Impact of Thruster Failure on Mooring-assisted Dynamic Positioning System

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ABSTRACT

This paper is concerned with the effect of one thruster failure on the mooring-assisted dynamic positioning system of a semi-submersible platform. The mooring-assisted dynamic positioning system is composed of a class-3 dynamic positioning system and a catenary mooring system. By numerical simulations, the impacts of different thruster failure modes on the offset and power consumption of the platform are calculated and compared. Finally, some feasible ways are proposed to reduce the failure impact so as to improve positioning accuracy and reduce power consumption.

KEY WORDS: mooring-assisted dynamic positioning system; numerical simulation; offset; power consumption

INTRODUCTION

Dynamic positioning system is widely used on the semi-submersibles in the exploration of ocean resources. Although it can help semi-submersibles to resist worse sea conditions and maintain a given position without the limitation of the water depth, they may lose its function when some failure modes happen. So as to improve the positioning accuracy and reduce energy consumption, mooring-assisted dynamic positioning system is developed on the basis of dynamic positioning system.

Generally, the mooring-assisted dynamic positioning system is composed of a dynamic positioning system and a mooring system, in which the dynamic positioning system controls the vessel's position and heading and the mooring system helps to resist parts of the external forces and reduce fuel consumption.

According to some rules of classification society (DNV-OS-E301), the mooring-assisted dynamic positioning system is designed to have enough redundancy when the system failure, which may lead to serious economic consequences or even dangers to life. Therefore, a failure mode and effect analysis (FMEA) should be conducted to provide a comprehensive analysis to establish the important failure modes with regard to station keeping of the mooring-assisted dynamic positioning system.

The study on mooring-assisted dynamic positioning system was first carried out in the 1970s based on model tests of dynamic positioning system. Sargent and Morgan (1974) proposed that the mooring-assisted dynamic positioning system would enhance the positioning accuracy and reduce cost. In the 1990s, NTNU has conducted a series of model tests of mooring-assisted dynamic positioning system. Strand, JP, Sorensen, AJ and Fossen, TI (1997) improved positioning accuracy by designing the controller. Johan Wichers and Van Dijk (1999) proposed the design method and analyzed the use of mooring-assisted dynamic positioning system on FPSOs in deepwater. Chris Jenman (2005) has proposed some rules on the combination of mooring system and dynamic positioning system. Nguyen,D and Sorensen, A (2009) designed a controller with transfer function which is used for detecting the environmental change and preventing the breaks of the mooring line.

Although the studies on mooring-assisted dynamic positioning system have been conducted for 30 years, there is few study on the issue of FMEA analysis. In an FMEA, there are different types of failure modes, such as mooring line failure, thruster failure and control system failure. As dynamic positioning system plays a key role in mooring-assisted dynamic positioning system, thruster failure may affect station keeping significantly or even causes a position loss. In addition, it changes dramatically the thrust allocation of other intact thrusters and the tension of mooring lines.

Given the severe influences on the whole system, thruster failure should be taken an FMEA, and since thrusters in different positions of mooring-assisted dynamic positioning system have different actions under a certain direction of external force, there will be several different thruster failure cases to analyze in an FMEA.

So in this article, the cases of one thruster failure are analyzed by time domain simulation and then the impact of one thruster failure on mooring-assisted dynamic positioning system will be studied.

VESSEL DATA

In this paper, the semi-submersible platform with mooring-assisted dynamic positioning system is to be analyzed. The semi-submersible platform's main particulars are included in the Table 1. The draft of the semi-submerged platform is 19m.