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Breaking the Decline: A New Paradigm for Injection Enhancement in Low-Temperature, Clay-Sensitive Reservoirs -Southeast Kuwait Case Study from the Greater Burgan Field

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Abstract

The Greater Burgan Fields, located in southeast Kuwait, represent one of the world's largest clastic reservoirs and have supported Kuwait's hydrocarbon production for nearly eight decades. As these mature assets continue to age, maintaining reservoir pressure has become increasingly reliant on effective water injection strategies. While several zones within the field have responded positively to conventional injection methods, specific intervals—particularly those with complex mineralogy—have exhibited persistent injectivity decline due to formation damage, reduced permeability, and incompatibility between injected fluids and in-situ clays.

The Upper Burgan reservoir, a fine-grained sandstone unit with elevated clay content, has been especially problematic. Despite multiple stimulation attempts utilizing conventional systems, injectivity deterioration continued to limit the efficiency of pressure support. Core analysis and mineralogical studies revealed the presence of swelling clays and fines, which, when contacted with standard injection brine or reactive acid systems, exacerbated pore throat blockage and compromised formation permeability. The reservoir's low temperature further restricted the applicability of traditional acid blends. To address these challenges, a novel single-stage acid stimulation methodology was developed, targeting clay stabilization, fines dispersion control, and formation damage removal in a single operational step. Laboratory evaluation focused on compatibility testing, permeability enhancement, and mineral dissolution efficiency using actual core material from the field. Two formulations were evaluated, with the selected solution demonstrating superior performance in restoring core permeability under representative temperature and brine conditions. The treatment was engineered to minimize in-situ precipitation reactions, reduce HSE risks, and simplify operational logistics by eliminating the need for multi-fluid sequences.

Field implementation was executed in a candidate well (Well A) which had exhibited a dramatic injectivity decline—from 800 bbl/day to below 100 bbl/day—despite continuous water injection. The treatment was deployed using a Coiled Tubing for accurate placement targeting the existing perforated interval. The stimulation procedure required no mechanical isolation or complex diversion systems, aligning with the reservoir's low-temperature conditions. Post-treatment diagnostics, including surface injection rate monitoring and Injection Logging Tool (ILT) surveys, HPT-SNL, confirmed a successful outcome. Injection

rates surged to 4,000 bbl/day with higher injection rates still possible—representing a 40-fold increase while ILT data verified enhanced fluid entry across the intended intervals with no signs of crossflow or unintended stimulation.

This application marks the first global field deployment of this low-temperature, low-risk single-stage sandstone stimulation system in a mature, clay-rich reservoir environment. The approach significantly simplifies the stimulation workflow while delivering robust injectivity improvement. It offers a scalable, cost-effective alternative to traditional sandstone acidizing techniques, especially in formations with complex mineral compositions and thermal limitations. Ongoing performance monitoring confirmed sustainability of the injection results spanning for more than 4 months. Preliminary outcomes indicate promising potential for broader field-wide implementation.