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Design of high temperature butterfly valve for diesel engine

Lin Li
School of Artificial Intelligence
Wuchang University of Technology
Wuhan 430223, Hubei, China
1256117220@qq.com

***Abstract*—Large Marine diesel engine is the core equipment of Marine power industry to achieve high quality development, in order to improve the localization of matching rate, implementation technology of autonomous control, the high temperature gas pipeline valve adopts the domestic independent research and development on the way, but the special working condition of the diesel engine make the traditional valve can not be run reliably for a long time. Based on this, combined with the traditional valve failure problem, using innovative design ideas and manufacturing methods, through continuous tests, developed a high quality large diesel engine special high temperature butterfly valve. Taking the high temperature butterfly valve used in a large diesel engine of a certain type of ship as an example, the structure design, strength calculation and manufacturing process of key parts of this high temperature butterfly valve are described.**

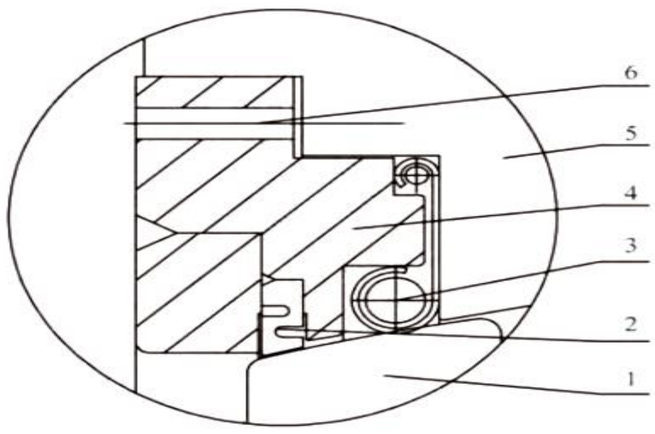
INTRODUCTION

With the improvement of automation requirements, reliability, long running time, maintenance convenience, power control and long service life have become the main technical indicators in the performance of large and high power diesel engines. These requirements greatly increase the development difficulty of the valve in the engine airway. Especially in the exhaust gas pipeline after combustion, the valve has high operating temperature, intense vibration, large temperature change gradient, high sealing performance requirements, fast opening and closing speed, and any failure of the valve will affect the operation of the engine, or even make the engine scrap and affect the operation of equipment. Therefore, the research and development of this kind of valve has become a bottleneck for major engine manufacturers to focus on breakthrough.

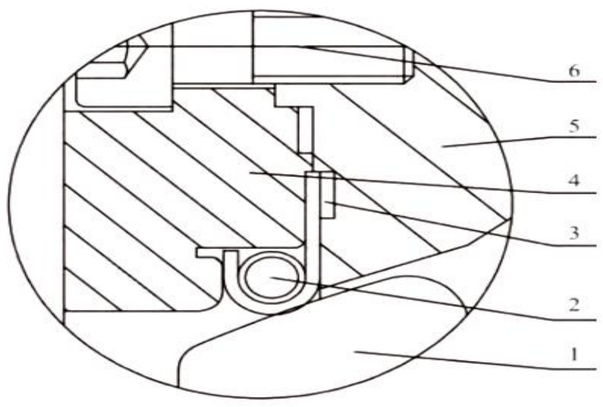
THE STRUCTURE DESIGN

In view of the requirements of installation space and vibration, the valve must be designed to be small and light. Through tests, it is found that the valve with butterfly valve structure is the best choice.

With properly raised neck and heat sink design, the packing and actuators operate at reliable temperatures.



1—Butterfly plate; 2—Auxiliary seal ring; 3—Metal elastic sealing ring; 4—Pressure plate; 5—The valve body;6—screw
Fig. 2 The valve seat part structure design scheme 1



1—Butterfly plate; 2—Metal elastic sealing ring; 3—gasket; 4—Pressure plate; 5—The valve body; 6—screw
Fig. 3 The valve seat part structure design scheme two

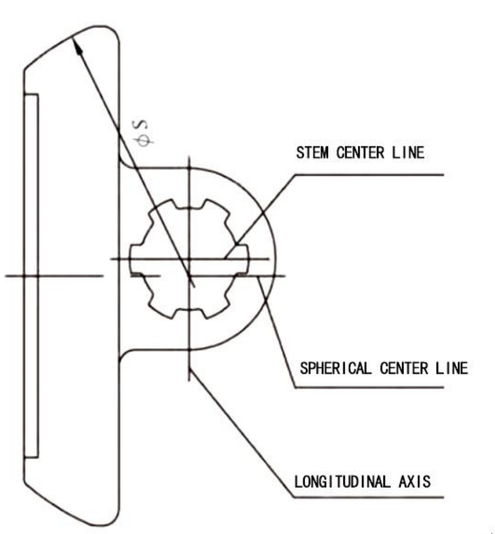


Fig. 4 Disc structure design drawing

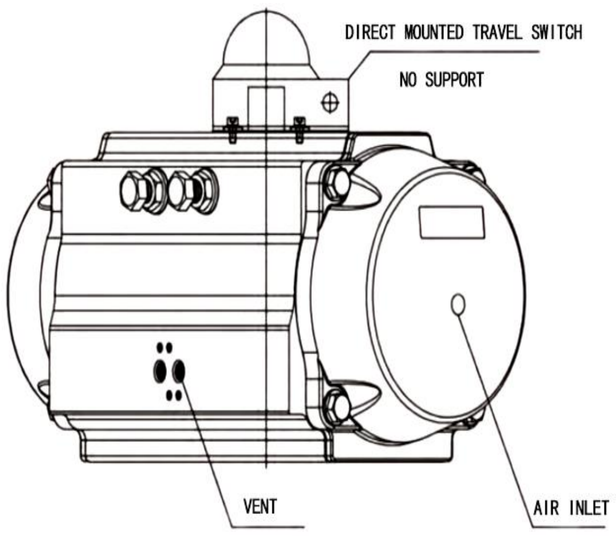


Fig. 5 Design drawing of pneumatic actuator

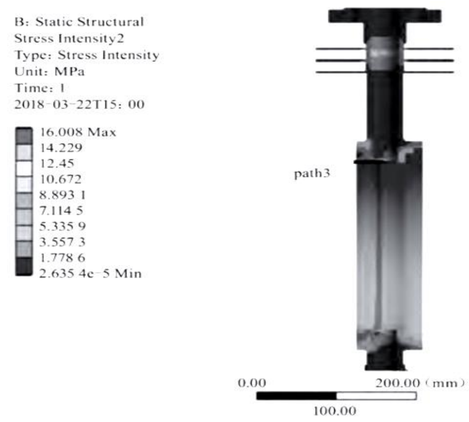


Fig. 6 Finite element stress analysis results of valve body under high temperature condition

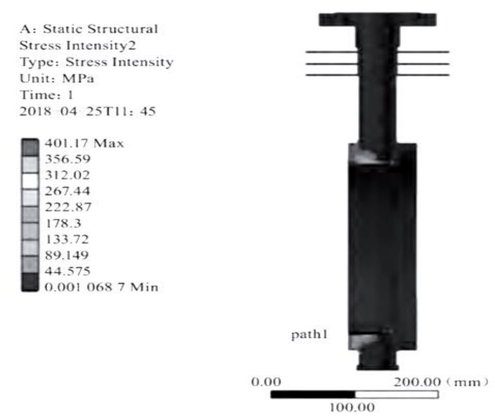


Fig. 7 Finite element stress analysis results of valve body subjected to vibration

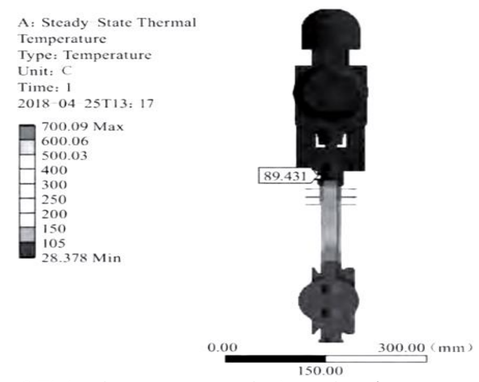


Fig. 8 Finite element stress analysis results of temperature distribution gradient field of valve body

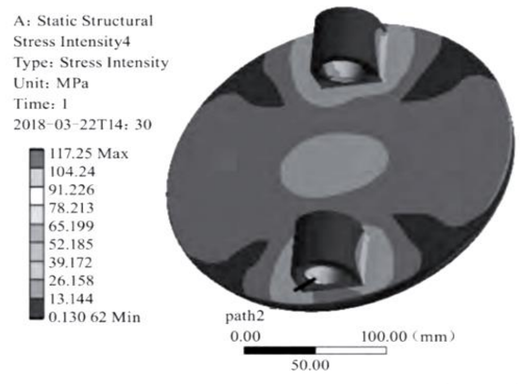


Fig. 9 Finite element stress analysis results of butterfly plate under high temperature and design pressure difference

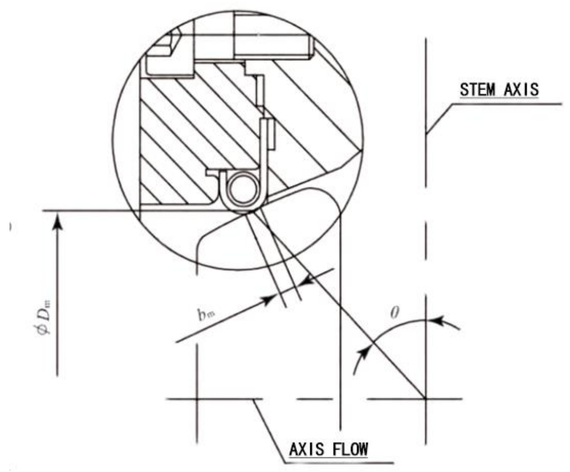
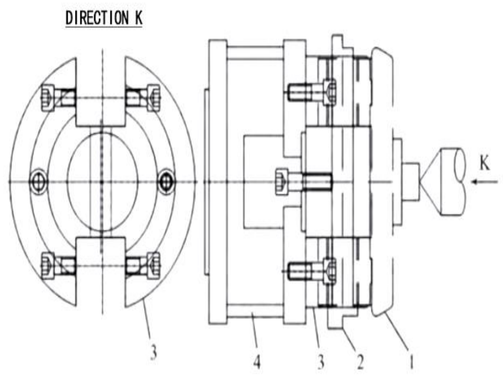


Fig. 10 The symbolic meaning of torque calculation



1—to be processed butterfly plate workpiece;2—fixed mandrel shaft;3—eccentric tooling;4—the support connected with the spindle of the machine tool.

Fig. 11 Diagram of eccentric butterfly cricket surface processing fixture

INSPECTION AND TEST

In order to verify the safety and reliability of the valve operating under high temperature and strong vibration, three valves of the same specification were selected after the first assembly to test the sealing performance and switching life under simulated high temperature and vibration.

The external heat method can be used in the simulation high temperature test, that is, the valve is put into the heat treatment furnace with controllable temperature, and the temperature is gradually heated. The operation and performance test of the valve is carried out at the temperature of each section, and the corresponding test is also carried out in the cooling stage.

The test under vibration adopts the real engine platform, which is generally carried out by installing the valve on the pipeline of the corresponding engine. This test method can detect a large number of unexpected faults and is very convenient for valve design.

CONCLUSION

Due to the large diesel engine with high temperature butterfly valve operation, its performance and reliability directly affect the development of domestic engine, after 3 years of carefully select material, make tooling/fixture design, preparation technology, innovation, and in accordance with the test outline formulated by various working condition of simulated experiment was carried out strictly, finalize the design after the valve can reliably run on the corresponding pipe system. This provides a cost-effective and stable valve for the development of diesel engines for domestic large ships, which not only reduces the dependence on foreign products, but also shortens the manufacturing cycle and reduces the construction cost