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Recent Modeling Studies of Gas Production From Hydrate Deposits and of the Corresponding Geomechanical System Response

George MORIDIS

Lawrence Berkeley National Laboratory

Gas hydrates are solid crystalline compounds in which gas molecules are lodged within the lattices of ice crystals. The vast amounts of hydrocarbon gases that are trapped in hydrate deposits in the permafrost and in ocean sediments may constitute a promising energy source. We use the TOUGH+HYDRATE simulation code to investigate gas production from a wide range of hydrate deposits in several geologic settings all over the world, including recent discoveries. Additionally, we investigate the geomechanical stability of oceanic hydrate-bearing sediments under production.

Class 1 hydrate deposits are characterized by a Hydrate-Bearing Layer (HBL) underlain by a two-phase zone involving mobile gas, and are obvious candidates for gas production. Class 2 hydrate deposits are characterized by a HBL that is underlain by a saturated zone of mobile water. Class 3 hydrate deposits are characterized by an isolated HBL that is not in contact with any hydrate-free zone of mobile fluids. The base of the HBL in Class 2 and 3 deposits may occur within or at the edge of the zone of thermodynamic hydrate stability. Class 4 deposits involve disperse, low-saturation accumulations, are typical of marine systems, and represent the majority of the global inventory of hydrates.

Class 2 hydrates are promising, as they appear to yield large rates of hydrate-originating gas over long periods. Under favorable conditions and an appropriate well design, Class 2 deposits can deliver sustainably high, long-term rates. Production from depressurization-based dissociation of Class 3 deposits based on a constant bottom-hole pressure appears to be a promising approach even in deposits characterized by high hydrate saturations. This approach allows the production of very large volumes of hydrate-originating gas at high rates for long times using conventional technology. Finally, Class 4 deposits do not appear to be promising targets for gas production under any combination of system properties, initial conditions and production parameters.

Production from hydrate deposits is characterized by (a) the need for confining boundaries, (b) a continuously declining water production and an improving RWGC over time (opposite to conventional gas reservoirs), and (c) the development of a free gas zone at the top of the hydrate layer (necessitating the existence of a gas cap for production). Depending on the type and properties of the sediments in the hydrate-bearing media, gas production from oceanic deposits may affect (possibly seriously) the wellbore stability and the geomechanical integrity of HBS under the conditions that are deemed desirable for production.

* Corresponding author. E-mail: gjmoridis@lbl.gov