

The effect of elevated methane pressure on methane hydrate dissociation

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ABSTRACT

Methane hydrate, equilibrated at P , T conditions within the hydrate stability field, was rapidly depressurized to 1.0 or 2.0 MPa and maintained at isobaric conditions outside its stability field, while the extent and rate of hydrate dissociation was measured at fixed, externally maintained temperatures between 250 and 288 K. The dissociation rate decreases with increasing pressure at a given temperature. Dissociation rates at 1.0 MPa parallel the complex, reproducible T -dependence previously observed between 250 and 272 K at 0.1 MPa. The lowest rates were observed near 268 K, such that >50% of the sample can persist for more than two weeks at 0.1 MPa to more than a month at 1 and 2 MPa. Varying the pressure stepwise in a single experiment increased or decreased the dissociation rate in proportion to the rates observed in the isobaric experiments, similar to the rate reversibility previously observed with stepwise changes in temperature at 0.1 MPa.

At fixed P , T conditions, the rate of methane hydrate dissociation decreases monotonically with time, never achieving a steady rate. The relationship between time (t) and the extent of hydrate dissociation is empirically described by:

$$\text{Evolved gas (\%)} = A \cdot t^B \tag{1}$$

where the pre-exponential term A ranges from 0 to 16% s^{-B} and the exponent B is generally <1. Based on fits of the dissociation results to Equation 1 for the full range of temperatures (204 to 289 K) and pressures (0.1 to 2.0 MPa) investigated, the derived parameters can be used to predict the methane evolution curves for pure, porous methane hydrate to within $\pm 5\%$. The effects of sample porosity and the presence of quartz sand and seawater on methane hydrate dissociation are also described using Equation 1.