



Research on Deepwater Dredging Electric Motor

Author: Qiu Puying, Xiao Yiwei,
Zhang Xinli, Yan Qing

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1. Abstract

Under water electric motor

1

It has been widely applied in the dredging industry for many years, and have been used in driving twisting cutters, pumps and other equipment.

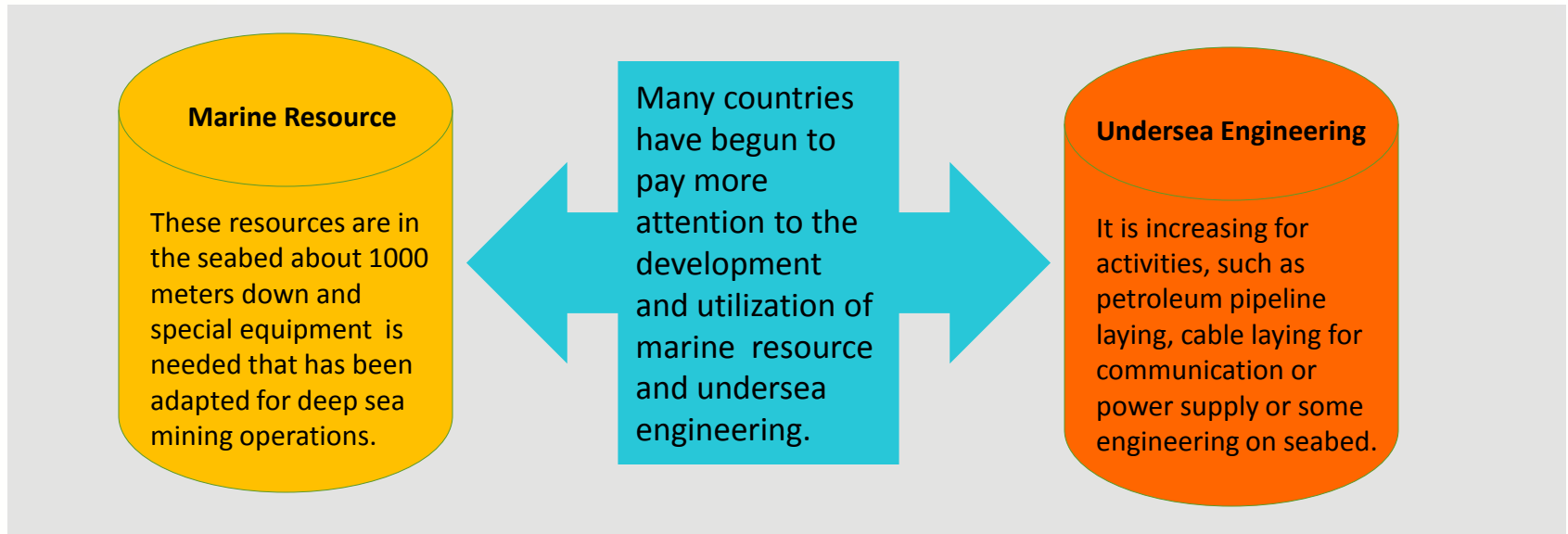
2

Their efficiency, control, environmental protection and reliability have a great advantage, but the submergence depth normally isn't more than 40 m.

3

Now it has been adapt to a depth of 300 meters. This paper will discuss the technology associated with the deepwater electric motor.

2. Introduction



1. The depth is continually becoming deeper from dozens of meters in the past to several hundred meters now.
2. Deep sea equipment will have a wide market in the future and the driving power for most of this equipment will be electric motors.
3. Compared to hydraulic motors and internal-combustion engines, the electric motor is convenient, a high efficiency, long distance transmission, little influence on the environment and easy to be automatically controlled.

2. Introduction

- In the deep sea environment, an electric motor needs to have working characteristics with high pressure, diving operations, more corrosion, and complicated working conditions.
- During design, manufacture, testing and application, these characteristics point to difficulties associated with systematic design, changes of technology and concepts.
- We need special design analysis for them, and in fact, a lot of technical work has been done on the research and development of deepwater electric motors.

2.1 Overall description & General structure

Main Issues: Pressure & Sealing

- ❑ The motors for driving submersible pumps, twisting cutters and other similar equipment are usually squirrel cage three-phase asynchronous motors that are normally submersed underwater no more than 40 meters.
- ❑ The reliability of any motor sealing will be dramatically reduced if more than 40 meters underwater. This will result in failures of the motor stator insulation due to leakage.
- ❑ When the motor is submersed underwater several hundred meters and even thousands of meters, it will be very difficult to guarantee the sealing.
- ❑ With increasing submersed depth, the motor enclosure will endure more pressure which will also have an impact on the strength of the enclosure.
- ❑ **Therefore, the key points of the research is to solve the issues of pressure and sealing.**

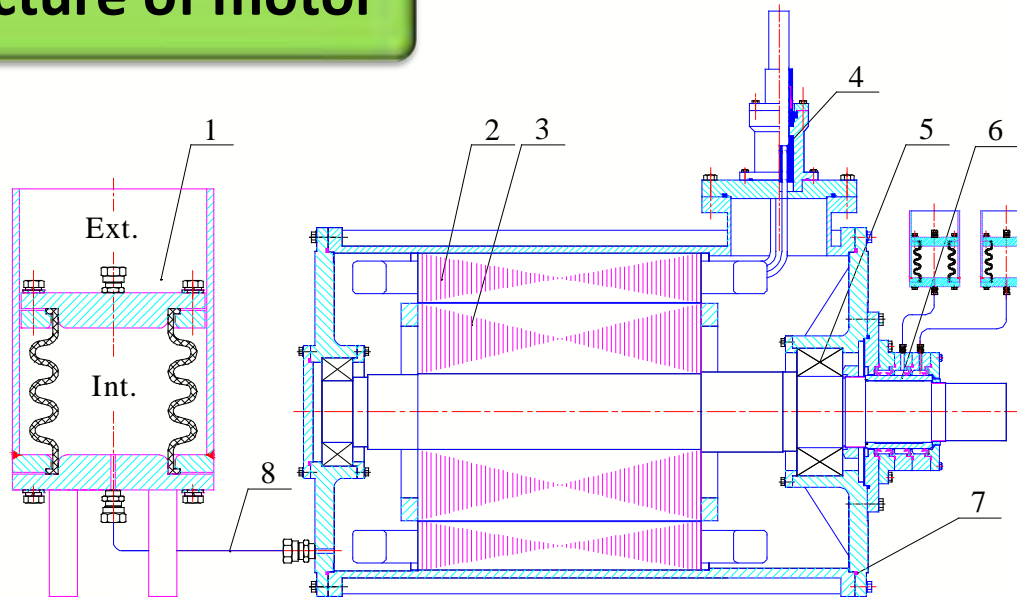
2.1 Overall description & General structure

Solutions

- ✓ The solution to above issues is to fill the motor with fluid and to balance the external pressure with this fluid.
- ✓ By being connected to a pressure compensator in the inner chamber of motor, the internal pressure of motor can change simultaneously with any change to the submersed depth and always balance the internal pressure with the external pressure.
- ✓ The sealing pressure of the rotating shaft and the pressure difference inside and outside the enclosure are very small, so it will be easy to guarantee the static sealing of the mating surface, shaft sealing and the strength requirement of the enclosure.

2.1 Overall description & General structure

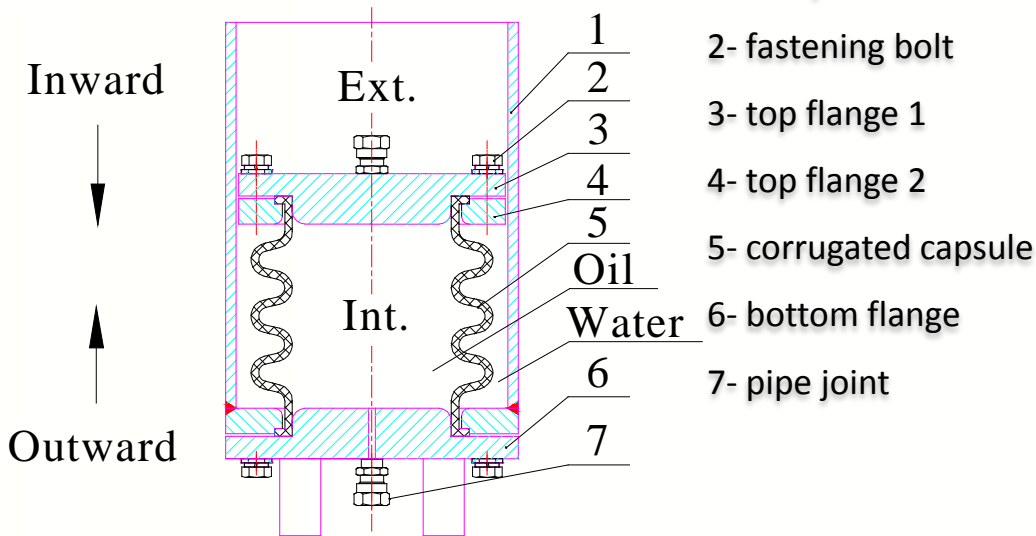
Structure of motor



- 1- pressure compensator
- 2-stator
- 3-rotor
- 4-cable leading device
- 5-bearing
- 6-shaft seal
- 7-seal ring
- 8-connection pipeline.

◆The inner chamber of motor is connected to a pressure compensator mounted outside of motor with a pipeline providing two-way flow and sealing.

2.2 Pressure compensator



The oil expansion rate is calculated as follows:

$$\Delta L = \gamma V (T2 - T1)$$

ΔL - Maximum oil expansion volume Unit: l

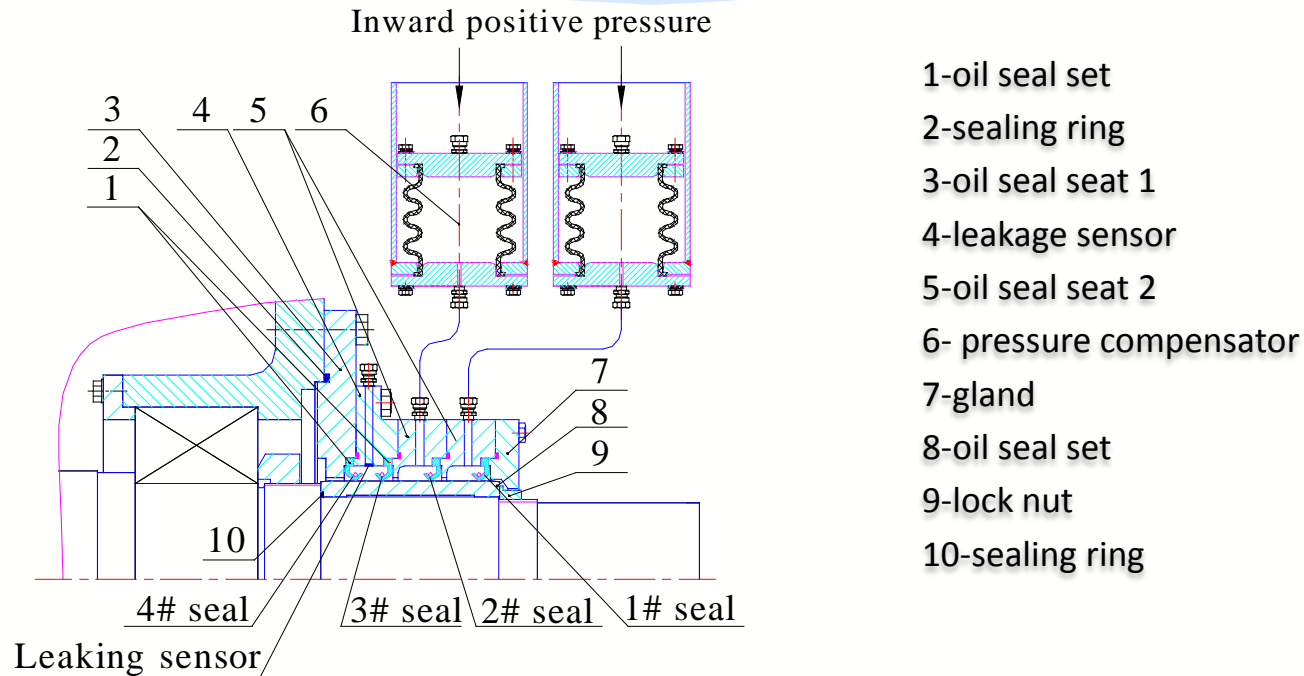
γ - Volumetric thermal expansion coefficient
 , unit:1/°C, Usually can be calculated by
 0.7×10^{-3}

T1- Minimum liquid temperature unit:°C

T2- Maximum liquid temperature unit:°C

- When the motor is submerged into water, the water pressure will compress the capsule and transmit the pressure into the inner motor.
- When the motor is running, the volume of the heated internal oil will increase and the capsule will expand outward eventually reaching a balance between internal pressure and external pressure.

2.3 Shaft sealing device



- ◆ The oil seal set consists of four oil seals. The 1#, 2#, 3# oil seal lips are mounted inwards to seal the oil from the chamber of motor, the 4# oil seal lip is mounted outwards so as to provide a seal from water
- ◆ The pressure compensator is connected between each adjacent oil seal, which is designed to be of a positive pressure type to ensure the internal pressure in balance with the external pressure. And the internal pressure is higher than the external pressure.
- ◆ When any leakage occurs on the first three oil seals, the leakage sensor alarm activates to secure the insulation and protect the electric motor.

3. Application

Case 1: Non-touching type ditching machine



1

The equipment opens ditches using water flow from the pumps in order to lay petroleum pipelines in the seabed.

2

The max operating depth of this equipment operating in China is 300 meters.

3

The control switchboard is put on deck and the power supply is transmitted to the electric motor by an umbilical cable.

4

It can supply the water with 44,000m³/h toward seabed, and ditch a channel with 8-10m width and 3-5m depth.

3. Application

Case 2: Deep water robot



1

The under water electric motor drives an hydraulic pump supplying power to hydraulic machine hands.

2

This kind of mechanical equipment is utilized in dredging under the sea, and its max operating depth is around 200 meters.

3. Application

Case 3: Submersible sand pump



1

The centrifugal pump driven by an electric motor mines sand under water.

2

The pump, driven by an electric motor, directly extracts sand slurry from the seabed and transmits it to a barge where it is deposited.

3

Its max operating depth is around 100 meters under the sea.

4. Technical tips

We must pay special attention to following:

Firstly:

The pressure compensator may fail to work if there is air inside the chamber of the running electric motor. The electric motor must be entirely filled with oil before running.

Secondly:

Any kind of dynamic seal will have a trace of leakage. The oil level will decline during running, so it will be necessary to constantly check the oil level and add oil in a timely manner.

5. Conclusion

- ◆ The deepwater electric motor is the kind of product designed specially by our corporation for deepwater engineering. This is also exploring the developing deepwater equipment.
- ◆ The designed maximum submersed depth is 2000m and the designed power is less than 3MW.
- ◆ **At present, we are seeking the opportunity for the actual application of 2000 meters underwater.**
- ◆ Along with the exploration and exploitations of deep-sea resources, deep sea equipment will be constantly developed. As one of the main driving devices being used, the deepwater electric motor will play an important role in the promoting the development.



THANK YOU.



willyan@china.com

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