Particulate oil tracers vs liquid-form oil tracers

How liquid-form oil tracers generate false-positive results: a laboratory demonstration

Oil-soluble tracers are placed into fractures of multistage wells during stimulation to provide important stage-specific diagnostic information. They function by preferentially partitioning (dissolving) only into the oil phase of formation fluids. Laboratory analysis of produced oil samples quantifies the amount of each tracer recovered from the well, permitting relative oil contribution from each stage to be determined. Oil-soluble tracers were originally deployed in liquid form, which is still commonly used.

A recognized disadvantage of liquid-form oil tracers is that unpartitioned liquid-form oil tracers can be transported from fractures to the wellbore by formation pressure and water flow. In the wellbore, unpartitioned liquid-form oil tracer from one stage will partition into oil from other stages during transit to the wellhead. When produced oil samples are analyzed, the amount of tracer recovered will result in "false positives" that over-represent the amount of oil produced from that stage and can even indicate oil production where there is none.

OST particulate oil tracers

NCS Multistage Tracer Diagnostics[1] introduced OST™ particulate oil tracers in 2014 to address the issue of false positives. These tracers are manufactured using a proprietary process in which tracer chemical is adsorbed onto highly porous[2] activated charcoal particles. These particles are injected during well stimulation and are embedded in propped fractures. OST tracer chemicals are extremely hydrophobic (K_{ow} values as high as 45,000) and can only be desorbed from the carrier particles by direct contact with hydrocarbons. Since the particles are immobile and water cannot trigger tracer release, OST tracer recovery is related to the mass of oil flowing around the tracer particles and is therefore proportional to oil contribution from each traced stage.

Laboratory demonstration

To demonstrate the undesirable mobility of unpartitioned liquid-form oil tracers, two "fracture beds" were prepared by packing columns with Ottawa sand. OST 2910 particulate tracer was placed on top of one sand column, and an equal mass of the same tracer in liquid form was placed on top of the other sand column. To simulate water production from a reservoir, an equal volume of pure water was pumped through both columns at the same pressure and rate. The "produced water" from each column was collected in four successive 5mL samples to represent early, post-frac flowback. The samples were then analyzed using high-resolution mass spectrometry, which detects OST tracer chemicals in parts-per-billion concentrations.

Results

The water samples collected from the simulated fracture bed with OST particulate oil tracer contained no detectable oil tracer; the samples from the other column contained 4 ppm, 11 ppm, 15 ppm, and 15 ppm of liquid tracer, respectively, demonstrating that pressure and flowing water can force liquid-form oil tracers out of a propped fracture and into a wellbore—even in the absence of hydrocarbon flow.

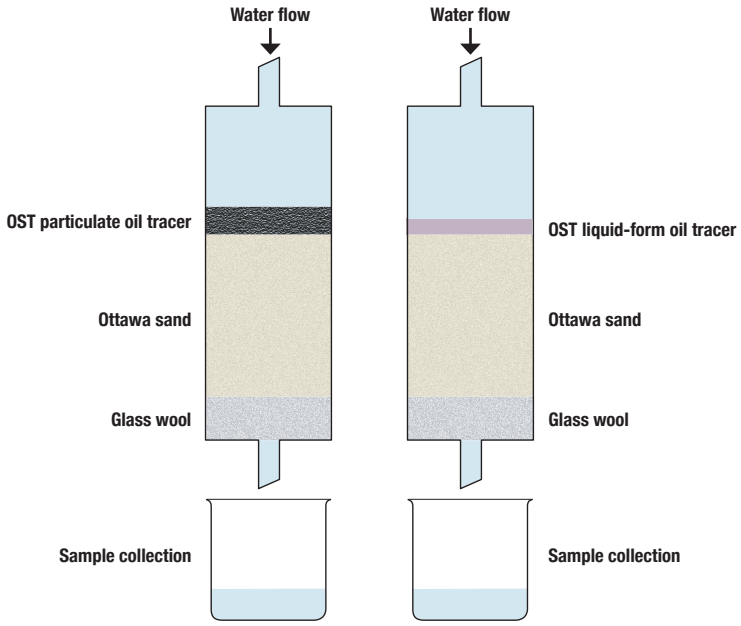
	Unpartitioned Tracer Detected, ppm			
	Sample 1	Sample 2	Sample 3	Sample 4
Particulate column	0	0	0	0
Liquid-form column	4	11	15	15

Water flowing through the simulated fracture bed mobilized no tracer chemical from the particulate-form, while significant concentrations of liquid-form tracer chemical were detected in all four samples.

Recommendation

Since 2014, patented OST particulate tracers have delivered long-term, reliable diagnostic data in thousands of wells in major basins throughout the world. Given the inconsistent results and false positives typical of liquid-form oil tracers, NCS Multistage Tracer Diagnostics recommends particulate OST tracers for all oil tracing applications.

[1]Formerly Spectrum Tracer Services, acquired by NCS Multistage in 2017.
[2]One gram of activated charcoal presents more than 32,000 ft2 of surface area.



Simulated fracture beds were prepared by packing Ottawa sand into an empty column and layering either particulate or liquid-form oil tracer on top. The beds were then washed with water to simulate water production, and collected water samples were tested for tracer content.

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