Sand management by using ultrasonic systems at deep- and ultra deepwater installations

MAY 2008

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• Sand production, why measure sand
• Sand monitors, How we can measure sand
• Field cases
Sand production can be a good thing!
Use the sand detectors

• Use the sand detectors actively
• Use (and understand) the sand data
Sandmonitoring as part of Sand management

- Why are we measuring sand.
- How are we measuring sand
Controlled sand production

Perforation seen from the tubing showing the channels created by sand being produced from the well.

The channels can often be quite stable, some occasional sand production will usually be seen.
Operating Range Concept

Flow Rate

Q₃ → Massive sanding
Q₂ → Production enhancement
Q₁ → No sanding

Sand Strength

Sand #1
Sand #2

Upper limit of safe operation
Sand-free limit line

ULTRASONIC INTELLIGENT SENSORS

THE LEADER IN SAND, PIG AND CORROSION-EROSION MONITORING
<table>
<thead>
<tr>
<th>What do we want to know</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Sand rate,</td>
</tr>
<tr>
<td>- gram per second</td>
</tr>
<tr>
<td>• Sand</td>
</tr>
<tr>
<td>concentration,</td>
</tr>
<tr>
<td>- gram per M² or pound per 1000 barrels</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>What can be measured</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Acoustic energy</td>
</tr>
<tr>
<td>- Raw value, nanovolt</td>
</tr>
<tr>
<td>• Metal loss</td>
</tr>
<tr>
<td>- Nanometer</td>
</tr>
<tr>
<td>• Sand sample</td>
</tr>
<tr>
<td>- gram per M² or pound per 1000 barrels</td>
</tr>
</tbody>
</table>
Working principle acoustic sandmonitors

- The sensor have to be installed immediately downstream of a bend
- Particles being transported with the flow, will by gravity hit the pipe wall in a bend
- This will create ultrasonic pulses, detected by the sensor
How it works

The measured raw signal, representing the energy released by particles hitting the pipe wall can easily be converted to a mass, if the velocity is known.

\[ e = \frac{1}{2} m \cdot v^2 \]

\[ m = \frac{2e}{v^2} \]

\( e \); a direct measurement
\( v \); fluid or gas can be measured.

Sand velocity is never measured.
How it works

\[ m = \frac{2e}{v^2} \]

Gram per second

Raw value - zero

Step

\[ g/\text{sec} = \frac{\text{raw-zero}}{\text{step}} \]
Sand detector configuration

![Sand detector configuration image]

### Sensors Configuration

#### Parameters:
- **Velocity**: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
- **Zero**: 2000, 2500, 2900, 3600, 4500, 5600, 6000, 14000
- **Step**: 500, 500, 3000, 4500, 6000, 9000, 14000
- **Exp**: 1, 1, 1, 1, 1, 1, 1

#### Graph:
- **Zero vs. Step**
- **Exp**

**Import** | **Export**
---|---

**CLAMPON**

The leader in sand, pig and corrosion-erosion monitoring.
Sand monitoring system

- Sand monitoring system
- Calculations
- Alarms
- Output
  - Scada
  - PI
  - Client

- Process data
ClampOn Ultrasonic Intelligent Sensors

- DSP Particle Monitor
- DSP Pig Detector
- DSP Leak Monitor
- DSP Corrosion - Erosion Monitor
- Versions:
  - Topside
  - Compact Subsea (2500m)
  - Deepwater (4500m)
ClampOn Ultrasonic Intelligent Sensors

Compact Subsea Model

Design depth: 2500m

All parts in Titanium
ClampOn Ultrasonic Intelligent Sensors

Deepwater Model

Design depth: 4500m

Sensor → Titanium
Funnel → 316SS / Carbon Steel
Field data
## Boosting – Earnings

Increased earnings per day:

- **Statoil - Statfjord**: 540,000 USD/Day
- **Conoco - Murdoch**: 34,285 USD/Day
- **BHP - Ravenspurn**: 55,660 USD/Day
- **BP - Cleeton**: 12,570 USD/Day
- **Shell - Brunei (onshore)**: 8,100 USD/Day
- **Exxon - GOM**: 6,800 USD/Day
- **Mobil - GOM**: 23,950 USD/Day
- **Shell East (Soku)**: 5,000 Bbl/day
- **BP Andrew**: 5,000 Bbl/day
- **Total increase in Nigeria**: 100,000 Bbl/day
Increasing sand production

![Graph showing sand production over time with data points and a legend indicating the measurement of Sand, Velocity, and Raw values.]

<table>
<thead>
<tr>
<th>Date Printed: 2/14/2007 12:13:24</th>
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<tr>
<td><strong>Application:</strong> ClampOn Sand Client</td>
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<tr>
<td><strong>Sand</strong></td>
</tr>
<tr>
<td><strong>Minimum:</strong> 0 g/s</td>
</tr>
<tr>
<td><strong>Average:</strong> 0 g/s</td>
</tr>
<tr>
<td><strong>Total:</strong> 0.02 kg</td>
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Sudden sand production

![Diagram showing sudden sand production with data points and time axis.]

**CKB-QT-0221 - Historical**

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<tr>
<td>Application:</td>
<td>ClampOn Sand Client</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Maximum:</strong></td>
<td>0.0298 g/s</td>
</tr>
<tr>
<td><strong>Minimum:</strong></td>
<td>0 g/s</td>
</tr>
<tr>
<td><strong>Average:</strong></td>
<td>0.012 g/s</td>
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<tr>
<td><strong>Total:</strong></td>
<td>29.75 kg</td>
</tr>
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**CLAMMON**

THE LEADER IN SAND, PIG AND CORROSION-EROSION MONITORING

ULTRASONIC INTELLIGENT SENSORS
Response
Costly misunderstanding
Thank you for the attention