Green Chemical Products

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• Drilling Fluids
• Drilling Waste Management
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1. **Prevention**
   It's better to prevent waste than to treat or clean up waste afterwards.

2. **Atom Economy**
   Design synthetic methods to maximize the incorporation of all materials used in the process into the final product.

3. **Less Hazardous Chemical Syntheses**
   Design synthetic methods to use and generate substances that minimize toxicity to human health and the environment.

4. **Designing Safer Chemicals**
   Design chemical products to affect their desired function while minimizing their toxicity.

5. **Safer Solvents and Auxiliaries**
   Minimize the use of auxiliary substances wherever possible make them innocuous when used.

6. **Design for Energy Efficiency**
   Minimize the energy requirements of chemical processes and conduct synthetic methods at ambient temperature and pressure if possible.

7. **Use of Renewable Feedstocks**
   Use renewable raw material or feedstock rather whenever practicable.

8. **Reduce Derivatives**
   Minimize or avoid unnecessary derivatization if possible, which requires additional reagents and generate waste.

9. **Catalysis**
   Catalytic reagents are superior to stoichiometric reagents.

10. **Design for Degradation**
    Design chemical products so they break down into innocuous products that do not persist in the environment.

11. **Real-time Analysis for Pollution Prevention**
    Develop analytical methodologies needed to allow for real-time, in-process monitoring and control prior to the formation of hazardous substances.

12. **Inherently Safer Chemistry for Accident Prevention**
    Choose substances and the form of a substance used in a chemical process to minimize the potential for chemical accidents, including releases, explosions, and fires.
Cradle to the Grave

The full life circle of chemicals needs to be considered.
The optimization of cost, performance vs. environmental profile is important.
Weatherford Drilling Fluid Systems – Aqueous (WBM)

**WEL-DRILL™**
- KCL PHPA

**WEL-DRILL™ CPG**
- Cloud Point Glycol

**WEL-DRILL™ HP**
- High Performance Water Based Mud

**WEL-DRILL™ Plus**
- High Temperature High Pressure

**WEL-DRILL™ S**
- Silicate Systems

**WEL-DRILL™ MMO**
- Mixed Metal Oxide

**WEL-DRILL™ F**
- Formate Systems

**WEL-DRILL™ RDF**
- Reservoir Drilling Fluid

**WEL-DRILL C**
- Cationic systems
Weatherford Drilling Fluid Systems – Non Aqueous (OBM)

**WEL-VERT™**
Invert emulsion for use in wide range of base fluids

**WEL-VERT™ D**
Optimized diesel based system

**WEL-VERT™ FR**
Flat Rheology System

**WEL-VERT™ Plus**
High Temperature High Pressure

**WEL-VERT™ RDF**
Reservoir Drilling Fluid
Weatherford Drilling Fluid - Air and Foam Systems

**Water Based:**

- **DuraFoam**  Economical non recyclable
- **KleanFoam** Recyclable (successfully used in over wells
- **TransFoam** Recyclable, unique pH control
- **EnviroFoam** Completely biodegradable

**Oil Foam Based:**

- **OleoFoam EF**  HF 100 base
- **OleoFoam HT** Crude, Diesel or Synthetic
- **OleoFoam C** Condensate Base
Weatherford Solids Control and Drilling Waste Management

- Full range of Solids Control and Drilling Waste Management Services
- Solids control systems:
  - Shakers, Centrifuges, Mud Cleaners, hydrocyclones
- Drilling waste management solutions
  - Transport, treatment and disposal
- Filtration services
  - DE and Cartridge
- Fluid system design and manufacture
- Total Site Management Designs
Engineered Fluids Management\textsuperscript{SM} (EFM\textsuperscript{SM}) is a holistic based engineering approach to providing drilling fluid and waste management services.

EFM\textsuperscript{SM} solutions utilize tried and trusted project management, environmental management, and site management techniques to combine fluids, engineering, solids control and waste management services to provide a seamless value adding service which delivers improved environmental performance.
- A scoring system based on the potential impact on human health and the environment.
- Have a unique/systematic scale to evaluate/compare all the products in a standard/customized framework.
GreenWERCS - Criteria

- Persistent, bioaccumulative and toxic substances (PBTs)
- Carcinogens, mutagens or reproductive toxicants (CMRs)
- Probable endocrine disrupters
- Potential hazardous waste

Standard and user defined criteria
Standard criteria
Scores of Weatherford Drilling Fluid Additives

<table>
<thead>
<tr>
<th></th>
<th>WEL-LUBE Ultra</th>
<th>WEL-SCAV HS</th>
<th>Envirodrill</th>
<th>WEL-MULP</th>
<th>WEL-XAN XG</th>
</tr>
</thead>
<tbody>
<tr>
<td>WFT Environmental</td>
<td>15</td>
<td>0</td>
<td>30</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>WFT Health</td>
<td>1</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>WFT Physical</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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</tbody>
</table>
Drilling Fluid Products – Generic Analysis

The red component in DF will determine the overall profile.

<table>
<thead>
<tr>
<th>O/SBM</th>
<th>WBM - RDF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diesel</td>
<td></td>
</tr>
<tr>
<td>Base oil</td>
<td>Organic clay inhibitors</td>
</tr>
<tr>
<td>Emulsifiers/wetting agent</td>
<td></td>
</tr>
<tr>
<td>Rheology modifiers</td>
<td>Scavengers</td>
</tr>
<tr>
<td>Brines</td>
<td></td>
</tr>
<tr>
<td>Fluid loss additives</td>
<td>Viscosifiers – Synthetic polymers</td>
</tr>
<tr>
<td>Weighting agent</td>
<td>Weighting agent</td>
</tr>
<tr>
<td></td>
<td>Viscosifiers – Biopolymer</td>
</tr>
<tr>
<td></td>
<td>Starches</td>
</tr>
</tbody>
</table>
In addition to drilling fluid additives, there are additional residual on drilling cuttings.

<table>
<thead>
<tr>
<th>O/ SBM</th>
<th>WBM - RDF</th>
</tr>
</thead>
<tbody>
<tr>
<td>PAH – aromatics</td>
<td></td>
</tr>
<tr>
<td>Base oil content</td>
<td>PAH – aromatics</td>
</tr>
<tr>
<td>Scavengers - reacted products</td>
<td></td>
</tr>
</tbody>
</table>
The Microtox® test system is the industry standard for rapid toxicity screening and analysis. Microtox® rapid toxicity detection is an in vitro test system that uses bioluminescent bacteria for the detection of toxicity in water and is used as a screening system to detect the relative toxicity of a sample.

The simplicity of the test is that a measurable activity of the living luminescent bacteria is the production of light. If the bacteria’s metabolism slows or the bacteria die, the quantity of light lessens or ceases. This phenomena allows us to measure a 50% effective concentration (EC50) of a sample, which is a 50% reduction in bioluminescence.
## Microtox® Toxicity Test

<table>
<thead>
<tr>
<th>Test</th>
<th>EC20</th>
<th>EC50</th>
<th>PASS/FAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTX – Threshold ClayGuard</td>
<td>9.6 L/m3</td>
<td>68 L/m3</td>
<td>N/A</td>
</tr>
<tr>
<td>MTX - Confirmation @ 68 L/m3</td>
<td>23%</td>
<td>85%</td>
<td>PASS</td>
</tr>
</tbody>
</table>

Third Party Lab Results from 10/12/2012

<table>
<thead>
<tr>
<th>Test</th>
<th>EC20</th>
<th>EC50</th>
<th>PASS/FAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTX - Threshold ClayGuard</td>
<td>16.4L/m3</td>
<td>43.70L/m3</td>
<td>N/A</td>
</tr>
<tr>
<td>MTX - Threshold CC-300</td>
<td>12.8L/m3</td>
<td>29.84L/m3</td>
<td>N/A</td>
</tr>
</tbody>
</table>
Good practice plus green additive will minimize the overall environmental impact of DWM process.
Weatherford systems – 1 High Performance Water Based Drilling Fluids

- Green additives
- Excellent lubrication
- ROP enhancement
- Shale Inhibition
**Weatherford systems – 2. SafeBrine**

### Physical Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Observation</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>Up to 23.6 ppg</td>
<td>11-15.2 ppg Commercially available</td>
</tr>
<tr>
<td>Solubility in water</td>
<td>Easy to dilute</td>
<td>Reasonable weigh-up cut-back window</td>
</tr>
<tr>
<td>Color</td>
<td>Colorless</td>
<td></td>
</tr>
<tr>
<td>Turbidity</td>
<td>1.44 NTU</td>
<td>14.22 ppg brine</td>
</tr>
<tr>
<td>Corrosivity</td>
<td>Mild to skin</td>
<td>Quite easy to handle</td>
</tr>
<tr>
<td>Toxicity</td>
<td>PLONOR Listed</td>
<td></td>
</tr>
</tbody>
</table>
Goal: Greener life circle

Chemicals

Environment

Hydrocarbon recovery

Applications
THANK YOU

QUESTIONS