The Problem

The oil and gas industry estimates that between 50% and 75% of oil and gas reserves are left behind or remain in reservoirs due to the ineffectiveness or cost prohibitive nature of current extraction technologies and processes. A relatively small increase in percent of oil extracted from the Bakken, Eagle Ford, or Permian formations could result in significant value for exploration and production (E&P) operations (for example, as much as a 1% increase in the Bakken corresponds to roughly 4 billion barrels of oil in 2016). Since drilling new wells is marginally economical in comparison to extracting more hydrocarbons from existing wells, operators are placing a greater emphasis on exploring methods to tap this valuable resource.

The Solution

RTI has developed FloShell™, a proprietary encapsulation technology platform that enables controlled, inside-out release of chemicals intended to improve oil and gas production and well profitability. Customizable nano- and micro-sized core-shell particles enable delivery of oil field chemistries with the ability to optimize for particle size, timing and mechanism of release and cargo load. Target application parameters will influence choice of cargo and shell chemistries.

Value Proposition

Increased oil production
With deeper penetration of chemicals into the reservoir, more oil can be released from the rock and recovered, improving per well profitability.

More efficient and environmentally friendly use of chemicals
Oil field chemistries are not diluted or contaminated by bore hole or drilling mud fluids, requiring lower volumes of chemicals to be released into the environment.

Customizable drilling and chemical delivery programs
Encapsulation parameters can be customized to meet a specific reservoir need.

Technology applications
- Fracturing
- Enhanced Oil Recovery (EOR)
- Cementing
- Corrosion Control

RTI’s FloShell™: Improving efficiency of new and existing wells

FloShell™ offers oil and gas producers:
- increased well production potential
- improved efficiency of chemical use
- customizable drilling programs
- deeper well penetration of encapsulated cargo
Core-Shell Particles for Engineered Delivery

RTI’s nano- and micro-sized core-shell particles are optimized according to cargo volume, chemistry, desired delivery mechanism, and location for varying well conditions. Technical specifications will change based on cargo and shell chemistries due to variations in formulation compatibility. The following table includes a comparison of nano- and micro-particle sizes, coordinating chemistries, and advantages offered by each.

<table>
<thead>
<tr>
<th>Particle Type</th>
<th>Size Range</th>
<th>Coordinating Chemistries</th>
<th>Advantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nano</td>
<td>50-500nm</td>
<td>breakers, cross linkers, surfactants, emulsifiers, tracers (e.g. fluorescent dyes, other nanoparticles), bactericides</td>
<td>finer placement control, targeted delivery, deeper permeability into the reservoir</td>
</tr>
<tr>
<td>Micro</td>
<td>500nm - 100µm</td>
<td>strong acids/acidizing agents, surfactants, lubricants, viscosifiers, tracers, scale inhibitors, corrosion inhibitors</td>
<td>higher cargo volume delivery, higher core to shell ratio optimized for in or near-well bore</td>
</tr>
</tbody>
</table>

FloShell™: Delivery of encapsulated chemistry for downhole oil and gas applications

Well Conditions
- Depth: 7,500 - 10,000 ft
- Temperature: 40º F to 300º F
- Pressure: 10 psi to 15,000 psi
- Salinity: 60,000 PPM to 200,000 PPM

Notable FloShell™ Development Efforts

Encapsulated HCl
Strong (6M) hydrochloric acid was successfully encapsulated in polymer microparticles. The particles demonstrate delayed release versus conventional acidizing treatments for carbonate dissolution in 60ºC and API Brine.¹

Chromium Crosslinker
Nanoscale particles containing chromium are deployed to delay polymer crosslinking mechanisms in waterflood applications for improved product placement and efficacy. Particles average 300nm in diameter and have been evaluated in up to 50ºC in API Brine.²,³

Zone 1: Cased Zone
Corrosion inhibitors, fines control
Chemistries used in the cased zone may be used to protect metal drill string components and in-line filters.

Zone 2: Non-Perforated Zone
Drilling lubricants, tracers
Chemistries used in the non-perforated zone may be used to protect drilling components or monitor progress.

Zone 3: Perforated Zone
Acids, surfactants, polymers, catalysts
Chemistries used in the perforated zone are intended for reservoir management and EOR.

For More Information
RTI is presently seeking co-development and partnership opportunities for FloShell™. Contact Ginger Rothrock at grothrock@rti.org or 919.541.6025 to learn more about our encapsulated chemistries for oil and gas production.


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