Split Structure Design of Magnetic Liquid Sealing Device for High Power Motor

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Abstract. According to the special working conditions of high-power motors, this paper designs a split magnetic liquid sealing device. The material is 316 austenitic stainless steel, which has good mechanical properties. In addition, the material contains Mo element, which has good corrosion resistance and high temperature resistance. It is suitable for use under harsh conditions and meets the special use conditions of high-power motors. In addition, the end cover also adopts a split structure, and a connecting hole is opened on it for the two parts of the split structure to be connected with hexagon socket head screws. The pole piece is a key component in the magnetic liquid sealing device. Its function is to form a magnetic circuit. The material is required to have high permeability and low coercivity.

1. Introduction
Ferrofluid sealing is a new type of non-contact sealing [1]. According to the special working conditions of high-power motors, this paper designs a split magnetic liquid sealing device. The material is 316 austenitic stainless steel, which has good mechanical properties[2]. The pole piece is a key component in the magnetic liquid sealing device. Its function is to form a magnetic circuit. The material is required to have high permeability and low coercivity.

2. High-power motor sealed enclosure design
The shell is designed with a split structure, and a connecting hole is opened on it for the two parts of the split structure to be connected with hexagon socket head screws. The outer end of the shell is in the form of a flange with 30 holes evenly distributed for connection and fixation with other devices. As shown in Figure 1 and Figure 2, the shape of the split housing and the design of the connection are actually processed. The material is 316 austenitic stainless steel, which has good mechanical properties[3]. In addition, the material contains Mo element, which has good corrosion resistance and high temperature resistance. It is suitable for use under harsh conditions and meets the special use conditions of high-power motors[4]. In addition, the end cover also adopts a split structure, as shown in the figure.
Fig1. The shell of split sealing structure device

Fig2 The shell joint of split sealing structure device

Fig3 The cover of split sealing structure device
3. High-power motor sealed pole shoe design
The design of the pole shoe also adopts a split structure, and a connecting hole is opened on it for the two parts of the split structure to be connected with hexagon socket head screws. The pole piece is a key component in the magnetic liquid sealing device. Its function is to form a magnetic circuit. The material is required to have high permeability and low coercivity. In the past, electrician pure iron was used to make pole shoes in the magnetic liquid seal, which has high saturation magnetic flux density value (=2.15T), high permeability (generally pure iron=20000Gs/Oe), and high Curie point (=770°C). But its resistivity is very low [5], can produce a large iron loss (3-6W/kg), so it can not be used for AC magnetic field. Experiments have proved that 1Cr13 has good magnetization properties, is a martensitic stainless steel, is not easy to rust, has good machining properties, and has better dimensional stability than electrical pure iron. Therefore, 1Cr13 material is selected in the design. The shape of the pole teeth is processed into a triangle, as shown in Figure 4.

4. Design of sealed permanent magnets for high-power motors
There are many materials for permanent magnets, and their performances vary greatly. Therefore, when designing a magnetic fluid sealing structure, it is first necessary to select suitable permanent magnet materials and specific performance indicators. Commonly used can be divided into three categories: one is aluminum nickel cobalt (Al-Ni-Co) permanent magnet materials; the other is permanent magnet ferrite; the third is rare earth permanent magnet materials. This category can be divided into three generations, namely SmCo5 type, Sm2Co17 type, Nd-Fe-B type. After considering the performance and reliability, the neodymium iron boron (Nd-Fe-B) material was selected because of its large remanence, high coercivity, large maximum magnetic energy product, and excellent overall performance. However, NdFeB materials also have shortcomings, such as its poor thermal stability and irreversible demagnetization at high temperatures, mainly because the ternary NdFeB alloy has a large temperature coefficient of remanence and coercivity, which hinders the alloy Normal work at higher temperatures, and the stability of the coercive force is the main factor that limits the temperature range of its use. The temperature coefficient of coercive force can be effectively reduced by adding elements such as Dy, Ga, V, and Nb, and the magnetic flux can be reduced. Irreversible loss. However, the addition of these elements often leads to a significant reduction in remanence. Through comprehensive analysis and comparison, we finally use neodymium iron boron (Nd-Fe-B-Dy-Sn) N38H magnets. The design principles of permanent magnets include two basic requirements: (1) Ensure that the magnetic field strength in the sealed working gap meets the selected value, and should not be too high or too low; (2) The magnetic field intensity and magnetic induction intensity inside the permanent magnet are required to work at the maximum magnetic energy product of the material, so that the internal magnetic energy can be effectively utilized. In general, the permanent magnet of the magnetic liquid sealing device is designed in a ring shape and coaxial with the rotating shaft. However,
due to the huge size of the magnetic fluid device designed this time, the annular structure does not require processing and installation. Considering that the housing and pole shoes are designed as a split structure, as shown in Figure 5, it is decided to use a total of 68 small cylindrical permanent magnets between the pole shoes. Structures arranged along the circumference.

5. Sealing ring design of high-power motor sealing device
The design principle of the O-ring seal is the same as that of the traditional static seal. The size of the groove where it is located can be determined according to the empirical formula: Slot length Groove depth Where is the cross-sectional diameter of the O-ring. In addition, the O-ring material should not react with the sealing medium Freon (F113), so nitrile rubber is used, as shown in Figure 6.

6. Conclusions
According to the special working conditions of high-power motors, the split magnetic liquid sealing device must be following:

The material is 316 austenitic stainless steel, which has good mechanical properties. In addition, the material contains Mo element, which has good corrosion resistance and high temperature resistance.

It is suitable for use under harsh conditions and meets the special use conditions of high-power motors. In addition, the end cover also adopts a split structure.

The design of the pole shoe also adopts a split structure, and a connecting hole is opened on it for the two parts of the split structure to be connected with hexagon socket head screws.

The pole piece is a key component in the magnetic liquid sealing device. Its function is to form a magnetic circuit. The material is required to have high permeability and low coercivity.
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