

Advanced biotechnology alleviates wax-related flow assurance problems in Kazakhstan Field

Cold weather brings with it a lot of winter-related problems to oil producers, and flow assurance is among the most challenging. Flow assurance for oil lines is always critical, and low temperatures worsen many flow-related problems. Crude oil loses heat and pressure as it reaches the surface and enters surface facilities. That can trigger many of the heavy components to precipitate out in tubulars, lines and tanks. The result is manifest in plugged flow lines, waxy tank bottoms and frequent interventions, including well pulls, hot oiling and line pigging.

Micro-Bac International, Inc., a 23-year pioneer in oilfield biotechnology, put new-generation biologicals to the test in Kazakhstan. The Uzen oil field is the second largest field in Kazakhstan with original oil reserves greater than 1.1 billion tons. Oil produced in the Uzen field is highly paraffinic. Pour points of the oil approach 40°C and wax appearance temperatures as high as 65°C are common. Flow assurance in the field is challenging because the field is located in a geographical area that often has low ambient temperatures and "winter-type" conditions for several months of the year. This harsh climate adds to the difficulty of producing the highly paraffinic oil. As part of a field rehabilitation program, Micro-Bac was invited to test the effectiveness of biologicals to control paraffin-related problems. Objectives were to minimize paraffin-related operating expenses and moderate the steep decline in oil production rates.

Unique challenges

Paraffinic oils are particularly problematic in cold environments. Paraffin waxes are a natural component of crude oils, and are comprised primarily of the alkane fraction of the oil from C₁₆ and higher. As the molecular weight of the paraffins increases, these compounds become progressively less volatile and higher in viscosity. In crude oil, paraffins contribute to oil viscosity and lower oil mobility. Higher molecular weight paraffins have high melting points. Uzen field produces paraffinic oil with alkanes through C₁₀₀ and residue greater than C₁₀₀ making up more than 20 percent (mass % by GC analysis) of some samples. As the oil cools, these compounds solidify in the oil and form microcrystalline aggregates that precipitate out of the crude. Paraffin accumulations in the production string caused increased failure of lift equipment, which increased operating costs and led to lost production and low revenue. On the surface, the cold climate of the region compounded the problems, which were evident in problems in flow assurance and transportation.

Recent advances in biotechnology have enabled development of high-activity microbial strains that target paraffins at the molecular level. Industrial cultures developed by Micro-Bac International are able to metabolize and shorten high molecular weight paraffins, according to the Director of Research at Micro-Bac International. Shortening the paraffin chains shifts the relative composition of the crude oil, reducing the amount of high-molecular-weight paraf-

ins, and increasing the amount of solvent in the oil. Upgrading of the oil, including increases in API gravity and decreases in wax appearance temperature and cloud point, frequently occurs with this reduction in the average molecular weight in the hydrocarbon component.

New-generation biologicals tested

Compared to traditional chemicals, microorganisms provide several distinct advantages for treating paraffin problems. Microorganisms injected into the wellbore and near-wellbore region colonize the treatment zone and can maintain activity for extended periods of time. They attach to surfaces where paraffin deposition is occurring and act directly at the site of deposition. Micro-Bac International's new-generation biologicals metabolize high-molecular-weight paraffins and improve quality of the oil. Metabolic products, including oil-mobilizing biochemicals, are continuously produced *in situ*. This sustained activity results in a longer-term effect than can be achieved with conventional chemical treatments. Moreover, microbial treatment of paraffin damage does not lead to formation damage, as is often the case with chemical and thermal methods.

A 50-well program was implemented to assess the efficacy of biologicals to alleviate paraffin-related problems. Forty-five wells received wellbore treatments to remove existing paraffin deposits and prevent new deposition in the wellbore, pump, production string and flowline. These wells were treated bi-weekly with annular batch treatments. Paraffin-related skin and formation damage were treated in five wells. These wells received matrix squeeze treatments with Micro-Bac International's biologicals to remove paraffin-related damage, open the formation to increased oil flow and improve flow properties. Several indicators of production and operations were monitored closely for 10 weeks.

Results

Data collected during the 10-week program indicate that biologicals were effective for controlling and remediating paraffin accumulations throughout the production system. Treatments with Micro-Bac International's biologicals led directly to fewer equipment failures and less downtime. Results from monitoring the number of hours per week that each well was producing revealed that the average production time increased by 13 percent after the biological treatment program was started. Not only did this reduce operating costs and well expenditures through fewer breakdowns, but the increased pumping time caused increased oil production as well. Oil production records from the 45 wells which received wellbore treatments showed a seven percent increase in oil production rates, primarily because more time was spent pumping oil. In wells that received matrix treatments, oil production rates stabilized at 40 percent above pretreatment levels.

Effects of the biological treatments carried over into the flowlines as the biologically treated oil entered the transportation

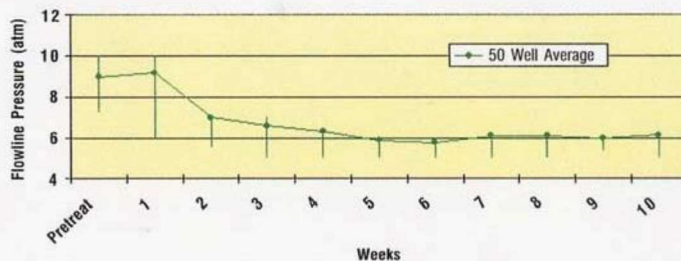


Figure 1.

system. One to two weeks after well treatments were started, measurements of flowline pressure began to record a decrease (see Figure 1). Biologicals added to producing wells continued to work throughout the production system to remove paraffin blockage and increase mobility of the oil. Data show that average flowline pressure decreased by 33 percent by the fifth week after treatments began, and stabilized at the lower level.

Treatments with Micro-Bac International's new-generation biologicals removed paraffin damage in the production system, improving the flow properties of Uzen's paraffinic oil. The benefits provided immediate savings in CAPEX and OPEX budgets. In addition, more on-line production time created more oil revenue.

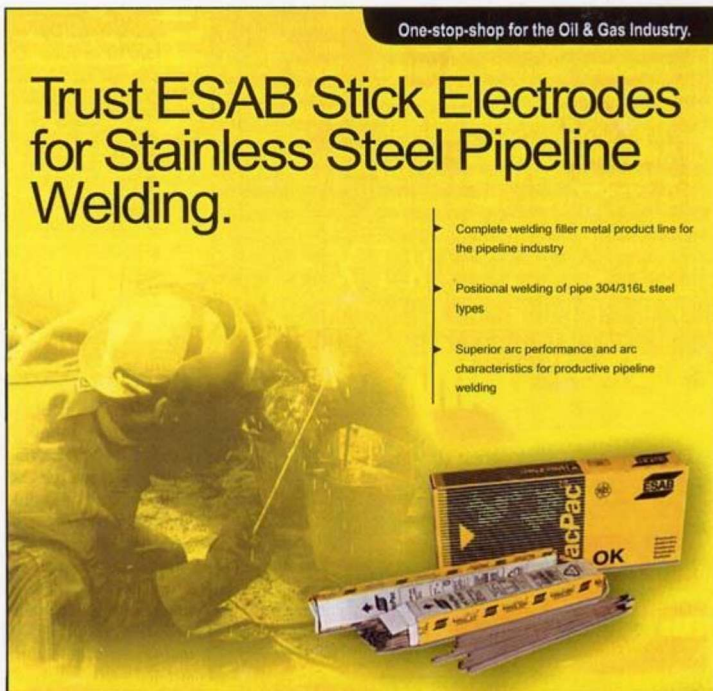
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