Current Situation and Development Trend of Arctic Drilling Equipment

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ABSTRACT

With conventional onshore and offshore oil production no longer able to meet growing global energy demand, the emphasis of hydrocarbon exploration and development has shifted to the remote and cold Arctic. In order to overcome the many challenges posed by the rugged environment in the Arctic, global R&D investment for Arctic drilling technology continues to grow and Arctic drilling equipment continues to improve. Based on investigations of Arctic oil and gas drilling equipment, the challenges faced in Arctic drilling and the status of Arctic drilling equipment are discussed in this article. Some exploratory viewpoints and recommendations for Arctic oil and gas exploration and development are also proposed.

KEY WORDS: Arctic drilling; polar drilling; drillship; drill platform; icebreaker; challenges; the Arctic.

INTRODUCTION

Offshore hydrocarbon development has been increasing in the Arctic Circle to meet the increasing global demand for oil and gas. In this area, the temperature is extremely low, the wind is extremely strong, and the sea wave is high with plenty of cold ice (Aggarwal and Souza, 2011). In 2011, ExxonMobil listed the unique challenges faced in this region: remote location, changing ecology, icebergs, prolonged darkness, mobile pack ice, severe storms, permafrost, earthquakes, a sensitive environment and deep water (Kennedy, 2011).

In 2009, the US Geological Survey estimated the undiscovered Arctic reserves to be 90 billion bbl of oil, 1 669 tcf of natural gas and 44 billion bbl of natural gas liquids (NGLs) (Gautier, 2009). In the Arctic, 10 different oil and gas fields have been discovered, including the giant Shtokman gas field in North Russia, whose estimated recoverable gas is 135 tcf, with excellent development prospects. In 2012, Norway issued 26 petroleum development permits in the Barents Sea and the Norwegian Sea and plan more in 2013. The offshore energy development in the Arctic will attract 100 billion dollars in investment in the next decade, according to Lloyd's of UK. Many national oil entities and independent oil corporations are interested in the hydrocarbon resources of the Arctic Ocean and have been constructing various kinds of drill platforms (Chi et al., 2009). However, their utility in the harsh Arctic environment requires strong tolerance for cold weather, strong wind and high waves, as well as great loading capacity and high crew security, so there are very few drill platforms fit to work in the Arctic. This paper systematically lists the environmental challenges faced in Arctic drilling, and the current situation and development trend of Arctic drilling equipment, in order to track the development of international polar drilling.

TECHNICAL CHALLENGES OF ARCTIC DRILLING

Ultralow Temperature and Floating Ice Challenges

In the Arctic, solar energy is lacking, and the average temperature in January is between -20°C and -40°C. Even in August, the average temperature is only -8°C (Wei, 2002). The surface of the Arctic Ocean is mostly covered with sea ice, and the maximum covered area in winter can reach three quarters of the Arctic Ocean, while in summer the ice can cover half the area. In addition, there are many icebergs and ice islands. The ultralow temperature in the Arctic year-round and floating ice environments bring great challenges to polar drilling, including difficult operation and maintenance, effects on drilling equipment and tools mechanical behavior, easy brittle failure of drill strings, drilling fluid performance changes, marine risers easily destroyed by floating ice and difficult crew working conditions.

Remoteness Challenges

The Arctic is one of the most remote areas on the earth. There are few people or materials in the Arctic, which makes it difficult to provide stable and reliable rear-service supply.

Vulnerable Ecology Challenges

Because the ecology of the Arctic is vulnerable, it would be difficult to construct a relief well once a blowout occurs during drilling. An oil spill could easily destroy the whole Arctic environment and threaten the wildlife. Since the Arctic lacks sunshine in the winter and the temperature is extremely low, the absorption and degradation from an oil spill are more difficult than in lower latitude regions.

Wind and Wave Challenges

The average wind speed is 10 m/s in the Arctic, 18% higher than in the Gulf of Mexico. The severe wind and waves of the Arctic can cause the drift of drilling ships, which would lead risers to deform or vibrate,