Dynamic risk analysis on offshore natural gas hydrate production test based on DBN-GO method

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ABSTRACT

Preventing secondary hydrate formation caused by low temperature and the high-pressure environment is one of the key factors for the success of offshore gas hydrate production test. In this paper, a dynamic Bayesian network and GO (DBN-GO) model are used to build a successful GO method model for offshore gas hydrate production experiments and map it to the DBN model. The results show that the success rate of preventing the secondary formation of gas hydrate in the test of offshore gas hydrate production cannot reach 100% due to the influence of artificial operation and equipment degradation. Through the maintenance of the equipment, the success rate of preventing the secondary formation of hydrate can be significantly improved. Compared with unmaintained equipment, it is more conducive to the successful development of offshore gas hydrate. Regular maintenance of equipment can significantly improve the success rate of prevention of secondary formation of hydrate. Through sensitivity analysis, it is found that the failure rate has the most obvious influence on the reliability and availability of subsea pumps.

KEY WORDS: Dynamic risk; natural gas hydrate; dynamic Bayesian network; GO methodology.

INTRODUCTION

Natural gas hydrate (NGH) is regarded as an important follow-up energy in the 21st century (Makogon et al., 2007) because of its huge reserves, wide distribution, high energy density, and clean combustion products. Because the exploitation of offshore natural gas hydrate is difficult, there is no consensus on the exploitation of natural gas hydrate in the world. Therefore, the mining of offshore natural gas hydrate is still in the stage of exploration, trial production, and small-scale mine. Studies have found that the secondary formation of hydrate is one of the important problems in the process of hydrate mining (Sloan Dendy, 1998). In the production testing of natural gas hydrates, the secondary formation of hydrates caused by the low temperature and high-pressure environment on the seabed will lead to the blockage of pipelines and equipment, leading to serious safety problems (Sloan et al., 2010). Therefore, it is necessary to quantitatively evaluate the risk of preventing secondary gas hydrate formation in offshore gas hydrate production experiments.

To prevent the secondary formation of gas hydrates, researchers have proposed such approaches as heating (Bardon et al., 2007; TZOTZI, 2014), depressurization (Bollavaram and Jr. Sloan, 2003; Nazridoust and Ahmadi, 2007; Sloan et al., 2010) and chemical injection (Brustad et al., 2005; Chua et al., 2012) and other different technologies to prevent hydrate formation.

Risk analysis is an effective tool to determine the probability of accidents in offshore operations. At present, quantitative risk and reliability analysis techniques have been widely used in Marine operations to reduce the accident rate. Common risk analysis methods include fault tree (Badida et al., 2019; Giraud and Galy, 2018), event tree (Rahman et al., 2018), a reliability block diagram (Guo and Yang,