Development of axial piston pump / motor technology

Axial piston pump/motor is an important power component and executive component in hydraulic system. It is widely used in industrial hydraulic and walking hydraulic fields. It is one of the most widely used hydraulic components in modern hydraulic components. In addition, the axial piston pump/motor is one of the hydraulic components with high technical content because of its complex structure and high requirements for manufacturing process and materials. In recent years, with the development of materials, manufacturing, electronics and other technologies, new axial piston pump / motor technologies have emerged in endlessly, such as the Hell series multi-functional pumps tailored for construction machinery by Saul-Danfoss Company of Denmark, the electronic intelligent pumps produced by Rexroth Company of Germany, etc. Since the development of CY series and the introduction of Rexortht technology in China in the 1960s and 1970s, the development of axial piston pump / motor technology has been slow. In recent years, with the rapid development of China's economy, in the process of industrial modernization and large-scale urbanization, the demand for axial piston pump/motor is very strong in the fields of construction machinery, plastic machinery, metallurgy, machine tools and agricultural machinery, so it is very urgent to improve the performance of axial piston pump/motor in China, and the technology of axial piston pump/motor is also very important. The requirement of technological innovation is also very urgent! Overview of the development and evolution of axial piston pump/motor technology at home and abroad has important guiding significance and practical significance for understanding the development trend of axial piston pump/motor and accelerating the development of axial piston pump/motor technology in China.

According to the distribution mode, axial piston motor can be divided into valve distribution type and end distribution type, but valve distribution relies on one-way valve to achieve the distribution, stepless variable difficult, poor self-priming ability, irreversible, so its application is less and less. For the end flow distribution, it can be divided into two types: swashplate type and inclined shaft type. As the inclination angle of the inclined shaft pump/motor is larger than that of the inclined disk pump/motor, it can reach about 400, so it has good starting effect and large output torque as a hydraulic motor. But its complex structure, poor workmanship, and can not achieve through-axis structure, coupled with complex variable structure, so that its application as a hydraulic pump in modern hydraulic field has been reduced. Swashplate pump in addition to the swashplate angle is slightly smaller than the swashshaft pump, all other aspects have achieved good comprehensive performance. In recent years, the development trend of axial piston pump presents the following new characteristics.

(1) high speed and high pressure are the development direction of axial piston pump / motor. This reflects the improvement of power density, and makes it can be directly matched with the engine, more convenient for application.

(2) Both quantitative and variable oblique shaft motors have good prospects because of their good starting performance and large torque transfer.

(3) Light axial piston pump can compete with vane pump because its cost is only 20% higher than vane pump, but its performance is much higher than vane pump. This is also a

development direction of axial piston pump.

(4) combined with electronic technology to achieve various control modes. The electronic pump introduced by Rexroth realizes accurate closed-loop control of pressure and flow rate. Besides, frequency conversion control has been gradually applied in the fields of hydraulic elevators, injection molding machines and so on.

During the development of axial piston pump/motor, the three friction pairs, plunger pair, distributor pair and contact pair between plunger and swashplate (now basically slipper structure), have not changed much. They are the most important links of oil absorption, oil pressure and flow distribution to complete the work of the pump/motor. They also produce energy dissipation, leakage and flow pulsation. The performance and life of the pump/motor are closely related to these friction pairs. Therefore, the modification and optimization of the friction pairs has become one of the most important key technologies of the axial piston pump/motor.

Vibration and noise reduction is the key technology related to the future development of axial piston pump / motor. With the progress of society, people's demands on the working environment are getting higher and higher. Noise is an important indicator to balance the quality of the working environment. There are clear rules for noise of hydraulic pumps all over the world. In hydraulic equipment, pump / motor is the main noise source of hydraulic equipment. Because of the discontinuity of the oil output from the cylinder block and the separation structure of the oil suction and pressure chamber, the axial piston overturning motor produces large flow pulsation and hydraulic noise, in addition to the cavitation noise generated by the complex flow channel. The interweaving of hydraulic noise and mechanical noise forms the overall noise of axial piston pump.

Variable control modes of axial piston motor are various. According to different control modes, there are manual, electric, proportional, servo, etc. According to whether feedback can be divided into open-loop and closed-loop control, closed-loop control has constant pressure, constant current, constant power and load-sensitive adaptive control, etc. The control mode of axial piston pump has been superior or inferior. It has become an important indicator of its quality, but there are also some problems in variable control. The improvement and solution of these problems is also an important technology of axial piston pump/motor.

(l) Because of the axial piston pump/motor flow distribution structure, it will produce large flow and pressure pulsation, which will interfere with the control.

(2) the range of variables is small. Swashplate pump mainly depends on changing the inclination of the swashplate to achieve variables, inclination by the inclination moment and the structure of the slipper and other factors, generally less than 18 years. The German Linde company 02 series pumps adopt the new slipper hinge structure to increase the inclination angle to 21. The ordinary ball hinge is a Slipper Shoe stopper structure, while the 02 series is a plunger pack slipper structure, and the ball socket is made on the plunger. This structure makes the displacement increase by 16% and the volume reduction by 18%.

(3) Variable mechanism of axial piston pump/motor is generally sensitive to oil contamination

and needs to be well maintained.

Because of the complex structure, movement and flow field of axial piston pump/motor, the key friction pairs have high requirements for wear and force, and in order to ensure the clearance of oil film, the machining accuracy is higher. Therefore, the application of new materials and new manufacturing technology have important significance for improving the performance of axial piston pump. Only the new materials and manufacturing industries need to rely on the breakthrough of materials related disciplines and the improvement of the overall manufacturing level to achieve.

Domestic axial piston pump/motor mainly imports foreign technology products and our own research and development of CY series piston pump/motor. The introduction of foreign technology Rexroth, Yuken and other series, the performance between foreign products and CY pumps. Looking at the development of domestic axial piston pump / motor, the following characteristics are main.

(l) As far as performance indicators are concerned, the displacement, rated pressure and rotational speed of domestic eRxorht series are larger than those of CY series. The rated pressure is 35 MPa, the peak pressure is 40 MaP, the rotational speed is over 2000:r/min, while the CY series rated pressure is 31.SMaP, and the rotational speed is generally limited to 1 soo:r/min.

(2) In terms of market share, CY still holds a certain low-end market share because of its price advantage, but its profit margin is low. Because of its unstable performance, it is difficult to be used in construction machinery, injection molding machine and other fields. A small number of domestic Rexroth products are used in cranes and other fields. Foreign products occupy a large high-end market share with performance advantages.

(3) As far as enterprises are concerned, there are many manufacturers of axial piston pump/motor in Europe and America, but there are only 6 to 8 manufacturers of axial piston pump/motor in China, and most of them adopt foreign technology. Because of the weak foundation of the hydraulic industry in our country, compared with the foreign technical level, the domestic is still relatively backward, mainly in the field of axial piston pump / motor in the following aspects.

(L) compared with several enterprises in China, the number of foreign enterprises is large and large. For example, Rexroth, Eaton, Linde, Parker, Denison, Danfoss, Hawe, Yuken, and other enterprises, such as Komatsu, Kawasaki and Mitsubishi, produce pumps / motors directly for their own construction machinery complete set.

(2) Foreign manufacturers have rich product lines, many product lines, product models, such as Rexorht's AF series, AV series, KVA series, etc., for industrial hydraulic and engineering machinery hydraulic industry configuration of a rich product line.

(3) the performance of foreign products is excellent and the technology is fast updating. Displacement from a few milliliters to thousands of liters, some of the rated pressure can reach

more than 40 MaP, self-priming speed is mostly over 2OO0r / n, a few small displacement even up to 8000r / min above, and long life, low noise.

(4) In terms of variable control methods, there are many foreign product variable methods, and various variable methods have many optional functions. Although there is a gap, the demand for axial piston pump/motor in our country has been very strong, which is a great opportunity for the development of axial piston pump/motor. As long as we can continue to innovate in structure and technology, the technology and products of axial piston pump/motor in our country can certainly go up to a new level.

In the development of axial piston pump/motor, the basic structure remains stable, high speed, high pressure and good control method is the direction of its development. With the development of electronics, computer, materials and manufacturing technology, multi-disciplinary cross-application in the study of pump/motor makes the simulation and test closer to reality, and the efficiency of pump/motor design and optimization is greatly improved. Axial piston pump/motor technology in China is still relatively backward, but the strong demand for the development of axial piston pump/motor technology has a great role in promoting. Therefore, as long as we can keep up with the international technological trend and give full play to the advantages of backwardness, we will surely catch up with the international advanced level and even catch up with the latter.