Natural Hydrate Kinetics from Classical Nucleation Theory

B. Kvamme
Telemark Institute of Technology, HIT/TF
Kjølnes Ring 56
N-3914 Porsgrunn, Norway

Classical nucleation theory is applied to the calculation of the kinetics of methane hydrate. The theory is based on a model where gas is transported towards the interface by kinetic gas theory. Adsorbed amount of gas is calculated from a statistical mechanical adsorption theory. The kinetics of further conversion to metastable particles are modelled using simulated properties of water. Further growth of metastable particles are calculated according to classical nucleation theory using a discrete set of intermediate core sizes below critical size and analytical solution of the Zeldovic equation for steady growing particles above the critical size. The theory will generate a distribution of stable growing particles of different sizes. Comparisons of theory with experiment indicate that what is normally interpretated as the induction time seems to be close to the onset of the first stable cores. After that time the consumption of water and hydrate former accelerates by the increased number of new stable cores as well as the increase in sizes of the previously formed stable cores. The agreement between theory and experiment is good. The theory is also general and may be applied to mixed hydrate formers as well as mixtures containing therrnodynamic as well as kinetic hydrate inhibitors. In particular the effects of different concentrations of sodium chloride on the kinetics of carbon dioxide hydrate is discussed in detail.