A New, Self-cleaning, Continuous, On-line Oil-in-Water Analyzer for the Petroleum Industry

18th Annual Produced Water Seminar

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Clearlake, TX
Topics / Outline

- Unocal Thailand Operations
- Produced Water Treatment Process
- Improved OiW Monitor & Installation
- Conclusions
Introduction

Gulf of Thailand

700 km in length
600 km in width
Shallow water:
  Average depth
  20 m
  (20 – 100 km offshore)
Maximum depth
  90 m

Chevron Fields
**Thailand Operations**

**Exploration and Production:**

- 13 Blocks
- 5 million acres (16,000 sq. kilometers)
- 1.5 bcfdd natural gas
- 100,000 bopd
- 40,000 bcpd

Chevron Oilfields

PTTEP
Thailand Operations

Offshore Facilities:

> 2500 wells drilled

> 140 platforms

> 1000 kms interfield pipelines

3 FSOs

1 FPSO
Produced Water Treatment

Overboard discharge limits:

- 30 ppm TPH
- 10 ppb Hg
- 250 ppb As
Thailand Operations

Water disposal:

• Seven fields currently inject 100% water

• By 2009, two additional fields to inject 100% water

• Two fields currently overboard water at rate of 10 – 30 kbwpd
Produced Water Treatment Process

- Skim Tank
- Injection Pump
- To Wellhead Platform for Reinjection
- Desander Cyclone
- Chemical Treating Process
- Clarified Water to Sea
- Separation
- Deoiler Cyclone
- Chemical additions
- Sludge
- Clarified Water to Sea
Produced Water Treatment Process and OiW Monitors

- Precipitates from water treatment sometimes fouls conventional OiW monitors. Conventional OiW monitors required constant maintenance, optics cleaning and re-calibration.

- Frustrated operators – turn off conventional OiW monitors

- Need improved OiW monitor that is less susceptible to fouling by sticky precipitate

- Kontavisor OiW Monitor (Systektum) installed in Chevron Netherlands. Difficulty Exporting to Thailand.

- Advanced Sensors OiW Monitor
Advanced Sensor Presentation
Objective

To produce an accurate, reliable (maintenance free) Oil in Water monitor for effluent discharge, re-injection and process management.

In collaboration with StatoilHydro and Talisman Energy.
OIW EX 1000 Oil in Water Analyser
Oil in Water Analyser

Installation
StatoilHydro, Brage
Measurement Technique

Laser induced UV Fluorescence
Online Analyser Challenges

1. Fouling
2. Oil Droplet Size Variation
3. Chemical Additive Interference
4. Operating Range
5. Accessibility
1. Online Analysis Challenges

• **Fouling**
  - Of measurement window
  - Chamber
  - Pipelines

• **Objective:** Stay clean. Without the need for manual intervention, use of acids, detergents or introduction of additives.

• **Solution:**
  - Combined Ultrasonic transducer and optical sensor.
2. Online Analysis Challenges

• **Oil Droplet Size Variation**
  - Oil droplet size variation has direct impact to fluorescence measurement

• **Objective**: Standardisation of oil droplet size. Without the need for manual intervention, or additives.

• **Solution**: Ultrasonic sample homogenisation.
The combined Optical-Ultrasonic sensor head provides cleaning and sample homogenisation.
3. Online Analysis Challenges

• Chemical Additive Interference
  • Many process chemicals are now commonly known to fluoresce and corrupt oil in water measurement.

• Objective: Isolate effects of chemical additives from fluorescent measurement.

• Solution: Real Time UV Spectrometer built into unit.
UV Spectra results from inbuilt Spectrometer

Crude oil

Produced Water plus chemicals

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## Measurement after chemical isolation

### Chemicals for testing and respective concentrations:

<table>
<thead>
<tr>
<th>Date</th>
<th>Item Description</th>
<th>Concentration</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>2/08/07</td>
<td>Tap Water</td>
<td>0.2ppm</td>
<td>0.2ppm</td>
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<tr>
<td></td>
<td>(5.0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>EC1110A satellite gas corrosion inhibitor</td>
<td>42 ppm</td>
<td>1.4ppm (14.9)</td>
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<tr>
<td></td>
<td>EC2176A Demulsifier</td>
<td>9 ppm</td>
<td>0.8ppm (10.5)</td>
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<tr>
<td></td>
<td>MEG Heating medium</td>
<td>181 ppm</td>
<td>0.2ppm (4.5)</td>
</tr>
<tr>
<td></td>
<td>EC1188A Heating medium Cl</td>
<td>0.60 ppm</td>
<td>0.2ppm (5.0)</td>
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<tr>
<td></td>
<td>EC1442A Export gas corrosion inhibitor</td>
<td>45 ppm</td>
<td>0.4ppm (7.0)</td>
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<td></td>
<td>EC9021A H2S scavenger</td>
<td>73 ppm</td>
<td>0.2ppm (5.5)</td>
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<tr>
<td></td>
<td>EC6354A Coagulant/de-oiler</td>
<td>100 ppm</td>
<td>0.2ppm (5.5)</td>
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<tr>
<td></td>
<td>Methanol</td>
<td>5443 ppm</td>
<td>0ppm (1.1)</td>
</tr>
</tbody>
</table>
Benchamas

Crude Oil + 300ppm Corrosion Inhibitor PX 0191
Correlation of Instrument vs Lab
Following chemical isolation

Number of samples = 63
Sample range = 11 - 40ppm
Average variation = 0.5ppm
4. Online Analysis Challenges

- Operating Range

- 0 – 20,000 ppm (2% oil concentration)
Online Analyser Challenges

• **Remote Accessibility**
  - Field mobilisation generally required for calibration, diagnostics and detailed analysis of water content.

• **Objective:** Complete remote reach through providing virtual presence.

• **Solution:** Ethernet and ADSL connectivity.
  - Live Demonstration available during the week.
Conclusions

- **EX-100 performs well after 13 months at FPSO**
  - Excellent agreement with grab samples – SX with Wilks IR
  - Operators love “maintenance free” monitor
- **EX-1000 performs well after 6 months at FSO**
- **EX-1000 required on FSO to eliminate interference from demulsifier treatment**
- **AS OiW monitors reduce lab technician time and solvent use/exposure**
- **AS OIW monitors alarm to Control Rooms to “early warn” of water system upsets**