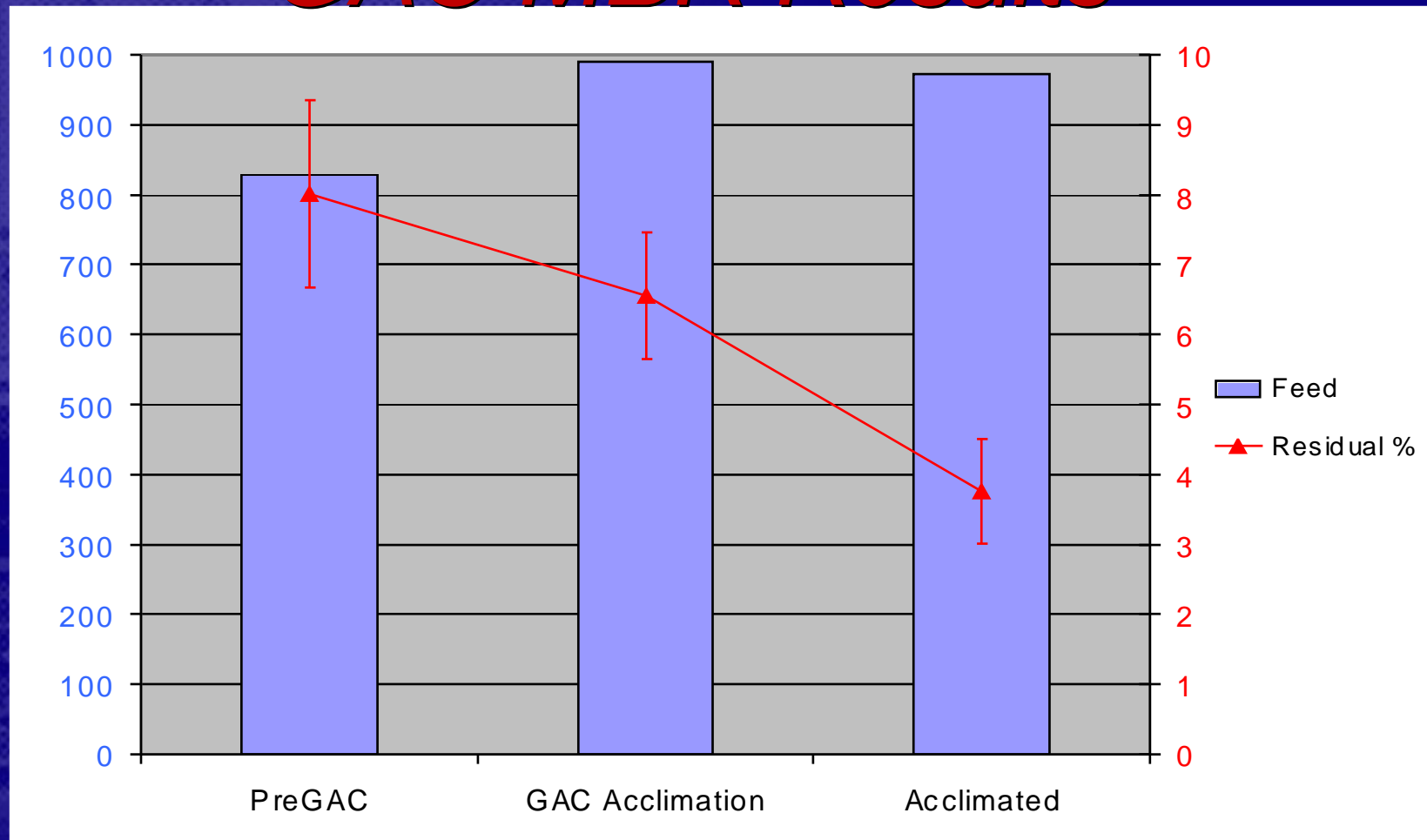
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GAC MBR – Samples



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GAC MBR Results



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- ***Saudi Aramco Plans***
 - ***Field pilot confirmation***
 - ***Refinery applications – marine***
 - ***Eliminate marine discharge***
 - ***Reuse WW – lower desalination costs***
 - ***Gas Plant applications – inland***
 - ***Eliminate evaporation ponds***
 - ***Reuse WW***
 - ***Reduce groundwater consumption***
 - ***Reduce desalination costs***

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- ***Saudi Aramco Plans – Continued***
 - ***Extend partnership with Siemens to:***
 - ***Develop a full-size system***
 - ***Improve the operational economics***

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----- Conclusions -----

GAC MBR advantages

- *Very stable system*
- *Bio-regeneration of GAC*
- *Green technology – effluent reuse/same or lower energy requirements*
- *Lower operating costs*
 - *No abrasion of membranes*
 - *Less sludge*
 - *Less carbon consumption*



Thank you