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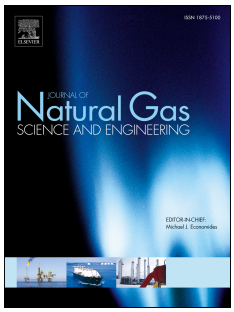

Influence of porosity and permeability heterogeneity on liquid invasion in tight gas reservoirs

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Influence of porosity and permeability heterogeneity on liquid invasion in tight gas reservoirs

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Abstract: Liquid invasion in tight gas reservoirs may damage near-wellbore permeability during the well drilling, completion, and stimulation processes. This study focused on a tight gas reservoir in the Sichuan basin. The physical properties of the basin and correlations among them were analyzed. The analysis indicated an obvious porosity and permeability heterogeneity for the Xujiahe Formation in the Dayi area and showed a relatively high correlation between porosity and permeability. Statistical analysis confirmed that both porosity and permeability generally followed the Weibull distribution and that the permeability heterogeneity was greater than the porosity heterogeneity. The Weibull distribution function and convection-dispersion model were both used to estimate the effect of heterogeneity on liquid invasion in tight gas reservoirs. The results showed that a smaller coefficient of permeability heterogeneity corresponded to a larger irreducible water saturation value. The dimensionless concentration profile propagated deeper into heterogeneous reservoirs than homogeneous reservoirs. The influence of heterogeneity on liquid invasion depended primarily on the permeability heterogeneity of the tight gas reservoir. As the coefficient of permeability heterogeneity decreased, the liquid invasion depth and invasion rate increased. Comparatively, the porosity heterogeneity had little effect on the liquid invasion rate but caused the invading liquid to travel deeper into tight gas reservoirs.

Key words: Tight gas reservoir; Liquid invasion; Permeability; Heterogeneity

1. Introduction

Tight gas reservoirs are characterized by low or very low permeability; trapped gas cannot be extracted at commercial rates without production optimization (Zou et al., 2012). With small pore throats, strong water wettability, and capillary imbibition effects, the exploration and development of tight sandstone gas reservoirs are significantly challenged (Bahrami et al., 2012; Li et al., 2014). The reservoirs can be subject to different damage mechanisms resulting from solid mud particle invasion or liquid invasion and water-blocking (Wang et al., 2012; Kang et al., 2014). Liquid invasion of the reservoir formation may damage the near-wellbore permeability through water-blocking, which can be a major

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