Chapter 10
A Source of Future Energy: Gas Hydrates

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ABSTRACT

Natural gas hydrate (NGH) has emerged as a future source of energy for the world that can fulfill the future energy demand. The natural gas hydrates hold twice the amount of energy than all available fossil fuels. At present, the energy demand is growing, but these are not available commercially. Various field applications on the dissociation of the natural gas hydrates have been performed till now, and the output of these field applications confirms the possibility of dissociation of the natural gas hydrates. At distinct locations in the world, the huge deposits of hydrates have been identified, but the safe and economic dissociation of gas hydrates is not known yet. Hence, the evolution of new and inexpensive, suitable methods and technologies are required for the dissociation of gas hydrates. In this chapter, the authors reviewed several articles to compare the different dissociation techniques of gas hydrates and their field applications. The advantages and disadvantages of these production methods have also been discussed.

INTRODUCTION

Gas hydrates are non-stoichiometric solid formed naturally by the entrapment of gas within the crystal structure of water molecules. When water molecules entrap gas molecules at high pressure and low temperature, then create the cage-like structure of gas hydrates. It is also called combustible gas because it can be burned at ambient temperature and pressure. Gas hydrates can be formed by methane, ethane,

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hydrogen sulfide, carbon dioxide, nitrogen, propane, isobutane, n-butane, etc (Gabitto and Tsouris 2010). At equilibrium conditions, 1m[3] of natural gas hydrates contain 160-180 m[3] of natural gas (Li et al. 2011). Naturally, the methane gas hydrates are made by combining the water and the methane gas released either by organic decomposition or by thermogenic gas leaking beneath the sea level or permafrost region (Zhou et al. 2009). The natural deposits of gas hydrates are classified as Class 1, 2, and 3 types of reservoirs. The Class 1 type of hydrate deposits are consisting of a layer of hydrate and an underlying free gas zone. The Class 2 deposits are consisting of a layer of hydrate and an underlying mobile water zone. The Class 3 type hydrate deposits are created with an isolated layer of hydrate with no underlying zone of free gas or mobile water. In Class 3 deposits, the whole layer of hydrates is in the stability zone and enclosed by the impermeable lower and upper burden layer (Huang et al. 2016).

Sir Humphrey Davy discovered the gas hydrates for the first time in 1810, but there is also a possibility that Priestley found it in 1778 (Sloan and Koh 1998). Natural gas hydrates can be found in the high altitudes/latitudes of permafrost or in the sediment layers, which occurs in deep water on the continental margins (Kvenvolden 1998; Kvenvolden and Rogers 2005). Small parts of red lakes, i.e., the continental land, seas of the Caspian Sea, Lake Baikal, and the Black Sea, also contain natural gas hydrates. These reserves were discovered in mountain permafrost regions or deep water, such as South China Sea, the Gulf of Mexico, Indian Ocean, Siberia, Arctic Alaska, multiple areas of Qilian and Mainland China (Ginsburg et al.1992; Ginsburg and Soloviev 1994; Lu et al. 2011). The curiosity for scientific research in gas hydrates increased exponentially when it became responsible for the blockage in oil and gas pipelines. Hence various research studies are in progress for the dissociation of the gas hydrates because it can solve the crisis of energy in the future and then become a potential source of energy in the world (Koh et al. 2009). Currently, the available methods for decomposing gas hydrates are chemical injection, depressurization and thermal stimulation (Kumari et al. 2020).

There is a need to find the cost-effective technologies for the economic dissociation of the gas hydrates, and the rate of dissociation will control this economic production of gas. Figure 1 depicts the available dissociation techniques of gas hydrates. Table 1 listed the list of some patents filed on new dissociation techniques of gas hydrates.

Figure 1. Dissociation techniques of gas hydrates
(Arora et al. 2015a)