Core-Based Diagnostics of Sanding Prone Pay Zones in the Ordovician Sarah Sandstone Reservoir, Northern Saudi Arabia

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Abstract. Core-based laboratory studies and field observations are conducted on the Ordovician Sarah Sandstone reservoir in exploration wells of Northern Saudi Arabia to assess their sand production risk. The reservoir has been a target for gas exploration over the last several years.

The study was prompted by the field detection of sand production at early stage of the exploration. A comprehensive coring, logging and dynamic testing campaign was conducted to establish the driving factors for sand production, to facilitate effective prediction, mitigation, and management of sand production. The diagnosis involved rock mechanical, petrophysical, and petrographic characterization of core samples acquired from the reservoir zones, in the key wells where sanding occurred. Identifying the rock types, most at risk for sand production, was then linked to the key changes to in-situ reservoir parameters, whose change trigger sand production. Statistical geomechanical models were built to assess the pressure drawdown threshold at which sand production is likely to be triggered, and the results are calibrated against actual dynamic tests in key wells.

This paper presents the methods used and the outcomes of the integrated analysis and modeling. The results show that all reservoir zones that produced sand in the studied key wells are clean, fine- to coarse-grained sandstones with dominantly rounded to surrounded grains. They are all highly porous and permeable; poorly consolidated; poorly cemented; and mechanically weak rocks. Rock mechanical testing reveals that sand production occurs persistently when the above mentioned rock types are characterized by low Young's modulus, low unconfined compressive strength, and low cohesion. In the field, sand production in the key wells increases as the wellhead pressure decreases and as the drawdown pressure increases. Hollow cylinder (thick wall cylinder) tests on the cores acquired from sanding prone rocks confirms that rock weakening and catastrophic failure in the studied reservoirs is facilitated by the increase in confining pressure (with depletion), and the reduction in wellhead pressure due to production. Where multiphase fluids exist, sand production exponentially increases with water production, because water reduces the capillary pressure and weakens the rock, facilitating failure and sand production.