The Design of the Active Heave Compensation System of the Lifting

Chen Jianmin [1,a], Gao Yuebing [2,b], Gao Pingmei [3,c], Yan Yu'e [4,d]

[1,2,3,4]China University of Petroleum (East China), Qingdao, Shandong, 266580; China

[a]jmchen1956@126.com, [b]gaogyb@126.com,

[c]gaopingmei@126.com, [d]282107378@qq.com

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Abstract. In order to reduce the influence of heave movement on lifting，make the ships still operate normally in the larger wave environment, a kind of active heave compensation system that is independent of crane is put forward, Take the heave motion displacement of the hull as the input parameter, and complete the compensate for the lifting goods through the hydraulic cylinder , This active heave compensation system is mainly for the following work including structural design, hydraulic system design and the effect of compensation equipment simulation.

Introduction

After the 2l century, the demands for energy keep growing all over the world, and the sea has become the focus of world energy strategy in the new century, All countries in the world have increased in Marine development efforts. With the large development of offshore petroleum, Large offshore project also develops flourishingly. These projects are inseparable from the floating crane.

The heave movement caused by wave loads seriously affects the work of offshore projects, if heave compensation can be used to the crane and make the ships still operate normally in the larger wave environment, this will significantly improve the offshore productivity and reduce standby time of offshore work. With the reduction of standby time, it is surelly able to increase production efficiency and reduce artificial cost greatly. Therefore, the research of heave compensation system has great significances to marine projects as well as the development of marine resources.Recetnly, a lot of work about heave compensation research has been carried out, But there is no convenient compensation device applied to marine projects,so we need a set of heave compensator that is convenient to marine projects.

Structural Design

This kind of active heave compensation system independent of crane is mainly composed of two connected hydraulic cylinders and an accumulator. The hook of the crane connects the hydraulic cylinder 1, where there is a hook at the bottom. This hook connects demanding goods. Hydraulic cylinder 1 is connected with the hydraulic cylinder 1 and the hydraulic cylinder 2, the latter connected with the accumulator, The role of the accumulator can reduce energy consumption. The piston rod of the hydraulic cylinder 1 is connected with a servo motor which is connected with Automatic Control System. Servo electrical motor impelled the piston rod of the hydraulic cylinder 2 to move through the given signal. Heave compensation can be done through adjusting the hydraulic oil in hydraulic cylinder.

When the ship on the rises, Servo electrical motor impelled the piston rod of the hydraulic cylinder 2 to move up with the given signal and the piston rod of the hydraulic cylinder 1 will move down. The actual movement displacement of the goods is equal to the distance that the one of ship moving up minus the one of hydraulic cylinder moving down. In fact, the movement of the goods is less than the movement of the ship, so that the compensation results meet the designed requirements. Similarly, When the ship down, Servo electrical motor impelled the piston rod of the hydraulic cylinder 2 to move down with the given signal and the piston rod of the hydraulic cylinder 1 to move up. The frame diagram of the heave compensator is shown in Figure 1.

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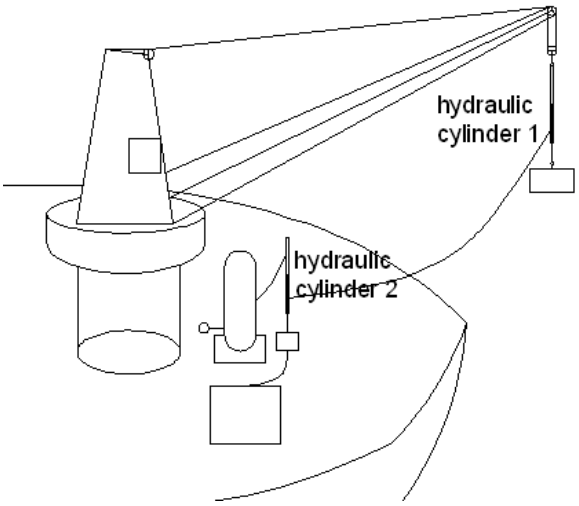

Fig. 1 Structure of the heave compensator

Hydraulic System Design

According to the work pressure of the hydraulic cylinder and lifting weight, we can figure out the inner diameter of the hydraulic cylinder and the piston diameter. Then according to the national standard we can choose the right size. According to the wave environment and the requirements of the hydraulic cylinder, we can determine the hydraulic cylinder stroke and so on. Through analyzing how the accumulator pressure changes on different accumulator volume, we can obtain the suitable sizes of the accumulator.

The frame and principle of the hydraulic system is shown in Figure 2. In order to reduce energy consumption, we must maintain an appropriate pressure balance between the accumulator and the hydraulic cylinder 2.

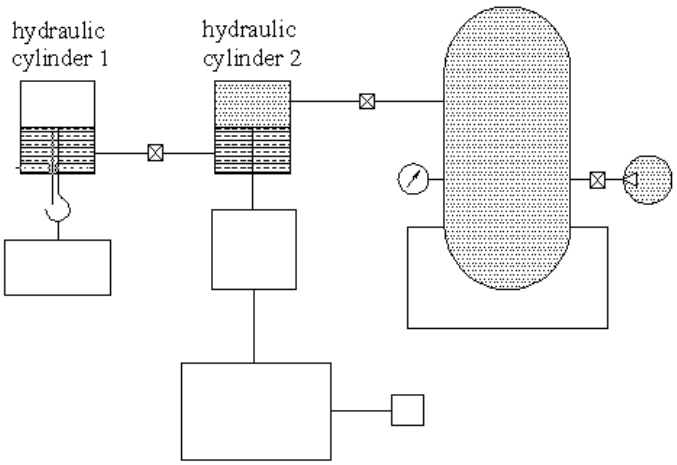

Fig. 2 Structure of the hydraulic system

Simulation

Through studying the theory of the ship's working state and hoisting work, the heave compensation system is simplified, so we can get simulation model in AMEsim. As shown in Figure 3, 1 is the hydraulic cylinder1, 2 is hydraulic cylinder 2, 3 is on behalf of the piston and 4 represents the goods.

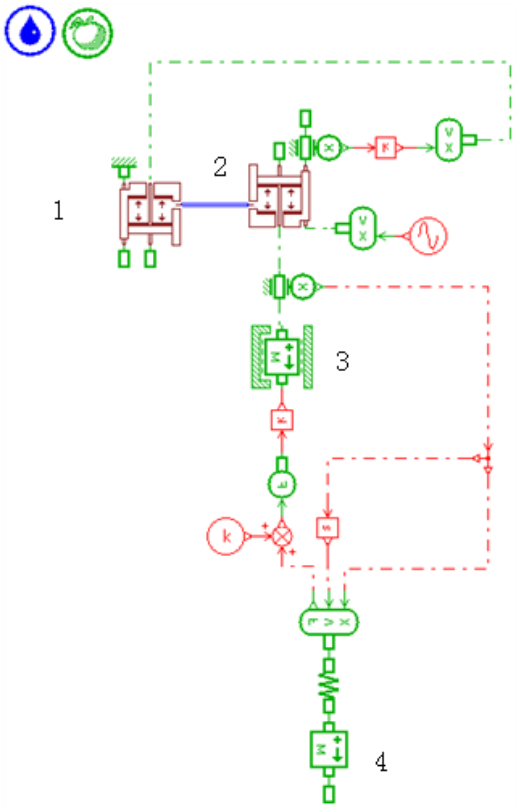

Fig. 3 Simulation model in AMEsim

According to the above parameters, the heaving process can be simulated, and the dynamic characteristics were analyzed. The effect curve of the system is shown in figure 4.

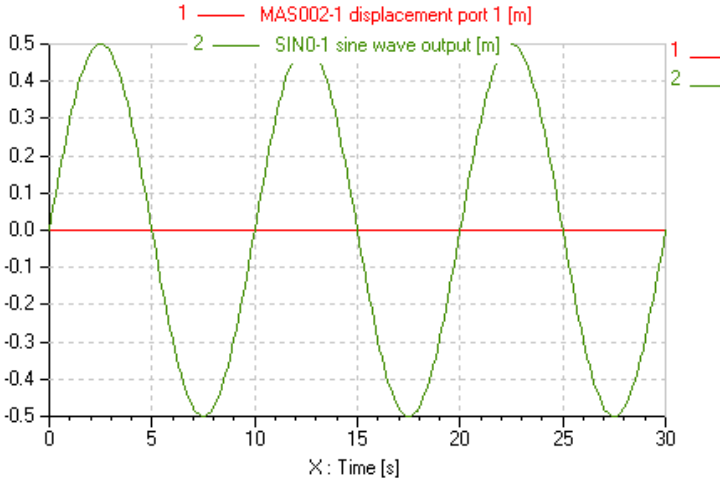

Fig. 4 Effect curve of the system

From the graph we can see, after compensation, the displacement of the hook is smaller than that of the ship.Keep the displacement of the hook controlled in a small range, the maximum displacement of the goods is 1.67 millimeter.

Conclusion

In order to reduce the influence of heave movement on lifting, make the ships still operate normally in the larger wave environment, a kind of active heave compensation system that is independent of crane is put forward.This active heave compensation system is mainly for the following work including structural design, hydraulic system design and the effect of compensation equipment simulation. The displacement of the hook cab be controlled in a small range.

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