Nanochemistry Drives New Method for Removal and Control of Wax

Dauren Tukenov, SPE, Diversitech

Paraffin wax precipitation and deposition is one of the pervasive nuisances in oil industry operations worldwide, with wax deposits creating problems from the wellhead to the refinery.

Up to 85% of the world's oil is adversely affected by paraffin wax precipitating out and solidifying at the wellbore, in tubing, perforations, pump strings, and rods, and throughout the transfer system of flowlines and pipelines (**Figs. 1a, 1b, and 1c**). Precipitation and deposition causes equipment failures, bottlenecks upstream and downstream, and loss of production, transport capacity, and storage.

Because of paraffin wax deposition, thousands of wells are shut in, numerous pipelines blocked, transport vessels taken out of service, tanks locked in, and refinery equipment shut down at any given time globally, all resulting in loss of revenue.

Common remedies such as the application of hot oil or hot water, mechanical scraping, and solvent cleaning can be cumbersome, costly, and hazardous. They also are effective only for short periods and soon need reapplications.

Paralax, a novel chemical treatment that controls wax precipitation, was developed by a small United States-based engineering firm that has been acquired by Diversitech Holdings. The treatment does not fit conventional wax-control chemical definitions. More than a dispersant, solvent, or inhibitor, the chemical works when mixed and activated with crude oil by a proprietary nanochemical mechanism and attacks wax differently.

Flushing wax with activated crude oil removes the wax by layers and creates a waxophobic (wax repelling) condition for an extended period. The chemistry is also environmentally friendly, being nontoxic and nonvolatile, and the activator is safe to handle. Spills can be washed down and no special handling requirements are needed.

The advantages of activated crude oil treatment over other dewaxing methods are

- Significantly less labor for wax control, freeing personnel for other important tasks
- Significantly less frequency of treatment
- "Smart chemistry" that works by itself for 2 to 3 months after treatment when accompanied by proper maintenance to replenish waxophobic nanostructures

The benefits of the post-treatment waxophobic condition are

- Extension of wax-free production time of up to 3 months
- Lower load on pump, rod, and drive
- Fewer workovers caused by wax, such as pump hang-ups and broken rods
- Better well performance because of less wax in the tubing

Case Study: Subsea Pipeline

A dewaxing treatment was performed to clear a 28-mile, 8-in.-diameter subsea oil pipeline in the US Gulf of Mexico. Wax in the pipeline had gradually built up over 7 years and very aggressively in the final year. Various efforts had failed to prevent the buildup.

Fig. 1—The effect of wax deposition is shown on (a) a well tubing string, (b) a cross-section of a flowline, and (c) the inside of a tubular. *Photos courtesy of Diversitech.*

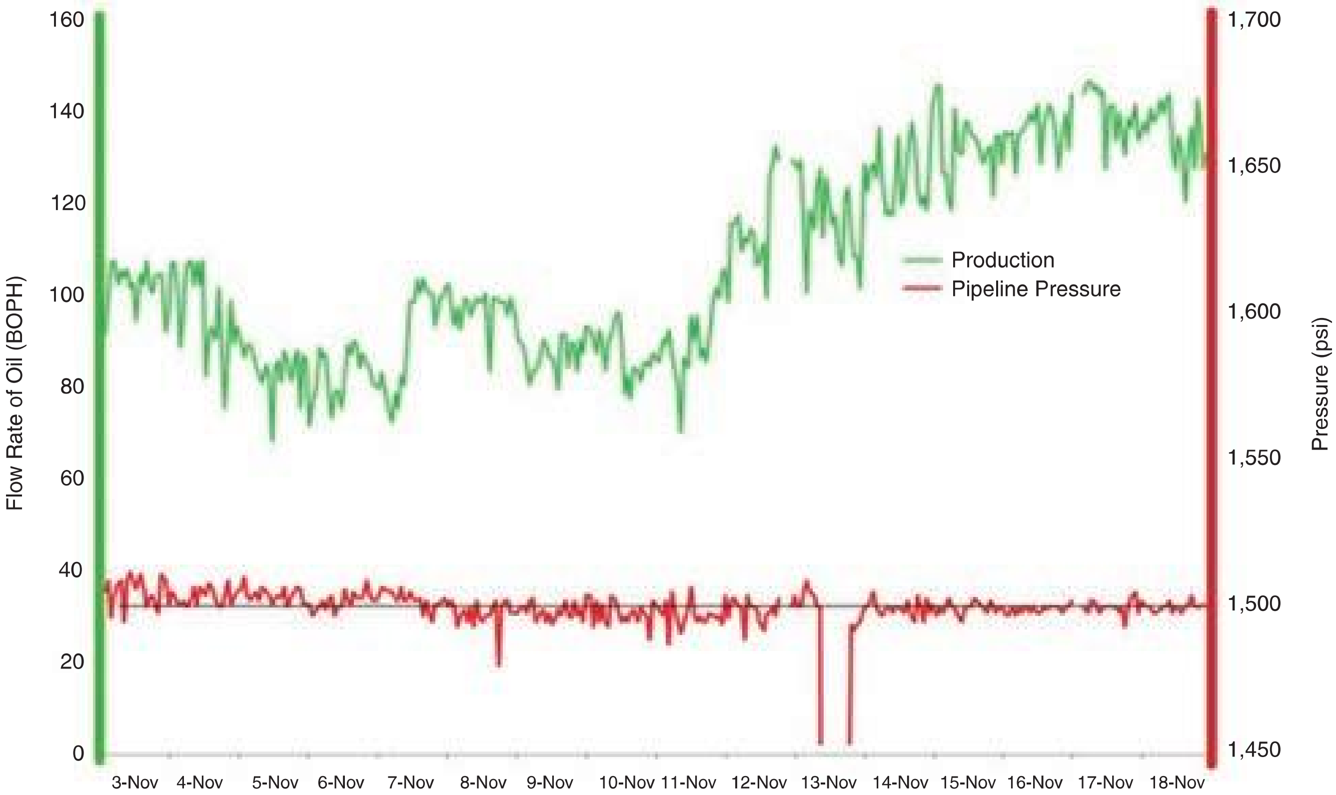

Fig. 2—The improvement in the flow rate of a subsea oil pipeline in the US Gulf of Mexico during wax removal with the Paralax waxophobic nanochemical treatment. *Graph courtesy of Diversitech.*

A drag reducer chemical had been used over the past year, which eliminated turbulence in the pipe and reduced pumping pressure by 200 psi. Pipeline pressure cannot exceed maximum working pressure, which limits flow rate as pipe throughput diminishes. Because of declining pipeline flow rate capacity, some wells had to be taken off line to avoid spills and overflows.

A special version of concentrated activator is designed for the removal and control of pipeline wax. The activator concentration of 400 ppm was injected at pump suction. The use of a drag reducer was initially continued. After 7 days of pumping, the operator was advised to stop using a drag reducer because it overcomes the turbulence needed for activated oil to aggressively attack the wax.

As a result of the wax-removal treatment, pipeline throughput increased from 80 bbl of oil per hour (BOPH) to 140 BOPH in the first 2 weeks (**Fig. 2**). The activator concentration during wax removal ranged between 400 ppm and 550 ppm. For wax control, the concentration was lowered to a range of 50 ppm to 100 ppm.

Case Studies: Central Asia

Pump-driven well. Oil is produced from a 2,850-ft well in Kazakhstan drilled in a sandstone formation in which all components of the crude oil remain in solution. The primary drive mechanism of production is a progressive cavity pump (PCP) that lifts oil up the tubing to the surface. Oil production causes a drop in temperature, which results in the dissolved wax solidifying and dropping out of the oil.

The wax deposits on the tubing walls create several problems. They are

- Resistance to oil flow, causing well production to underperform
- Resistance to rod/shaft movement, resulting in high torque on the pump shaft and high amperage current on the pump motor
- Pump failure caused by shaft or rod breakage, necessitating a workover
- The need for hot oil treatments every 7 to 10 days

The PCP flow was diverted from the flowline to the annular space, creating a closed-loop "tubing annulus." As 27 gal of the activator was slowly dosed into the flow loop, the annulus functioned as a fluid mixing tank and eliminated the need for additional equipment.

The well production of 170 BOPD at 300 rev/min increased to 378 BOPD at 300 rev/min after the treatment. To reduce the risk of sand and water incursion, the operator lowered the pump rate to 250 rev/min, resulting in a stabilized, long-term production of 265 BOPD. After 12 weeks, production remained at this level with no early indications of wax reappearing.

The operator was able to recover the treatment cost after 2 days of incremental production, an exceptional result that exceeded all expectations. Typically, the treatment cost is recovered in 1 to 2 weeks.

Wax-removal treatments can be modified to optimize results from wells operating on sucker rod or electrical submersible pump drive.

Gas lift well. Wax-removal and -control procedures have been developed and applied for flowing and gas lift wells. The major difference from the treatment of pump-driven wells is that packers at the end of the tubing prevent circulation in a closed-loop "tubing annulus." This also makes hot oil and hot water treatments impossible.

Conventional wax-removal treatments in flowing and gas lift wells use slickline units equipped with a gauge cutter to cut wax from the tubing walls every 4 to 7 days. To supplement this with the use of the waxophobic nanochemical treatment, activated oil is injected into the formation for additional wax removal and control, which can extend wax-free production time for weeks.

In a 12,250-ft well on gas lift in Turkmenistan, 110 gal of the activator was injected into the formation, resulting in 13 weeks of wax-free production and treatment cost recovery in 11 days.

Summary

The waxophobic nanochemical treatment is able to improve performance in wells, pipelines, and other facilities affected by wax precipitation and deposition, thus lengthening the time between wax-control applications. In wells, the treatment can considerably extend the period of wax-free production.

The use of these treatments reduces the need for workovers, places lower loads on pumps and drive systems, and typically costs much less than conventional wax-removal and -control treatments. In addition, the activation chemical is safe to handle, is nontoxic and nonvolatile, and if spilled, can be washed down without threatening the environment. **JPT**