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The Experimental Studies and Development Concept for the Offshore Natural Gas Hydrate

Qingping Li[1)], Hengyi Zeng[2)], Weiliang Dong[3)],， Zhijun Wang[4)],
China National Offshore Oil Corporation Research Center.
Beijing, P.R.China

Zi-Ping FENG[5)], Liang-Guang TANG[6)], Xiao-Sen LI[7)]
Guangzhou Institute of Energy Conversion, Guanzhou, P.R.China

ABSTRACT

Based on the brief review of the progresses on the natural gas hydrate exploration， this paper presents a concept development method for offshore natural gas hydrate， considering the current deepwater engineering practice. A set of one dimension experimental facility has been built to simulate the natural gas hydrate development process. The experimental studied of the depressurization and heat injection method used for produce natural gases from hydrates have been carried out. The hydrate dissociation kinetics, gas and water production rate have been analyzed, which are meaningful for the pilot scale and real industry scale production of natural gas hydrate.

KEY WORDS: natural gas hydrate; deepwater engineering; depressurization production; heat injection

INTRODUCTION

The natural gas hydrate, named as “burning ices”, is one kind of unconventional energy with the high energy density, wide distribution and vast quantities. In general，they are stored in permafrost regions and deepwater areas with water depth deeper than 300m. It is estimated that the total resource of hydrate is equal to $1.8\text{-}2.1*10^{16}$ m^3 methane gases, which is double to that current known carbon energy resource (oil, coal, natural gas etc.) all over the world. Globally, there are 84 offshore areas with hydrate have been detected directly or indirectly, among them more than 20 sites have obtained the natural gas hydrate core successfully. The trial productions of gases from the hydrate reservoir in the permafrost areas have also been carried out.

The Chinese broad offshore area and its economical zones indicate great potential resource foreground of natural gas hydrates. Some important evidences, such as BSR, carbonate shell, have been observed in the east sea mainland sloping、seabed groove、northern-eastern swoop areas in south sea、northern mainland sloping in south sea etc. How to exploit and utilize the natural gas hydrate, one of the most promising and potential clean new energy resource, is and will being the focus of not only china but also other countries.

PROGRESSES ON NATURAL GAS HYDRATE PRODUCTION

As earlier as 1810, it was the first time in the world that Mr. Davy from England Royal Academy formed chlorine hydrate in the laboratory. However, till 1971 the former Soviet Union successfully exploited the hydrate reservoir in its permafrost areas first time in the world, more and more interests have been being focused on the gas hydrate research.

THE BASIC HYDRATE PRODUCTION METHODS

According to the basic hydrate thermodynamic principle, three possible gas hydrate production methods have been suggested，such as the heat stimulation，depressurization and chemical injection. The basic principle for Natural gas hydrate production is to dissociate hydrate into free gas, than collect the free gas and transport them to seabed facilities, the continuously production of the natural gas hydrate reservoir can be realized by changing the hydrate phase equilibrium condition.

1) Thermal stimulation

This method is to increase temperature of the hydrate reservoir beyond the temperature at which hydrate can formed at a specified pressure，either by injecting steam, hot water, hot brine or in-situ heating, such as fireflood. The main disadvantage of this method is great heat loss, resulting in low efficiency.

(2) Depressurization

This method is to decrease the deposit pressure below the pressure of hydrate formation at a specified temperature. The main feature for this method is that no expensive stimulation is needed, therefore could be one of the effective methods for future large-scale hydrate production.

(3) Chemical injection

Some chemicals, such as methanol or glycol, can shift the pressure-temperature equilibrium boundary of hydrate. However, this method is expensive with heavy environmental pollution.

The above-mentioned methods are mainly stayed in the laboratory stage. Some of them have been tested in Canada Mallik-2L projects。Experimental results suggested that it is economy free only one method was used to produce hydrate reservoir, and combinations of the above