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Effect of Salt Dry-out on Shale Gas Reservoir Production Performance

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Shale gas reservoirs are typically characterized by nanometer pore throats and very low permeability matrix requiring hydraulic fracturing stimulation of horizontal wells. Water is the main fluid used in hydraulic fracturing and a variety of chemicals are mixed with the water each for a different pur¬pose. Given the very low permeability of shales, very high pressure gradients are experienced in order to achieve economic production rates. The pressure drop results in vaporization of the water by the producing gas. The water being vaporized may be the formation water or a mixture of formation water with the stimulation fluids leaked off into the reservoir. The more pressure drop, the more water is vaporized into the gas and, as a result, the more salt dries out. With the nano-meter size pores in shale gas reservoirs and significant pressure gradients required for economic production, the shale gas reservoir permeability can be significantly damaged due to salt deposition. Salt dry-out can significantly reduce the productivity. Significant adverse impact of salt precipitation on well performance were observed in Marcellus shale play where brine salinities are relatively high.
In this paper, we model a shale gas reservoir having gas-water thermodynamic equilibrium, and investigate the effects of pressure decline induced by production on salt deposition and its consequences on permeability reduction. Reservoir properties representative of Marcellus shale gas play are considered for this study. Peng-Robinson EOS is used for reservoir fluids (methane and water) modeling. A horizontal well is placed in the middle of the reservoir and hydraulic fracturing is considered to create fractures around the well. Conducting hydraulic fracturing, the fractures are invaded by stimulation fluid. Gas is then produced through the fractures under constant rate constraint and water is allowed to be vaporized. Gas-water flash calculations are performed to evaluate the amount of vaporized water. Water vaporization causes the dissolved salt to be dried-out. Change in porosity and then permeability due to salt dry-out is calculated using Kozeny-Carman formula. Saturation of dried-out salt is evaluated and correlated as a time-dependent skin around the wellbore. The method is verified by modeling salt precipitation during CO_2 injection into an aquifer and comparing the results with 1D analytical solutions found in the literature. Verifying the method, controlling the gas production from shale gas reservoirs by salt dry-out is elucidated.

References

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