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Innovative Ideas For EOR Presented At SPE Symposium

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I attended the Society of Petroleum Engineers' biennial Improved Oil Recovery Symposium (SPE-IOR) in April. I am admittedly biased in believing it to be the best meeting on this topic in the world. It is focused, compact, international, and diverse in many ways. Researchers intersect with technology providers, who intersect with technology users. New trends and developments are explored and improvements in tried and true technologies are discussed.

With the price of oil consistently high over the past few years, there is a resurgence in enhanced oil recovery applications. New ideas are being introduced. Here are three developments I found interesting–even compelling–from this meeting. I have addressed others in earlier columns.

Low salinity waterflooding was a dominant topic. Known for 20 years, "low-sal" flooding has had few intentional applications until the past few years, and only recently has the literature reflected this interest. Reports of pilot studies by the majors were daunting in preparation for major applications in both subsea and terrestrial reservoirs. British Petroleum has tried 150 applications. Such massive field applications merit a lot of detailed and expensive laboratory and field measurements on tests, creating a wealth of data. Hopefully, a better understanding will come from these efforts. Lowsal flooding has not yet yielded a consensus mechanism, although many aspects are being studied.

Some general guidelines for candidate reservoirs are a significant clay fraction, the presence of connate water, and mixed wettability conditions, but these are not sufficient. The concept is simple: Flooding with low salinity water can destabilize oil layers in pores, causing them to detach and accumulate in the pore in a water continuous phase. In other words, it alters the rock wettability.

Low-sal flooding also can reduce the produced water fraction, and can decrease hydrogen sulfide production while increasing oil production. BP reported an average 12 percent increase in oil production from its applications. Complications can include freeing clay particles as fines or swelling clays, which can plug reservoirs.

As with most extraction methodologies, one must have knowledge about the reservoir. We never know enough.

Smaller applications in older, watered-out fields should have success in appropriately targeted reservoirs. I am not expert in picking them, but a trial flood of reduced-salinity water could result in a lower water cut and less souring with increased production. If reservoir cores are available, core floods might be worth the investment. One paper showed poor correlations with outcrop cores likely caused by weathering. Like any new trend, it is important to be current in the literature, and there has been a significant number of publications in the last two-three years. Talking with the real experts is always in order.

The incremental cost is low for onshore applications, if one has a source of low-salinity water. The risks are clay swelling, water sourcing, and possibly produced water management, especially if treatment is required to recycle water. Some tests indicated a quick return to original production characteristics if the original waterflood conditions were re-established. There is a lot more to be learned about low-salinity flooding. Three SPE papers I recommend to gain some background are 154236, 154209 and 153933, all of which were presented at SPE-

IOR.

Another technology that surprised me was TIORCO's alkali surfactant polymer (ASP) formulation design for heavy oil. ASP floods have been tried in many reservoirs, but TIORCO reported on the flood design for a client with high potential without using steam or solvent flooding. It suggested recoveries up to 80 percent might be attainable under certain conditions. The design mechanism combines phase behavior and interfacial tension optimization. SPE paper 153570 describes the design.

Microbial enhanced oil recovery (MEOR) was the topic of only one paper, but I was impressed with the sophistication of the approach. Decades ago, several approaches involved pumping nutrients into reservoirs to grow in situ bacteria to accomplish one or another task. Often, nutrients were flooded into high-permeability zones to let the bugs plug those areas for mobility control or other purposes. Later, more selectivity in nutrients allowed some discrimination on which bacteria were stimulated.

Titan Oil Recovery reported on a Texas MEOR flood in the Big Wells Field with a targeted bacteria population that released a surfactant that modified the interfacial tension. That allowed the breakup of oil droplets in the reservoir, which released up to 10 percent of the original oil in place. Titan used a simple huff-and puff treatment of only 100-barrel slugs. It saw results in four-five months with 10-20 barrels a day. The reservoir was water-wet sandstone. The treatment was simple, the science was complex, the cost was $6-$10 per barrel of oil, but the average of all wells was a 102 percent oil increase. The magic is in Titan's proprietary knowledge. SPE paper 154216 describes its efforts.

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