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Design specification for the hydraulic equipment of submersibles

潜水器液压装置设计规范

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Foreword

This document complies with the provisions of GB/T 1.1-2020 "Standardization Work Guidelines Part

1.Structure and Drafting Rules of Standardization Documents". Drafting. Please note that some content in this document may involve patents. The issuing organization of this document assumes no responsibility for identifying patents. This document was proposed and is under the jurisdiction of the National Technical Committee on Standardization of Submersibles (SAC/TC306). This document was drafted by: China Shipbuilding Research Center, Shenyang Institute of Automation, Chinese Academy of Sciences, Zhejiang University, and Huazhong University of Science and Technology. University. The main drafters of this document are. Chen Zhida, Li Linglong, Ye Cong, Hu Zhen, Li Zhigang, Wu Shijun, Liu Yinshui, Wang Xuan, Yang Shenshen, and Liu Shuai. Zhao Xiaoyu, Zhang Lei, Wu Defa, Ma Yunxiang, Gu Lang. Design Specifications for Hydraulic Systems of Submersibles

1.Scope This document specifies the design basis, design criteria, design procedures, design requirements, design calculations, and design verification for the hydraulic system of a submersible. This document applies to the design of hydraulic systems for submersibles.

4.1 Functions and Components

4.1.1 Functions The core of a submersible's hydraulic system is to provide reliable and

precise power execution and support functions for the submersible to perform complex underwater operations. It uses hydraulic oil as the working medium and provides actuators (hydraulic cylinders) for various hydraulic users of submersibles through a power unit, pipelines, and control unit. (or a hydraulic motor) provides the necessary hydraulic energy to drive the actuator to complete a specific action.

4.1.2 Composition The hydraulic system of a submersible mainly consists of a power unit, a control unit, a compensation unit, an execution unit, auxiliary equipment and components, and sensor monitoring elements. Composed of components, etc., including.

a) The power unit is a hydraulic pump source;

b) The control unit is a hydraulic control valve box, including directional control valves, pressure control valves, flow control valves, etc.

c) The compensation unit is a pressure compensator;

d) The actuation unit is a hydraulic actuator such as a hydraulic cylinder or hydraulic motor;

e) Auxiliary equipment and components include compensating oil tanks, filters, pipeline fittings, etc.

f) It is recommended to configure sensor monitoring components, mainly including oil tank level sensor, water leakage alarm sensor, oil temperature monitoring sensor, and pressure sensor. Force sensors, etc. Figure 1 shows a schematic diagram of the composition and principle of a typical submersible hydraulic system.

4.2 Design Conditions The hydraulic system design should include the following requirements for the hydraulic system of the submersible.

a) Working condition requirements, including requirements for working depth, temperature, vibration, noise, corrosion, and leakage;

b) Performance requirements, including operating power/fuel supply pressure and flow rate requirements;

c) Control characteristics requirements, including the timing and coordinated control of actuators;

d) Interface requirements, including electrical interfaces, communication interfaces, hydraulic interfaces, and mechanical installation interface requirements.

5 Design Guidelines

The design guidelines should include the following.

a) The selection of pressure rating in hydraulic systems should meet the needs of various hydraulic users. 10 MPa and [other ratings] are recommended. 21MPa, and under hydraulic impact load conditions, the total pressure shall not exceed

1.5 times the rated pressure;

b) The flow rate of oil in the suction, pressure, and return lines of the hydraulic system shall comply with

5.4.6 of GB/T 3766-2015. Requirements;

c) The minimum and maximum dynamic viscosity values of the hydraulic oil in the hydraulic system should be within the allowable viscosity range for the operation of the hydraulic components;

d) The hydraulic unit should be connected to an external compensator, and the compensation pressure should be 0.02MPa~0.04MPa higher than the external working environment pressure;

e) The fuel tank should employ a pressure-compensated structure and integrate level, leakage, temperature, and pressure sensors to facilitate underwater condition monitoring and fault detection. Detection;

f) All equipment and accessories in the hydraulic system that come into contact with seawater shall be made of corrosion-resistant materials;

g) A one-way throttle valve should be installed at the front end of the hydraulic actuator to facilitate disassembly and maintenance of the device;

h) The hydraulic pump source should be equipped with a vent and an oil sampling port to facilitate oil sampling for oil cleanliness testing;

i) Filters should be installed on the inlet and return oil lines of the hydraulic system;

j) Hydraulic devices should adhere to the design principles of generalization, serialization, and standardization ("three-fold"), and mature technologies should be actively adopted during the design process. Standard parts, common parts, and modular units are used to improve design efficiency, ensure consistent quality, and reduce manufacturing and maintenance costs.

k) The design of hydraulic systems should follow the principle of economic design, and the design phase should fully consider the total life cycle cost, covering procurement, operation, and maintenance. Cost control in all aspects, including operation, maintenance, and disposal;

6 Design Program

The flowchart of the design is shown in Figure 2. Figure

7.1 Hydraulic Circuit Design

7.1.1 General Design Requirements The hydraulic circuit design should comply with the

requirements of GB/T 3766-2015 to ensure stable operation of the circuit under rated conditions and to have overload protection. It has basic functions such as protection, pressure compensation, and emergency pressure relief.

7.1.2 Pump Control Loop Design The pump control circuit design should select an appropriate control method based on the motion characteristics of the actuator (constant speed, variable speed, reciprocating motion, etc.). The core principle is... The specifications and design requirements are as follows:

a) The variable displacement pump control loop should have continuous displacement adjustment function, with an adjustment range of not less than 10% to 100% of the rated displacement; a constant displacement pump should be used. During power control, the constant power hyperbola should be matched with the load demand to avoid redundant energy consumption in the system.

b) The set pressure of the relief valve in the quantitative pump relief valve circuit should be 10% to 15% higher than the maximum operating pressure of the system, and it should be equipped with anti-relief features. The circuit should be equipped with a pressure buffer device to suppress pressure surges during pump startup, ensuring that the peak surge pressure does not exceed the set value.

1.2 times the pressure.

c) A pressure synchronization control module should be configured for the multi-pump joint control loop, and the difference in set output pressure between each pump should not exceed the system operating pressure. ±5%; when a single pump fails, the circuit should be able to disconnect the failed pump and switch to the standby pump, with system pressure fluctuations not exceeding [a certain value] during the switching process. Exceeding the system's rated working pressure by 10% to 15%.

7.1.3 Valve Control Circuit Design The valve control circuit should select a suitable hydraulic valve (throttle valve, proportional valve, servo valve, etc.) based on control accuracy, response speed, and load characteristics. The body design requirements are as follows:

a) In a throttling speed control circuit, the flow rate adjustment range of the throttling valve should cover 5% to 100% of the rated flow rate of the actuator.

b) For electro-hydraulic proportional/servo control loops, the valve input signal should match the controller output signal, and signal isolation and anti-interference measures should be configured. Device.

c) In the directional control circuit, the diameter of the reversing valve should be selected based on the maximum working flow rate and allowable pressure drop of the circuit. The peak value of the reversing impact pressure should not exceed [the specified value]. The pressure should be