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# DEVELOPMENT OF PASSIVE CHECK VALVES FOR PIEZOELECTRIC PUMP

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# ARTICLE DETAILS

# **ABSTRACT**

# Article History:

Received 26 June 2018 Accepted 2 July 2018 Available online 1 August 2018 In order to make the piezoelectric pump work well, it is necessary to reasonably select the passive check valve for the pump. The pressure difference between the two sides of the valve body is very small when the piezoelectric vibrators are powered, so the opening pressure of the valve must be very low. In this paper, in the past research on piezoelectric pump, several commonly used passive check valves for piezoelectric pump, such as cantilever valve, plate valve, dual cantilever valve and bivalvular valve, are introduced. The structure characteristics of various valves and the advantages and disadvantages in the working process are analyzed, which provides reliable data for the further design of the piezoelectric pump in the selection of valve bod.

#### **KEYWORDS**

Piezoelectric Pump, Check Valve, Slice Valve.

# 1. INTRODUCTION

The development of piezoelectric pumps is accompanied by the development of passive stop valves for pumps. As we all know, the piezoelectric pump is limited by its working principle, the vibration of the piezoelectric vibrator makes the pressure difference on both sides of the working valve very small, so the opening pressure of the working valve can not be too large, otherwise the valve will not work because of the inability to open the valve. The piezoelectric pump is divided into the valve piezoelectric pump and the valve free piezoelectric pump according to whether it has the cut-off valve, and the valve piezo pump can be divided into the active valve piezoelectric pump and the passive valve piezoelectric pump. The active valve piezoelectric pump is required to control the original part because of the need of the extra valve, so the piezoelectric pump is relatively complex in the structure design, and the design of the passive valve pressure pump valve is large. Most of them use thin plate structure, which not only makes the structure of the pump simple, but also ensures that the valve can open the pressure pump to work normally when the pressure is driven by the piezoelectric vibrator. The following are several commonly used piezoelectric pump valves are introduced.

# 2. CANTILEVER BEAM VALVE

The working principle of the cantilever beam valve is very simple [1-4]. No matter what the shape of the valve is designed, it is fixed at one end on the installation, and the end is in contact with the import and export of the pump. When working, the contact parts of the pump and the inlet and outlet are offset under the pressure difference, so as to control the flow direction. In processing materials, silicon carving or elastic thin metal plates are often used. Figure 1(a) is a cantilever beam valve carved by silicon. The cantilever valve is made up of two silicon wafers. The upper part is the execution part of the cantilever, and the following is the flow hole part, because the silicon has excellent mechanical strength, so it can cause a continuous shift of the cantilever to let the fluid pass through. In order to ensure the working accuracy of the valve, the bonding of the glue, the surface treatment of the silicon and the cleaning of debris are the key factors affecting the working performance of the valve. Figures 1 (b) and (c) are cantilever beams made of metal sheets. Because the working

environment of the piezoelectric pump may be more complex, such as the high temperature of the working medium, or some corrosiveness, the material of the valve should be selected according to the actual needs. The cantilever valve shown in Figure (b) consists of three layers. The intermediate part separates the two valves to form an inlet and outlet valve. The cantilever valve shown in Figure (c) is made of 0.05-0.07mm thick beryllium bronze, and the two valves are bonded together to form an inlet and outlet valve.

The advantage of cantilever valve is simple structure and easy to process. The disadvantage is that the opening degree of the valve is influenced by the length of the cantilever. The longer the cantilever is, the larger the opening degree of the valve is, the longer the length will affect the reverse cut-off of the valve.

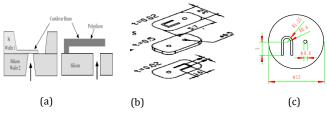


Figure 1: Cantilever beam valve

# 3. PLATE VALVE

Compared with the cantilever valve, the plate valve is fixed in the surrounding area [5-8]. This fixed form makes the execution part of the valve more flat, the valve is offset under the pressure difference, and the direction of the flow is controlled. In processing materials, silicon carving or elastic thin metal plates are often used. Figure 1 (a) is a cantilever beam valve engraved by silicon. The cantilever valve is closely connected to the plane of the outlet of the pump to increase the reverse cut-off of the valve. Figure 2 is a few plate valves with different structures. The middle plate is the valve plate (flap) is the valve's execution part, contact with the plane of the outlet hole, the valve is all around the valve arm, the valve arm is the spring beam.

The biggest advantage of flat valve is that the valve part is uniformly loaded, which improves the reverse cut-off of valves. The disadvantage is that some structure is more complicated. The spring force of the valve arm is too difficult to open the valve. Long time work makes the valve arm deformed and the valve part is no longer smooth, which affects the cut-off effect of the valve.

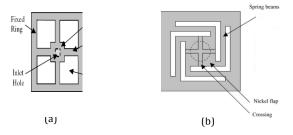
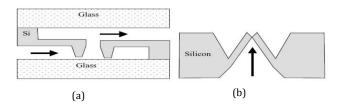


Figure 2: Plate valve

# 4. BUTTERFLY VALVE AND "V" TYPE VALVE

The working principle of the butterfly valve is similar to the working principle of the cantilever valve such as Figure 3 (a) [9,10]. Only each type of valve contains two cantilevers and an exit gap, as two cantilever pairs appear, like butterfly, so the butterfly valve is called. The disadvantage of butterfly valves is that the machining process of valves is rather complicated. The advantage is that the inlet valves and outlet valves can be machined on a base plate.

Figure 3 (b) is a structure diagram of the "V" valve. The valve's execution part is a pair of deformable valve wings, which can be opened by pressure difference, such as "V". The advantage of the "V" valve is that the valve's execution part is processed directly on the silicon layer and does not need to be cemented. The disadvantage is that there is a gap between the wings of a pair of valves and it is easy to leak in the work.



 $\textbf{Figure 3:} \ \textbf{Butterfly valve and "V" valve}$ 

# 5. OTHER STRUCTURE VALVES

With the continuous development of piezoelectric pump research, the demand for valves is higher and higher. The valve, which can carry a large output pressure, can still work well at higher frequencies [11,12]. The bearing pressure of this kind of valve can reach 10MPa, and the working frequency is as high as 10kHz. Figure 4 is the two form of the array valve, usually installed in a stack driven piezoelectric pump, because the stack pressure pump often output pressure, so the valve is required to have a higher bearing capacity [13,14].



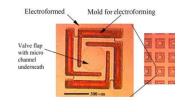


Figure 4: Array valve

# 6. CONCLUSION

In this paper, the structural characteristics of the piezoelectric pump valve are introduced, and the following conclusions are drawn:

- 1. Because the pressure on the two sides of the valve is smaller due to the volume change of the piezoelectric pump, the opening pressure of the valve must be ensured at design stage.
- 2. The structure of the piezoelectric pump valve basically chooses thin structure, which is convenient to install in the narrow space of the pump cavity and easy to open.
- 3. Flat valve in the installation due to the fixed peripheral uniform force, cut-off performance is better, so in the design of piezoelectric pump is more widely used.

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