UNCONVENTIONALS

CASE STUDY

Multi-Well Trial Demonstrates Enhanced Productivity Using RockOn® Surfactant

ROCK-ON-A-CHIP™ MICROFLUIDIC DEVICE EFFICIENTLY EVALUATES RELATIVE EFFECTS OF SURFACTANTS IN THE LAB

TEXAS, UNITED STATES

CHALLENGE

- Mobilize fluid flow through tight pore shale rock
- Reduce cost of hydraulic fracturing
- Improve efficiency of fracturing fluid evaluation

SOLUTION

Use Rock-on-a-Chip™ microfluidic device to:

- Directly visualize rock properties at the pore level
- Quickly screen surfactants for optimal production

RESULT

- Validated Rock-on-a-Chip microfluidic device findings produced in the lab to be accurate when field tested
- Use of RockOn® surfactant led to:
  - Higher oil recovery
  - Enhanced productivity
  - More efficient surface cleanup

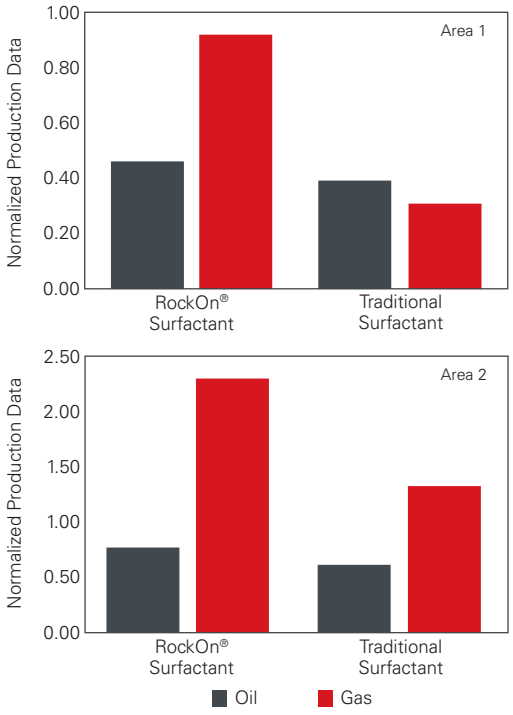
OVERVIEW

Variations in mineralogy, hydrocarbon and connate water requires careful tuning of fracturing fluid additives to maximize oil and gas recovery. Meticulous selection often is sacrificed for expediency due to time limitations of current analytical methods. Multi-Chem's laboratory services has improved this process with emerging advancements in nanotechnology and microscopy, significantly reducing analysis time and requiring decreased sample size.

A field trial was recently conducted in the Eagle Ford Shale, across 45 wells completed with similar design criteria, mineralogy, and frac fluid design, to test performance of the fracturing fluid surfactant selected in our lab via a new technique—Rock-on-a-Chip™ microfluidic device. This technique allows most geometric features observed in shale formations to be recreated digitally through photolithography and etching methods onto the "fingernail-sized" device, for the purpose of investigating fracturing fluid invasion, flowback and hydrocarbon recovery during well stimulation. This method is ideally suited for direct visualization of oil recovery with various surfactant fluids.

Initially, a lab experiment using the Rock-on-a-Chip microfluidic device approach compared a traditional surfactant to Multi-Chem's RockOn® surfactant exposed to the same driving pressure. The RockOn surfactant was found to be more effective, with higher oil recovery efficiency. Data was then validated by the field study, in which similar fracturing strategies were applied to wells in two separate areas over a period of 90 days. These results confirmed the lab finding, with RockOn surfactant outperforming traditional treatments for both oil and gas.

Averaged 90-Day Production Chart



Averaged 90-day production data for 45 wells studied in two Eagle Ford Shale areas, indicating RockOn® surfactant yielded more production than traditional surfactant.

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ROCK-ON-A-CHIP™ MICROFLUIDIC DEVICE BENEFITS

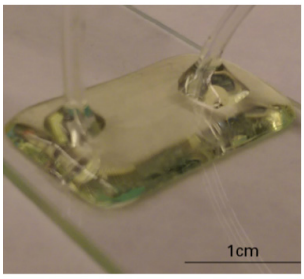
The Rock-on-a-Chip microfluidic device essentially provided rapid visualization through customizable fluid paths, mimicking the formation and fluid flow during fracturing operations. The following capabilities, showcased in this lab service and field trial, will potentially help other unconventional reservoirs:

- Address the multi-lithology complexity of unconventional resource formation difficulties in defining rock wettability and hydraulic flow patterns (particularly at the pore vs. fracture levels that affect the hydrocarbon producibility)
- Pattern homogeneous and heterogeneous networks to represent the formation matrix with well-controlled surface chemistry and pore size
- Model larger micrometer-sized channels to represent the natural or hydraulically stimulated fractures
- Simulate the dual surface affinity of shales—attributable to the presence of both organic matter (kerogen, oil-wet) and inorganic clay (water-wet)—by altering the wetting conditions through additives or deposition of the nanomaterials

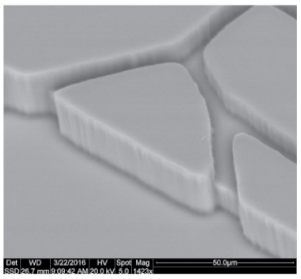
ROCKON SURFACTANT OUTPERFORMS TRADITIONAL SURFACTANT

This was the first time that the Rock-on-a-Chip device approach was used to screen surfactants in the lab for optimizing production of an unconventional shale play. While traditional techniques such as core flood could take days to yield a recommendation, tests using the Rock-on-a-Chip microfluidic device only took a matter of a few hours to arrive at the best fracturing fluid option. In this case, RockOn surfactant was found to have better oil displacement efficiency than traditional surfactant. Furthermore, the RockOn surfactant was proved to indeed be the right choice as evidenced by actual field production data, averaged across multiple wells and sections studied in the Eagle Ford Shale.

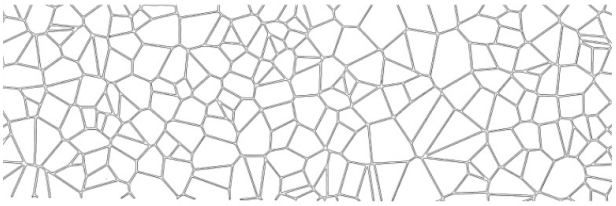
Rock-on-a-Chip™ Device



Inlet Channel



Homogeneous Pattern



Inlet Channel: *Micrometer-sized channels can be modeled to represent the natural or hydraulically stimulated fractures.*

Homogeneous Pattern: *Homogeneous and heterogeneous networks can be patterned to represent the formation matrix.*

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