Wyoming Enhanced Oil Recovery Institute
4th Annual IOR/EOR Conference

Enzymes / MEOR Applications in Well Stimulation, Paraffin Control and Water Flooding

John Gray - Jumpstart Energy Services, LLC
Larry Skow – Bio Resources, Inc.

September 10-11, 2012
Why Tiger Oilfield Solutions?

- Set up as marketing “umbrella” entity by Jumpstart Energy Services and Larry Skow with Bio Resources.
- Broadens applications for enzyme surfactant, bio-solvent and MEOR technologies.
- Expands reach for several small companies.
Highlighted Technologies

- Enzyme surfactant fluids for well stimulation.
- Microbe technology used for paraffin control.
- MEOR technology for waterflooding.
What are they?

- Proprietary formulations of batch fermented oil loving microbes which generate enzymes that are blended, then mixed with surfactant packages.

- Enzymes are “non-living” proteins that…
  - catalyze (i.e. accelerate) chemical reactions.
  - are not consumed by the reactions they catalyze, nor do they alter the equilibrium of these reactions.

- Jumpstart’s enzyme surfactant fluid for well stimulation is Tigerzyme®.
Improved Relative Permeability

- Primary purpose is to improve wettability and relative permeability near wellbore.

- Tigerzyme® was developed to improve efficacy and economics.

- Product utilizes proprietary environmental remediation technology that was modified to “recover” oil.

- Working with Bio Resources to test “combined” applications. Website and new products coming…
Enzyme in Water Wet System
Fluid Characteristics

- an aqueous enzyme surfactant fluid.
- a combination of enzymes, surfactants and water with a pH ~ target of (7-9).
- a environmentally friendly enzyme fluid that is non-toxic and biodegradable.
Test Data

- Online at www.jumpstartenergyservices.com
- Successful core fluid tests with PTS Labs at 5% and 2% concentrations.
- Antek Labs report (S. America). Note: translated version to be posted shortly.
- Intertek Labs test.
- Ongoing tests in Texas, Middle East and S. America.
- Proposed combined tests in WY with Bio Resources.
Table 2
Bulk Properties

Project: WTC-10-001811 - Oil Characterization
Customer: Jumpstart Energy Services - John Gray
Well: VARIOUS
Sample: 131929

<table>
<thead>
<tr>
<th></th>
<th>Before Treatment</th>
<th>After Treatment</th>
<th>Method</th>
<th>Temperature</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>0.9304</td>
<td>0.9057</td>
<td>ASTM D4052</td>
<td>180 °F</td>
<td>g/cc</td>
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<tr>
<td>API Gravity</td>
<td>13.8</td>
<td>17.4</td>
<td>ASTM D4052</td>
<td>60 °F</td>
<td>Deg API</td>
</tr>
<tr>
<td>Viscosity</td>
<td>105.73</td>
<td>69.51</td>
<td>ASTM D7042</td>
<td>180 °F</td>
<td>cP</td>
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<td>Viscosity</td>
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<td>76.75</td>
<td>ASTM D7042</td>
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<td>cSt</td>
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<tr>
<td>IFT</td>
<td>25.53</td>
<td>1.95</td>
<td>ASTM D971</td>
<td>180 °F</td>
<td>mN/m HMC*</td>
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<td>IFT</td>
<td>25.44</td>
<td>2.02</td>
<td>ASTM D971</td>
<td>180 °F</td>
<td>mN/m ZWC*</td>
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</table>

* HMC = Huh-Mason Correction; ZWC = Zuidema- Waters Correction
Minimal Equipment

- Simple pumper and a water truck.
Bio Resources Overview

- Existing sales in Rockies area with Bio-Klean.
- Production enhancement.
- Paraffin control.
- Oil remediation utilizing microbes.
- Treatment of salt water disposal wells.
- H2S abatement.
- Salt spill remediation.
- Worked with RAM Biochemicals on project for treating American Warrior wells in Kansas (paraffin control).
## American Warrior
MEOR Project
2011 Sales Report

### AMERICAN WARRIOR - MEOR TREATED PROJECT WELLS

<table>
<thead>
<tr>
<th>Lease Name</th>
<th>Pre-MEOR Period</th>
<th>Pre-MEOR Period Avg Monthly Sales BBLS</th>
<th>Post MEOR Period</th>
<th>Post MEOR Period Avg Monthly Sales BBLS</th>
<th>Additional Sales in 2011 @ $70 / BBL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Josephine S. Burchett B-1</td>
<td>2009-2010 [48 months]</td>
<td>46.02</td>
<td>2011 [7 months]</td>
<td>46.97</td>
<td>$465</td>
</tr>
<tr>
<td>H.H. Wulfemeyer B-1</td>
<td>2009 [12 months]</td>
<td>42.53</td>
<td>2011 [7 months]</td>
<td>71.67</td>
<td>$14,279</td>
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</tbody>
</table>


2011 MEOR TREATMENT COST = $7,500

TOTAL ADDITIONAL SALES IN 2011 @ $70 / BBL = $47,294
Some Advantages of Microbe Paraffin Control

*Puts more oil in sales tanks!*

- Reduces tank bottoms in tanks and buildup in flow lines.
- Reduces/eliminates H2S.
- Increases pump, rod and tubing life.
- Improves corrosion control.
- Reduced electricity costs with less paraffin weight.
- Removes oil hot oiling / skin damage.
- Removes old frac gel and skin damage.

*Clients see significant return on investment for money spent!*
Enhanced Oil Recovery

Enhanced Oil Recovery Methods

GAS (Miscible/Immiscible)
- CO₂
- Hydrocarbon
- Nitrogen
- Flue Gas
- Air

THERMAL
- Steam (soak, drive)
- Combustion (in situ)
- Hot water

CHEMICAL
- Polymer
- Alkaline/Caustic
- Micellar/Polymer
- Surfactant (foam)

OTHER
- Microbial
MEOR Overview

- Used to address a variety of production problems.
- Can be applied to single wells individually and to multiple wells by enhanced water flooding.
- Used to solve oil production problems and economically produce stranded oil.
- Some of the mechanisms that produce stranded oil are similar, but the materials used and application methods differ.
MEOR DIAGRAM

Microbial System + Bio-available Nutrient Injection / or

Bio-available Nutrient Injection

in situ microbial production of biochemicals & gasses

additional oil recovery
Plawowice Oil Field, Poland - Collaborative Effort

POGI – Polish Oil & Gas Institute
  Laboratory Evaluations
  Project Development
  Monitoring & Oversight (after microbial system injection)

POGC – Polish Oil and Gas Company
  Oil Producer
  Microbial System (MS) and Nutrient Injections
  Production Data

RAM – RAM Biochemicals, Inc.
  Produced Microbial System Materials
  Nutrient Evaluation & Augmentation
  Project Design & Assisted with Project Development
  Developed Application Protocols
  Project Coordination & Oversight (through MS injection)
Project Development
Systematic Approach

- Reservoir Characterization & Assessment
  - (geophysical, geo-chemical, oil saturation, injectivity)
- Selection Matrix Applied - MEOR Candidate [Yes / No]
- Oil / Water Analysis
  - (chemical & microbial)
- Microbial System (MS) & Nutrient Customization
- MS Recovery Factor Evaluated (core studies)
- Go / No-go for Field Implementation
- Project Design & Development
  - (MS manufacturing / application protocols)
- Field Application / Implementation
  - (inoculation & feeding)
- Monitor / Analyze
- Adjust / Optimize
## RESULTS

[BT] BEFORE TREATMENT

Plawowice Oil Field – Microbial Enhanced Water Flood
BT = Before Treatment Production

<table>
<thead>
<tr>
<th>Injector P311</th>
<th>Production Months</th>
<th>PI-52</th>
<th>PI-159</th>
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<tbody>
<tr>
<td></td>
<td>Oil</td>
<td>Water</td>
<td>Oil</td>
</tr>
<tr>
<td>2011 Jan</td>
<td>1</td>
<td>29.3</td>
<td>0</td>
</tr>
<tr>
<td>2011 Feb</td>
<td>2</td>
<td>64.2</td>
<td>0</td>
</tr>
<tr>
<td>2011 Mar</td>
<td>3</td>
<td>62.4</td>
<td>0</td>
</tr>
<tr>
<td>2011 Apr</td>
<td>4</td>
<td>26.6</td>
<td>0</td>
</tr>
<tr>
<td>2011 May</td>
<td>5</td>
<td>41.1</td>
<td>0</td>
</tr>
<tr>
<td>2011 Jun</td>
<td>6</td>
<td>36.7</td>
<td>0</td>
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<tr>
<td>2011 Jul</td>
<td>7</td>
<td>33.7</td>
<td>0</td>
</tr>
<tr>
<td>2011 Aug</td>
<td>8</td>
<td>24.1</td>
<td>0</td>
</tr>
<tr>
<td>2011 Sep</td>
<td>9</td>
<td>37.4</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>355.5</td>
<td>0</td>
<td>578</td>
</tr>
<tr>
<td>Average BT</td>
<td>39.5</td>
<td>0</td>
<td>64.2</td>
</tr>
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</table>

Production in Metric Tons/Month
Plawowice Oil Field – Microbial Enhanced Water Flood
AT = After Treatment Production

<table>
<thead>
<tr>
<th>2011</th>
<th>Time [months]</th>
<th>Pi-52</th>
<th></th>
<th>Pi-159</th>
<th></th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Oil</td>
<td>Water</td>
<td>Oil</td>
<td>Water</td>
</tr>
<tr>
<td>Oct</td>
<td>1</td>
<td>55.5</td>
<td>0</td>
<td>100.3</td>
<td>7.1</td>
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<tr>
<td>Nov</td>
<td>2</td>
<td>43.6</td>
<td>0</td>
<td>75.8</td>
<td>6.8</td>
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<tr>
<td>Dec</td>
<td>3</td>
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<td>45.6</td>
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<tr>
<td>Jan-12</td>
<td>4</td>
<td>51.7</td>
<td>0</td>
<td>75.3</td>
<td>9</td>
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<tr>
<td>Feb</td>
<td>5</td>
<td>44.8</td>
<td>0</td>
<td>63</td>
<td>6</td>
</tr>
<tr>
<td>Mar</td>
<td>6</td>
<td>44.1</td>
<td>0</td>
<td>75.2</td>
<td>8.2</td>
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<tr>
<td>Apr</td>
<td>7</td>
<td>42.9</td>
<td>0</td>
<td>73.1</td>
<td>9</td>
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<tr>
<td>May</td>
<td>8</td>
<td>56.6</td>
<td>0</td>
<td>80.6</td>
<td>9.3</td>
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<tr>
<td>Jun</td>
<td>9</td>
<td>64.5</td>
<td>0</td>
<td>79.1</td>
<td>6.8</td>
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<tr>
<td>Jul</td>
<td>10</td>
<td>59.1</td>
<td>0</td>
<td>83.6</td>
<td>9.3</td>
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<tr>
<td>Aug</td>
<td>11</td>
<td>76.7</td>
<td>0</td>
<td>86</td>
<td>9.3</td>
</tr>
</tbody>
</table>

Total | 568.8 | 0 | 837.6 | 86.7
Average AT | 51.7 | 0 | 76.1 | 7.9
Average BT | 39.5 | 0 | 64.2 | 5.8
% Change | 30.9% | | 18.5% |
Incremental Oil Produced | 134.3 | | 131.5 |

Production in Metric Tons/Month
Pre-treatment vs Post-treatment Production

[11 months into the 18 month project]

PI-52 + 30.9% - 134.3 metric tons of incremental oil

PI-159 + 18.6% - 131.5 metric tons of incremental oil

Total = 265.8 metric tons (2 wells)

[7.15 bbls per metric ton = 1,900 bbls]

At $80 bbl = ± $152,000

RAM Biochemicals, Inc
info@rambiochemicals.com
www.rambiochemicals.com
1. Microbial enhanced water floods projects must be designed, developed and implemented systematically using evidence-based data.

2. In situ growth characteristics and nutrient requirements of the selected microbial system must be considered in light of its interaction with indigenous microbial populations (consortium).

3. Small-scale water floods (1 injector + 2 production wells) can produce a significant ROI.

4. Economies of scale predict larger ROI’s for larger projects.

5. All oil fields are unique. No EOR / MEOR method can predict results with absolute assurance. However, MEOR risks can be limited with proper design, development and implementation.
Get More Oil from Your Wells!