Special Issue: Recent Studies of Petroleum Wells and Reservoirs

From the Editor of Special Issue

This special issue of the Journal of Energy Resources Technology highlights 11 papers presenting studies into recent challenges in petroleum engineering. Most of the selected papers were presented at two ASME international conferences on Ocean, Offshore, and Arctic Engineering (OMAE)—31st OMAE in Rio de Janeiro, Brazil and 32nd OMAE in Nantes, France. Additional two papers have been added due to their relevance to the subject matter of special issue.

As the petroleum technology undergoes transition from conventional to unconventional so does the petroleum engineering as academic discipline—in teaching and research. The transition process is driven by demand for extracting new subsurface sources of energy (geothermal), producing petroleum from the source rock (shale), or from new types of reservoirs (tight rocks and deep water), or adopting the wellbore technology for subsurface disposal/storage of pollutants (CO2 sequestration).

The papers have been organized by major areas in petroleum engineering: well drilling, production and stimulation, production systems, improved recovery, and subsurface integrity of wells and storage formations. Presented below, are short outlines of problems addressed by the papers.

Well Drilling

Undergoing transition from drilling vertical/deviated wells to long horizontal wells brings about a need for more precise design of well hydraulics resulting from frictional pressure losses in drilling mud circulation. Pressure loss in wells annuli is strongly affected by pipe rotation and eccentricity—the important effect in horizontal wells. The problem is addressed in the full-scale experimental study reported in JERT-13-1249, Effect of Drillstring Deflection and Rotary Speed on Annular Frictional Pressure Losses, by Oney Erge et al.

Well Completion

In contrast to vertical wells, long horizontal wells feature very long completion intervals resulting from multistage perforation and fracturing. Therefore, well’s production design shall consider additional frictional losses resulting from cross-interaction of flow in the well and inflow into the well through the perforations. A numerical simulation study of the effect is reported in JERT-13-1297, Influence of Radial Flux Inflow Profile on Pressure Drop of Perforated Horizontal Wellbore, by Abdulwahid et al. An analytical model of the effect is also developed and verified experimentally in JERT-13-1333, A New Comprehensive Model for Predicting the Pressure Drop of Flow in the Horizontal Wellbore, by Quan Zhang et al.

Well Production

Use of artificial lift in wells is unavoidable at the late stage of production and electrical submersible pumps ESP are the first choice. However, maturing wells produce both oil and gas that make ESP lifting unstable. A fundamental theoretical study into ESP instability resulting from two-phase flow conditions is presented by R. Viera and M. Prado in JERT-13-1232, Modeling Behavior of ESP Wells under Two-phase Flow Conditions.

Well Stimulation

Recent explosion of horizontal drilling has come, hands-in glove, with a new challenge to conventional techniques of well stimulation—a massive, multistage hydraulic fracturing. Low permeability formations bearing oil or gas can only be produced with a network of fractures. Moreover, hot and naturally fractured impermeable rocks bearing no petroleum may become heat producers if stimulated with fracture networks. An insight of the relationships between matrix-fracture characteristics of natural fracture systems and the properties of developed fracture networks is provided by Babdagli et al. in JERT-13-1211, Numerical Simulation of Complex Fracture Network Development by Hydraulic Fracturing in Naturally-fractured Ultra-tight Formations.

Another challenge of massive fracturing treatment is the understanding of mechanisms of fracture generation and propagation—particularly, the transfer and growth of fractures in the zones that are not subject of fracturing treatments. The effect, which has been monitored in the field, is explained theoretically by A.D. Taleghani and W. Wang in JERT-13-1304, Simulating Multi-Zone Fracturing in Vertical Wells.

Production Systems

In the offshore production systems, several subsea reservoirs are produced to the same production platform. An adequate design of such system requires sizing the platform fluids treatment capacity for anticipated production of the fluids. Several design methods are compared and evaluated by F. J. C. Hohendorf and D. Jose Schiozer in JERT-13-1267, Evaluation of Explicit Coupling between Reservoir Simulators and Production System.

Improved Recovery

Oil recovery is inefficient with excessive water production as it makes reservoir economics vulnerable to ever-fluctuating crude oil prices. In oil reservoirs underlined by aquifers water invades the producing well due water coning or cresting. An emerging technology for water coning control may also improve oil recovery as shown in the experimental and theoretical study described in JERT-13-1253, Enhancing Oil Recovery with Bottom Water Drainage Completion, by Shirman et al.

Well Integrity

Assuring integrity of wells is a requirement of well productivity, safety, and pollution prevention. Thus, integrity becomes a multifaceted problem involving mechanical installation/tools for internal integrity and new materials for external integrity—well cementing compounds. The most recent challenge to the
cementing technology has come from the need for subsurface sequestration of carbon dioxide. Theoretical prediction of long-term disintegration of well cements in the presence of CO₂ is discussed in JERT-13-1260, *Modeling Pore Continuity and Durability of Cementitious Sealing Material Exposed to Carbon Dioxide*, by Koenders et al.

Sealing wells with cement is not just a problem of the cementing compound but technological reality of the interface between the cement and rock. Not only the cement-rock interface is prone to developing a leak but also the interface is contaminated with residual drilling fluid and its filtration cake—thus preventing effective bonding of cement to the rock face. The problem is studied and presented in JERT-13-1279, *Experimental Study of the Impact of Drilling Fluid Contamination on the Integrity of Cement-Formation Interface*, by A. Nnamdi and M. Radonjic.

**Subsurface Integrity**

Permanent subsurface sequestration of CO₂ in geological strata is only possible when a structural trap prevents the gas from migrating upwards. Typically, the trapping structure is a shale caprock confining depleted petroleum reservoir or overlying an aquifer. However, as CO₂ is different to the in-situ fluids, caprock integrity becomes an issue and is a subject of the experimental study of A. Olabode, and M. Radonjic in JERT-13-1281, *Shale Caprock/Acidic Brine Interaction in Underground CO₂ Storage*.

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