Methane Re-saturation in Barnett Shale Core Plugs and Determination of Post-coring Gas Loss

Daniel A. Enriquez

ABSTRACT

Understanding the physiochemical mechanisms that control the loss of gas during coring processes are critical to accurately determining gas-in-place (GIP) resource assessments of unconventional shale-gas plays. An experimental approach, utilizing methane (CH_4) adsorption isotherms and degassing curves of methane re-saturated Barnett Shale core plugs, was used in our study to determine the amount of lost gas based on mass-balance analysis at different CH_4 re-saturation pressure and varied exposure time. Several readily available empirical methods for estimating lost gas were evaluated, quantified, and compared with our experimentally determined lost gas values.

A CH_4 isotherm measurement on ⅜″ Barnett Shale core plugs was performed at 35.4°C and the amount of gas adsorbed was then quantified and fitted to the modified Langmuir equation to determine the Langmuir maximum, Langmuir constant, and adsorbed gas-phase density. Two sets of CH_4 gas re-saturation and degassing measurements, one varying saturation pressures and the other varying exposure times, were performed on ⅜″ Barnett Shale core-plugs at an isothermal temperature of 35.4°C. Degassing curves were analyzed versus the square root of time, and the results suggest the mechanisms during degassing are dominated by nonlinear gas-expansion at the beginning of degassing that evolves into a linear desorption-dominated phase over time. Experimentally derived values for lost gas were determined by subtracting the sum of the emitted and retained gas from the amount of gas charged into the samples, and lost gas varies linearly with increasing gas re-saturation pressure and nonlinearly with increasing exposure time, indicating that lost gas is more sensitive to exposure time.

The evaluation of the uncertainty of lost gas determined by three empirical methods was conducted through comparison with mass-balance-derived lost gas from our experiment. Nonlinear least-squares extrapolation overestimates, and both linear extrapolation and polynomial equation fitting underestimate the mass-balanced lost gas control points. Among the three empirical methods, the polynomial-fitted lost-gas values most closely agree with mass-balanced lost gas, revealing that polynomial fitting to degassing curves is a viable way to estimate lost gas accurately and, more important, to estimate GIP values with up to 85% accuracy.

(Signed Name)

Advisor: Charles Kerans **(Printed Name)**