Prospects for low-cost gas hydrate development in shelf in China

Haoyuan Sun*

Peoples' Friendship University of Russia, Miklukho-Maklaya 6, 117198 Moscow, Russia

Abstract. Drilling costs account for a large proportion whether in onshore or offshore oil gas development, and the same truth for offshore gas hydrates development. Therefore, reducing drilling costs is a prerequisite for realizing industrial development of gas hydrates in sea, only by changing traditional deep water drilling technology portfolio can achieve low-cost development [1].

1 Gas hydrate development is expected to enter industrialization stage after 2025

Currently, major countries that carry out research and development of gas hydrate technology include the United States, China, Japan, Canada, India, Russia, South Korea, Norway, Germany, etc. Among them, China and Japan carried out trial production of natural gas hydrate in sea separately. In the period from May to June of 2017, China conducted a trial mining of gas hydrate in Shenhu area of the South China Sea, and created two world records of $30.9 \times 10^4 \text{ m}^3$ gas production volume and 60 days production length of time[3]. After the first round of trial mining, in August the same year, Ministry of Land and Resources of the People's Republic of China, People's Government of Guangdong Province, and China National Petroleum Corporation signed a tripartite cooperation agreement in Beijing to jointly promote industrial process of gas hydrate exploration, trial mining and exploitation in Shenhu area of the South China Sea. From February to March 2020, another trial production was conducted in Shenhu Area of the South China Sea, setting a global precedent for trial production of deep-water gas hydrates using horizontal wells, during the period, Chins has extracted $861,400 \text{ m}^3$ of gas, with an average daily extraction of $28,700 \text{ m}^3$, setting two new world records of total gas production and average daily gas production. Besides, a major breakthrough has been achieved in production mode from exploratory to experimental trial production mode, a critical step in the process of gas hydrate industrialization, making China the first country which adopts horizontal well drilling production technology in natural gas hydration exploration in sea. These two rounds of trial mining have put China among the ranks of offshore natural gas hydrate research and laid a solid foundation for the future industrialized mining of deep water gas hydrate[4].

* Corresponding author: shy657273629@gmail.com

In February of 2019, the Plan for the Development of Marine Energy and Mineral Resources released by the Ministry of Economy, Trade and Industry (METI) of Japan sets targets for sea gas hydrate[2], that is, to carry out industrialization projects led by private enterprises in fiscal year of 2023-2027 and formulate corresponding industrialization roadmap. In March 2019, the southern wharf and core bank of gas hydrate drilling ship (ocean drilling ship) project invested by Guangzhou Marine Geological Survey Bureau with a total investment of 1.06 billion yuan has passed the environmental impact assessment. The project is located in Nansha port area of Guangzhou Port[5]. The construction content includes 9 berths and 2 core banks. Meanwhile, related land supporting facilities will be constructed, and the total coastline length is 1145m, covering a area of about 19.75×10^4 m².

Based on all those, author believes that the development of gas hydrates in China and Japan is expected to enter industrialization stage after 2025. While for Chinese oil companies, it is necessary to develop low-cost drilling technology combination required by industrialized exploitation as soon as possible.

2 Low-cost drilling technology portfolio

The relatively shallow embedded depth of natural gas hydrate in sea and the low formation pressure has determined low output and short production cycle of a single well, however, the traditional deep-water drilling and production technology portfolio cannot achieve sustainable mining. Only by changing traditional deep-water drilling and production technology portfolio, using safe, efficient, low-cost drilling and production technology portfolio can improve operation efficiency and reduce operating costs, and then low-cost development can be achieved.

2.1 Low-cost medium-sized drilling ship

Conventional deep water drilling requires operation in several kilometers depth in seabed, due to that large deep-water semi-submersible drilling platforms or large deep-water drilling ships equipped with dual-operation ultra-deep well drilling rigs can be seen frequently, In 2019, average cost of large-scale deep-water semi-submersible drilling platforms and large-scale deep-water drilling ships in international market has dropped significantly compared that of 2014, but it is still above 200 thousand \$/d. Exploiting gas hydrate in sea generally operates in a few hundred meters below the seabed. A large deep-water semi-submersible drilling platform or a large deep-water drilling ship is much too costly, while low-cost medium-sized floating drilling equipment will be a wise option.

In the field of offshore workover operations, only around 10 multi-function floating operation devices equipped with drilling and workover rigs are in service worldwide, most of which are multi-function operation vessels, and a few are semi-submersible operation platforms. Major work of which include well completion, perforation, well testing, well washing, salvage, workover, stimulation, geological prospecting, subsea construction, oil and gas well disposal and etc[6].

A marine geological survey released that medium-sized geological survey vessels are used at home and abroad. Three new geological survey vessels built by Guangzhou Marine Geological Survey Bureau are named as Marine Geology No. 8, Marine Geology No. 9, and Marine Geology No. 10. The Marine Geology No. 10 is a small-tonnage deep marine geology research ship equipped with large drilling depth. It started service in December 2017, the ship hull is designed with a height of 75.8 m, width 15.4 m, and depth 7.6 m (Fig.1). The vessel can conduct high-precision comprehensive marine geological,

hydrology and physical oceanic surveys. Besides, it is equipped with a hydraulic cylinder-lifting full-hydraulic marine drilling rig developed by Baoji Oilfield Machinery co.,Ltd, which can carry out drilling and sampling work within the water depth of 1 000 m and fulfill deep formation in shallow water areas (up to 400 m).

Fig. 1. Marine Geology No.10 survey ship[10]

The large-scale application of multi-functional work vessels in marine workovers and marine geological surveys indicates that it is completely feasible for medium-sized floating drilling devices for marine gas hydrates exploitation, and priority should be given to medium-sized drilling vessels with self navigation. The medium-sized drilling vessel can be customized or transformed from existing multi-functional floating operation device.

Affected by continuous downturn in international oil prices, many multi-functional subsea work vessels are idle or being sold on the international market. To purchase a second-hand multi-functional subsea work vessel for modification could also be a wise option. The construction cost of a medium-sized subsea drilling vessel is much lower than that of drilling ships and semi-submersible drilling platforms, with lower renovation costs and daily drilling costs. China has rich experience and capabilities in the R&D, design, and construction of a variety of floating drilling and production equipment, and it only takes 2 to 4 years to develop, design, and build a medium-sized subsea drilling ship.

2.2 Compound coiled tube drilling rig

Semi-submersible drilling platforms or drilling ships are equipped with large-scale dual-operation drilling rigs with a drilling depth of more than 6 000 m. Exploiting gas hydrate in sea only drills a few hundred meters below the seabed, and large dual-operation drilling rigs are not required here[7].

It is an economical and reasonable way to equip a compound coiled tube drilling rig on a medium-sized drilling ship. The compound coiled tube drilling rig is light in weight, small in wind-bearing surface and footprint. It can be placed on a medium-sized drilling vessel. The rig can not only implement coiled tube drilling and pipe materials operation, such as bottom assembly, riser, and pipe columns, etc., and can complete operations such as casing running. Compound coiled tube drilling rigs can generally work in depth of more than 3000m, which is fully capable of drilling operations for gas hydrate in sea. The implementation of coiled tube drilling on a medium-sized drilling ship can also avoid possibility of coiled tube transportation problems on land.

Coiled tubing operations have large applications abroad on land and offshore (shallow and deep water) (Fig.2). The record drilling depth of $2\frac{3}{8}$ in (1 in = 2.54 cm) coiled tubing reaches 7 325m[8]. China National Petroleum Corporation possesses R&D, design, and manufacturing capabilities for coiled tubing, coiled tubing machines and coiled tube

drilling rigs, as well as complete set of technical equipment for coiled tubing operations. On condition that basically equipped with a set of technical equipment for coiled tube drilling, a large number of coiled tube operations have been carried out on land, with coiled tube drilling trails being carried out, as well as on-going compound coiled tube drilling rigs.

Fig. 2. Offshore coiled tubing operation[8].

2.3 Composite riser and riserless drilling

Conventional offshore drilling requires cutting-edge steel risers, which are large in diameter, bulky, heavy, and costly, and time-consuming to install and disassemble. In the future, the industrialized development of gas hydrate only takes a few hundred meters below seabed to drill, an exploitation well can be built in a few days. In addition, the coiled tube does not rotate, so requirements for the riser are not high.

In areas where the water depth is below 1 000 m, the implementation of riserless drilling can be a beneficial option (Fig.3), that is, subsea pumps are used to transport the drilling fluid returned to the wellhead through a dedicated pipeline to the medium-sized floating drilling platform for processing[9]. A double-walled coiled tube (coiled tube-in-tube) made of cabled carbon fiber composite material is also a good choice, which can be used as a drill pipe as well as a riser

Fig. 3. Riserless drilling (subsea wellhead + subsea pump)[9]

3 Conclusions

It is recommended to formulate a company-level gas hydrate mid- and long-term development plan, set up a major company-level gas hydrate science and technology project, increase R&D investment, accelerate R&D progress, and focus on research and development of low-cost drilling technology portfolio, here are several advise:

1. Customize a medium-sized deep-water drilling ship or vessel suitable for coiled tube drilling, or purchase a second-hand multi-functional deep-water ship from the international market and transform it into a medium-sized deep-water drilling ship for coiled tube drilling.

2. Accelerate the industrialization of compound coiled tube drilling rigs, accelerate the promotion of coiled tube drilling technology in the development of onshore oil and gas fields, and accumulate coiled tube drilling experience.

3. Develop low-cost composite material risers and reserve research on riserless drilling technology.

4. Develop or purchase over-water blowout preventer groups for deep-water coiled tube drilling

References

1. A promising new energy: gas hydrate (2020), <http://www.cnpc.com.cn/>
2. W. Zhang, Analysis of Japan's new marine energy and mineral resources development plan (2019), <http://www.zgkyb.com/>
3. Successful trial production of gas hydrate in China's seas (2017), <http://www.gov.cn/>
4. Record-breaking trial production: China takes the lead in re-alizing horizontal well drilling and production of deepwater gas hydrate (2020), <http://scitech.people.com.cn/>
5. Reply to the environmental impact report on the southern wharf and core bank of the gas hydrate drillship (ocean drills ship) project (2019), <http://www.mee.gov.cn/>
6. Well enhancer (2020), <https://www.helixesg.com/>
7. Pristine gas hydrate samples recovered in the gulf of Mexico (2017), <https://www.energy.gov/>
8. STEP energy services: shatters coiled tubing depth record (2018), <https://www.marketscreener.com/>
9. D. Smith, W. Winters, B. Tarr, New deepwater riserless mud recovery system opens door to deepwater dual-gradient drilling, (2010)
10. Marine Geology No.10 survey ship, <https://baike.baidu.com/>