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Numerical calculation of temperature and pressure in the fracture during supercritical carbon dioxide ($SC\text{-}CO_2$) fracturing

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Supercritical carbon dioxide fracturing can solve the problem that hydraulic fracturing consumes a lot of water. On the other hand, part of the carbon dioxide after the fracturing enters the pores of the reservoir rock or is adsorbed by the coal, which plays the role of carbon dioxide storage and helps to alleviate the warming caused by the increase of atmospheric carbon dioxide concentration.

In supercritical carbon dioxide fracturing, wellbore, reservoir, temperature, pressure and carbon dioxide physical parameters interact, so in order to study this complex process, a thermal-hydro-mechanical (THM) coupled supercritical carbon dioxide fracturing model needs to be established, which fuses wellbore model and fracture propagation model. The finite difference method is used for the calculation of the wellbore model; the boundary element method is used for the calculation of fracture propagation; the finite volume method is used for the calculation of carbon dioxide flow; the energy conservation criterion is used to calculate the temperature of carbon dioxide. Both the wellbore model and the crack propagation model use implicit solutions, and the coupling process is solved based on Picard successive approximation method. Based on the model, the effects of Young's modulus, leak-off coefficient, in-situ stress of reservoir and reservoir temperature on the fracture morphology and temperature of supercritical carbon dioxide were analyzed.

The results show that the reservoir rock mechanical properties have a significant effect on the heating rate of carbon dioxide in the crack, and the reservoir temperature and pressure have a significant effect on the fracturing effect compared with conventional hydraulic fracturing. And in order to ensure supercritical carbon dioxide fracturing effect and cost savings, a drug that can reduce leak-off needs to be developed.

Biography

He Yuting has expertise in numerical simulation of hydraulic fracturing fracture growth, multi-field and multi-phase coupling, calculation of carbon dioxide phase state and physical and chemical parameters and enhanced geothermal system (EGS) and oil and gas stimulation theory and technology. With his years of experience in research, he has built this supercritical carbon dioxide (SC-CO2) fracturing model coupled thermo-hydro-mechanical Processes (THM) based on the implicit fully coupled solution of boundary element method (BEM) and finite volume method (FVM) The model can accurately calculate the change of physical properties of carbon dioxide during fracturing, which has important guiding significance for SC-CO2 fracturing.

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Chemical reagents based on surfactants for oil-contaminated soils treatment: Efficiency, advantages and concerns

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The enhanced soil washing, as a method of oil-contaminated soils treatment, is considered one of the Best Available Techniques due to GOST R 57447-2017 and Industrial Emission Directive 2010/75/EU (Final Draft 2017). The choice of the chemical reagent is supposed to be based on various criteria, containing efficiency, environmental safety and economic feasibility, which should be obligating for potential consumers (REACH regulation system in European Union since 2007). Nowadays Russian legislation has a lack the applicable regulation document for chemical reagents. The study is aimed to set up the major characteristics to estimate the efficiency of oil-contaminated soil washing, using chemical reagent based on surfactants, and their environmental safety due to secondary pollution probability.

Methodology: the efficiency of the enhanced washing process using different chemical reagents was determined for several soil matrix types and various oils. Ecotoxicity of the chemical reagents was studied through infusoria and higher plants bioassay. Solubilization of humic substances was determined by water solution extraction of unpolluted peat.

Findings: a study of a solubilization efficiency towards oil and natural organic compounds showed a significant effect of the washing solution pH and the soil matrix type, which is apparently due to two factors – the sorption capacity of the soil and the nature of the surfactants affecting the ability of surfactant molecules to be absorbed by the soils. The study results presented mainly high ecotoxicity level of the chemical reagents for infusoria and higher plants. Chemical reagent treatment has led to the overall biotoxicity increasing due to biotoxicity of chemical reagent and rising of oil substances and heavy metals bioavailability.

Conclusion & Significance: the study results point the necessity of chemical reagent regulation system development and its implementation to maximize the efficiency and environmental safety of the enhanced soil washing as a treatment method.

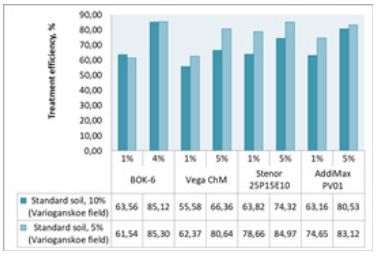

Figure 1. The enhanced washing efficiency for standard sandy soil contaminated with 5 and 10 wt% of light crude oil (0.84 g/cm3)

Biography

Olga Kulikova is PhD Student, supervised by Dr. Eng.Sc., Prof. Elena Mazlova, has her expertise in oil-contaminated territories remediation. The results of her research were obtained by intensive laboratory studies carried out on the basis of research laboratories of Gubkin University, MSU and TU BA Freiberg. As well as a great contribution to the work was made by the results of the Arctic expedition 2018, during which Olga acted as the leader of the expedition group.

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A new approach for screening potential shale gas intervals

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There are many criteria that can be used to differentiate potentially productive organic-rich shale reservoirs from barren shale intervals. Among these, organic richness, thermal maturity status, porosity, fluid saturation, thickness, and brittleness are the major criteria for shale gas ranking. During exploration phase, having access to these types of information may not be possible or sometimes expensive to obtain. Well-log data can be a reliable alternative approach to estimate these parameters.

This paper introduces a deterministic approach that can be used to differentiate organic-rich shales from lean shales. The method is also applicable to calculate Total Organic Carbon (TOC) content when calibrated with some core data.

A forward modeling method based on electromagnetic theory to measure the parameters of hydraulic fracture

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Hydraulic fracturing is the pivotal technology of tight unconventional reservoir, and accurate monitoring of fracture morphology is related to fracturing effect evaluation, well productivity prediction and the follow-up measures. Compared with traditional methods, electromagnetic monitoring can obtain the Effective Propped Volume (EPV) that actually reflects the productivity, solve the abuse such as low fracture identification accuracy, limited by the specific time. This paper introduces a physical and numerical model that uses electromagnetic characteristics to accurately monitor the parameters of the fracture. A triaxial transmitting - triaxial receiving instrument which is approximate to the construction site is set up, the relationship of electromagnetic monitoring signals and the fracture parameters is obtained. By placing the transmission source plane perpendicular to an appropriate coordinate axis in a three-dimensional rectangular coordinate system the length and height of the fracture could be monitored by the signal of the long receiver while the transmitting source surface being perpendicular to the Z-axis. The azimuth could be inverted according to the magnitude of the signal peak when the transmitting source surface is perpendicular to the X-axis. The sign of azimuth could be determined by setting a M-axis (the Z axis rotates counterclockwise 45 degrees in the XZ plane).

A study on dynamic hydraulic fracture: the relation between crack tip and fluid front

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We present direct observation and theoretical analysis on the relation between the crack tip and the fluid front in dynamic hydraulic fracturing of impermeable material. A laboratory-scale hydraulic fracturing device is built to induce dynamic mode I hydraulic fracture in PMMA specimen. The derived analytic solution of stress intensity factor for this configuration is in good agreement with the existing numerical results and the experimental result obtained using the combination of the digital image correlation and the Williams' series. Taking the horizontal component of crack-flank resistance into consideration, the force-balance equation of the fracturing fluid under constant fracturing pressure accounting for the dynamic relation between the crack tip and the fluid front is established. Results show that the theoretical predictions conform well to the directly observed results of these two fronts. The analysis on energy terms show that the kinetic energy of the fluid occupies over half of the total input energy before the fluid front approaches the crack tip. When the crack slows down or arrest, this ratio further increases. Then we explore the existence of equilibrium state in this dynamic system, which indicates that if the hydraulic fracture propagates at a constant speed V_C, the fluid front will also travel at a constant velocity $P_E V_C$ ($0<P_E<1$) after a certain period of time, and will not catch up with the running crack tip. The separation criterion of the crack tip and the fluid front is established and found to conform well to the experimental data. The dynamic relation between the two fronts in different crack profile proposed by recent experimental research are investigated. Results show that the crack profile and the crack opening level only exert very limited influence. This study provides a better understanding on the dynamic relation between the crack tip and the fluid front in hydraulic fracture.

Well production planning and optimization by using CMG software

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Statement of the Problem: Reservoir engineer who have experienced problems in production optimization at their working field or industry. Production planning and optimization plays a key role in company's profit and their position in competitive oil sector because it leads to economic growth and sustainability of company. In recent years, Researchers have reported that usage of all data which available with them are not sufficient to analyze; they need to do more filtration of data and resolve the uncertainties in predictable zones of reservoir. However, this topic has been previously studied but it needs in depth way to get better results. The purpose of this study is to describe the importance of simulation tool usage in production optimization and planning. Methodology & Theoretical Orientation: The usage of cmg software tool to know number of wells, economical production of time and production rate. A framework was utilized to focus on the interaction between the well actual & theoretical production data to understand this relationship and the context in which it occurs.

Findings: The study will give more information about production analysis and future forecast of the production.

Conclusion & Significance: Software tools usage in production of oil from reservoir leads to more economical and appreciable results.

Investment in electricity capacity under fuel cost uncertainty: Dual-fuel and a mix of single-fuel technologies

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We study the effect of the price and price volatility of natural gas on investment in electricity capacity in two technology scenarios: (1) dual-fuel units that use natural gas and diesel; and (2) a mix of single-fuel plants that use coal or natural gas. We develop a two-stage (capacity and operation) model and derive analytical solutions for both scenarios. We show, based on the observed log-normal distribution of the natural gas price, that optimal capacity investment increases moderately with natural gas price volatility, thereby disputing a commonly held view that fuel cost uncertainty tends to discourage capacity investment and reducing the "missing money" problem. We use Texas data to show that higher gas price volatility implies higher profits and consumer surplus in the first scenario, even when the per MWh diesel cost is much higher than the expected value of the per MWh gas cost. In the second scenario, firms invest only in gas capacity, unless the per MWh coal cost is significantly below the expected per MWh gas cost, explaining the popularity of gas generation.