Our Goal
# Pilot Project - 17 ½” Hole Section

<table>
<thead>
<tr>
<th>MudCube</th>
<th>Metric</th>
<th>Imperial</th>
</tr>
</thead>
<tbody>
<tr>
<td>FLOW:</td>
<td>1500 l/m</td>
<td>396 gpm</td>
</tr>
<tr>
<td>ROP:</td>
<td>20-25 m/hr</td>
<td>65-82 ft/hr</td>
</tr>
<tr>
<td>FL Temp:</td>
<td>18.6°C</td>
<td>65°F</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Avg Shaker</th>
<th>Metric</th>
<th>Imperial</th>
</tr>
</thead>
<tbody>
<tr>
<td>FLOW:</td>
<td>900 l/m</td>
<td>238 gpm</td>
</tr>
<tr>
<td>ROP:</td>
<td>20-25 m/hr</td>
<td>65-82 ft/hr</td>
</tr>
<tr>
<td>FL Temp:</td>
<td>18.6°C</td>
<td>65°F</td>
</tr>
</tbody>
</table>
Experience

• Onshore Testing
  – 3 Years of Research and Development Testing
  – 5 Fluids (2 OBM, 3 WBM) Tested Prior to being qualified for Statoil Pilot
  – Various side by side testing vs. conventional shaker system with many fluids including cuttings waste streams, completion fluid, etc…

• Offshore Qualification
  – Statoil: Oseberg B Platform Ongoing
  – WBM / OBM
  – 6500m (21325’) Total Depth
Test Center

• Full Drilling Fluids & Cuttings Test Loop
• Used for technology development and rapid prototyping
• Used for qualification of new equipment and side-by-side comparisons
• HSE research

Specifications:
• Weighted oil-based/water-based mud capabilities
• Maximum flowrate: 475 (1800l/min)
• Maximum simulated flowline temperature: 185˚F (85˚C)
• Remote Control System with Real-Time Data Logging (WITSML Compatible)
• VSM 100 shaker /complete MudCube system
• Mudlab and office area
Potentially Replace These…
With this MUDCUBE Solution
Specifications

Assumption:
$25\text{ Construction Costs / lb. of equipment}^1$

Savings:
>$625\text{k in Construction Costs}$

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Dimensions
Screen Information

- **Change Time**
  - <5 minutes
  - No Additional Space

- **Weight**
  - 7lbs each

- **Specifications**
  - 16.1’ x 3.94’ (63.4ft\(^2\) area)
  - 1.5’ per second (0.48m/s)
  - Full API Screen Ranges are available

- **Life Expectancy – Limited Data**
  - >35 hours in the test center
  - Offshore not determined yet, new carrier belt design should extend life considerably
Printer Business Model
Screen Cost

- Assumptions
  - 15 screens total for a three double deck shaker system
  - 3 screens for a three VCS system
  - VCS & shaker have the same screen life
  - VCS screens cost three times more than the shaker screens
  - 5-year shaker screen cost of $22.9m

5 year savings of > $8m Operating Cost
Screen Cleaning & Failure Detection

A. Provides the main suction of drilling fluids
B. Air Knife dries cuttings, and helps dry screen
C. Air Knife cleans sticky cuttings from screen blowing them into cuttings trough
D. Secondary filter captures any cuttings that bypass a damaged screen belt and alarms to the console in case of failure (no cuttings into active system)

Manual cleaning can be achieved by running the unit without cuttings to blow the screen dry, changing the screen, or pressure washing the screen during operation. Note that cuttings drying has been performed with very viscous / solids laden fluids with no issues. No experience with gumbo.
Maximum Flow

• Onshore Data  
  (Limited to 475 gpm per unit at test center)
  – >475 gpm (1800l/m) Tested with API 170 (200 Mesh) screens and 12.9ppg (1.55sg) both OBM and WBM
  – 713 gpm (2700 l/m) Tested with low weight WBM during early stages

• Offshore Data - Ongoing
  – Expected Results / No Red Flags
  – Cooling Effect
  – Visually Dryer Cuttings
## Oil On Cuttings

<table>
<thead>
<tr>
<th>MOBM Cuttings Analysis</th>
<th>Start</th>
<th>VCS1</th>
<th>VCS2</th>
<th>VCS3</th>
<th>VCS4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass of oil / kg of wet cuttings</td>
<td>188.41</td>
<td>57.23</td>
<td>73.08</td>
<td>66.45</td>
<td>85.9</td>
</tr>
<tr>
<td>Mass of oil / kg of dry cuttings</td>
<td>299.93</td>
<td>75.47</td>
<td>95.93</td>
<td>86.53</td>
<td>118.84</td>
</tr>
<tr>
<td>Oil %</td>
<td>18.84</td>
<td>5.72</td>
<td>7.31</td>
<td>6.64</td>
<td>8.59</td>
</tr>
<tr>
<td>Water %</td>
<td>18.34</td>
<td>18.45</td>
<td>16.51</td>
<td>16.56</td>
<td>19.13</td>
</tr>
<tr>
<td>Oil Reduction</td>
<td>-</td>
<td>69.6%</td>
<td>61.2%</td>
<td>64.7%</td>
<td>54.4%</td>
</tr>
</tbody>
</table>
Dryer Cuttings

Start Volume

End Volume
Cuttings Example
# HSE: Shaker vs. MudCube

<table>
<thead>
<tr>
<th>Risks</th>
<th>Shakers</th>
<th>MudCube</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fume Exposure</td>
<td>High</td>
<td>None</td>
</tr>
<tr>
<td>Vibration Exposure</td>
<td>High</td>
<td>None</td>
</tr>
<tr>
<td>Flash Point / Fire Risk</td>
<td>Low</td>
<td>None</td>
</tr>
<tr>
<td>Noise Damage</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Fall Risk (From Height)</td>
<td>Med</td>
<td>None</td>
</tr>
<tr>
<td>Slips / Trips / Falls</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Hand / Back Injuries (Twisting/Pinch/Lift)</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Chemical Splashing</td>
<td>Med</td>
<td>None/Low</td>
</tr>
<tr>
<td>Pressure Washing (Cuts/Eyes/Exposure)</td>
<td>Med</td>
<td>None/Low</td>
</tr>
<tr>
<td>Number of Workers Exposed</td>
<td>Med</td>
<td>None/Low</td>
</tr>
</tbody>
</table>
Automated Mud Measurement

**MudCube Automation:**
- The software backbone of the MudCube can capture, and database information, along with transmit this data to other companies via industry standard WITSML.

**Density & Viscosity:**
- The Density / Viscosity Sensor operates like a tuning fork. The density is a function of the resonant frequency, the viscosity is a function of the bandwidth.

**pH:**
- pH probes are readily available from many industrial vendors.

**Early Kick / Loss Detection:**
- The signal from the known displacement transfer pump can be calibrated with the rig pumps for accurate early kick and loss detection.
Potential Alternate Uses

• Onshore / Offline Cuttings Drying / Processing
• Degassing/Scalping H$_2$S Areas
• Brine Filtration (Polymer Loading)
• Mud Cleaner
• MPD/UBD sealed units
• Air Drilling Dust Control
• Other Benefits
  – Rig Vacuum
Summary

- Step Change Technology
  - Improved Process
  - Significant Health, Safety & Environmental Benefits
  - Reduced Opex
- Visit us at AADE Fluids Conference, OTC, GPS Canada, ONS, OSEA