A Research of the Effect of Heeling and Trimming on a Specific Semi-Submersible Platform with Dynamic Positioning System

Han-lin Liu, Lei Wang and Gang Chen
School of Naval Architecture, Ocean and Civil Engineering, Shanghai Jiao Tong University.
Shanghai, China

ABSTRACT

This paper starts from the hydrodynamic performance of dynamic positioning system propellers of the semi-submersible platform. According to the relevant standards, provided by the register of shipping, which have set the maximum allowable tilt angle of a semi-submersible platform, a research is taken about the effect on dynamic positioning system under a series of heeling and trimming angles by studying the changes of thruster-thruster interaction patterns. After numerical simulations, the time-domain curves of positioning accuracy and power consumption can come out. Finally, an analysis is made about the reasons of the results, besides; some applicable conclusions can be carried out.

KEY WORDS: dynamic positioning system; heeling and trimming angles; time-domain curves; positioning accuracy; power consumption.

INTRODUCTION

Modern offshore industry techniques have been making increasing use of dynamic positioning (DP) systems for vessels especially deep ocean platforms in wave, wind and current environments, even in severe environmental conditions. The DP system controls the vessel’s motion in three horizontal degrees of freedom: surge, sway, and yaw. Generally speaking, the wave induced platform motions can be separated into two major components, namely the first order high-frequency motions and the second order low frequency motions. The DP systems are designed to counter the effects of the latter low frequency component, in addition to the effects of currents and wind. The purpose of DP system is to locate the vessel at relatively fixed position with high positioning accuracy and consuming power as low as possible.

For higher efficient dynamic positioning, azimuth-steerable thrusters are widely used in dynamic positioning system. Due to the thruster-hull and thruster-thruster interaction, the installed propulsion system may experience severe efficiency losses in DP conditions. Nowadays, many numerical and experimental tests have been taken from various aspects in order to take thruster-thruster and thruster-hull interactions into account. Depending on some experiences from tests of both ships and platforms, the loss of thrust is in the order of 30%-70%. Such loss of thrust could be caused by Coanda effect or interaction efforts, such as thruster-hull, thruster-current and thruster-thruster interactions, which are the results of complex physical phenomena (Nienhuis U, 1992).

With the help of CFD, comparison of thruster axis tilting versus nozzle tilting on the propeller-hull interactions at DP-conditions can be made (Fig.1). As a result of the research, it can be concluded that with only minor differences, all configurations have shown less thruster-hull or thruster-thruster interaction losses incorporating a $8^\circ$ axis tilt and it can be found that tilting the axis by gear-tilt also offers advantages regarding the interaction efforts for a monohull vessel (Palm, Jurgens, Bendl 2010).

Fig.1 propeller with $8^\circ$ axis tilt (left) and propeller with $5^\circ$ nozzle tilt (right)

One of the areas of dynamic positioning systems concentrates on the influence of two thrusters in close proximity, azimuthing so that flow into one thruster is influenced by the flow through the second thrusters and different current inflow velocities. Experimental tests are necessary as the hydrodynamic flow is complex and difficult to derive by analytical methods and these tests also suggest that either a reduction or