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Editorial: Production technology for deep reservoirs

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Editorial on the Research Topic
Production technology for deep reservoirs

The diversity of energy sources in deep reservoirs encompasses shale gas/oil, hot dry rock geothermal systems, tight gas/oil formations, and coal gasification. However, the production of deep reservoirs has significant stimulation difficulty. To efficiently extract energy from deep reservoirs, technological advancements are flourishing across Europe, North America, and Asia. This Research Topic accepted thirty-six research articles. These articles discuss lots of aspects about production of deep reservoirs, such as fracturing, production enhancement methods, safety and well testing.

We have collected several papers on fracturing methods and fracture propagation. Zhang et al. constructed a simulation model and found that increasing the wellhead back pressure is a recommended strategy to mitigate the issue of displacement gas kick encountered in horizontal wells. Ding et al. conducted a study on the swift propagation dynamics of fractures induced by waterflooding. The experimental results indicate a notable decrease of the fracture propagation pressure by approximately 20% and a significant propagation of waterflood-induced fractures during the waterflooding process. Wang et al. investigated about the impact of shale heterogeneity on fracture behavior through a physical simulation experiment. The important factors include shale bedding, lithological variations and natural fracture around perforation hole. Wang et al. devised an advanced mathematical model that comprehensively captures the intricacies of quasi-elastic energy dynamics within shale oil reservoirs and they used an embedded discrete fracture model for precise fracture characterization. Meanwhile, Zeng et al. introduced a novel method using water hammer signals for efficient and accurate hydraulic fracture size inversion, reducing data processing time and enhancing measurement accuracy, especially for fractures distant from the well toe. These studies highlight the importance of advanced modeling techniques and efficient data analysis in optimizing shale reservoir development.

Some papers have proposed different production enhancement measures such as CO_2 injection, water drive, etc. to improve the recovery of oil and gas wells. Cui et al. utilized investigated on the influence of CO_2 huff and puff on recovery efficiency. The numerical simulation results indicate that important factors include injection volume, injection rate and soaking duration. In order to get a optimal achievement, those factors should be optimized according to geological conditions of reservoirs. Li et al.; Junshuai et al. focused on the efficiency of water injection development in carbonate rock reservoirs in the Middle East. They explored methods and techniques, such as improving injection patterns and differential perforation, to enhance reservoir development efficiency and recovery rates. Based on the results of error analysis, Yang et al. used the Gray model to precisely estimate the pressure distribution within shale gas wellbores and identified the practical pressure limit.

We have received several papers that provide insights into safety issues affecting oil and gas field production, such as sand production in oil wells and inter-well interference. He et al. discovered the underlying causes of sand production in oil and gas wells, subsequently delving into the core principles, implementation methodologies, and consequences of conventional sand control measures. Du et al. provided carried out a comprehensive assessment of production variations within several reservoirs, leveraging the analysis of Blasingame type curves to understand the definitions of dimensionless parameters. Moreover, the study scrutinized critical impact on production performance, including the production output of neighboring wells, the distance between these wells, and the commencement timing of production from neighboring wells. Fan et al. conducted an extensive applicability assessment of plunger lift technology in shale gas wells, meticulously evaluating the suitability of a specific well for this technology. The evaluation encompassed a thorough analysis of factors such as the height of the liquid column residing above the plunger, the production efficiency under pressure conditions, and the overall duration of well shut-ins, to determine the well's compatibility with plunger lift operations.

Well testing is an indispensable part of oil and gas field development. Through well testing, the production potential and economic viability of the well can be better evaluated, guiding subsequent production and development decisions. Chen et al. proposed a novel well testing model to devised specifically for partially perforated wells in natural gas hydrate (NGH) reservoirs. This innovative model incorporates the dynamic decomposition of hydrates. By simulating the behavior of a perforated the NGH well with a dynamic dissociation interface, the model effectively divides the reservoir into two distinct zones. In this study, a sensitivity analysis is performed utilizing the parameters sourced from partially perforated wells as well as the formation properties of the NGH reservoirs. Wang et al. investigated the non-linear seepage flow patterns for ultra-low permeability tight gas reservoirs. Through the analysis of scale invariance in the seepage flow dynamics of ultra-low permeability tight gas reservoirs, researchers have formulated a fractal geometric representation grounded on the capillary pressure curve. Subsequently, they delved into the fractal characteristics of matrix porosity and fractures, examining their influence on the stress sensitivity of these reservoirs.

The studies highlight a range of innovative techniques aimed at improving production efficiency and addressing operational challenges. Advanced simulation models for fracture propagation and optimized well performance, alongside production enhancement measures such as CO_2 injection and water drive, underscore the role of technological innovation in boosting recovery rates. Additionally, analyses of sand control methods, inter-well interference, and non-linear seepage flow patterns provide insights into mitigating production issues and optimizing reservoir management. Well testing models and sensitivity analyses further aid in evaluating well potential and guiding strategic development decisions. These valuable contributions significantly enrich our comprehension of reservoir behavior, thereby providing actionable strategies to bolster the economic feasibility and sustainability of oil and gas extraction operations.

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Conflict of interest

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