Study on high reliability safety valve for railway vehicle

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Abstract. Now, the realization of most of the functions of the railway vehicles rely on compressed air, so the demand for compressed air is growing higher and higher. This safety valve is a protection device for pressure limitation and pressure relief in an air supply system of railway vehicles. I am going to introduce the structure, operating principle, research and development process of the safety valve designed by our company in this document.

1. Introduction
Now, the realization of most of the functions of the railway vehicles rely on compressed air, so the demand for compressed air is growing higher and higher. This safety valve is a protection device for pressure limitation and pressure relief in an air supply system of railway vehicles. When the pressure of the system reaches the preset value, the safety valve opens automatically to release the pressure to prevent the continuous rising of pressure. When the pressure is reduced to the specified value, the safety valve closes in time to prevent the loss of compressed air in the system. The reliability and performance of the safety valve is directly related to the safety of equipment and people, and is closely related to energy conservation and environmental protection.

The safety valves does not open during the daily service, but it must work once there is a overpressure danger occurs in the air supply system. So the reliability of the opening of safety valve is a key item.

2. Description of structure and operating principle

1.lead sealing, 2.steel wire, 3.protection slice, 4.check ring, 5.knob, 6.body, 7.rod, 8.clamp nut, 9.spring, 10.sealing element, 11.copper spacer, 12.chamber

Figure 1 Structure Diagram
As shown in figure 1, the safety valve consists of components from number 1 to number 11, there is a sealing surface, an entrance A, an exhaust B, an exhaust C and a chamber 12 after assembly.

The sealing element 10 presses the sealing surface to realize the sealing of product.

The air supply connects the safety valve with entrance A.

The safety valve releases compressed air from exhaust B and exhaust C.

Controlling the operation of safety valve by the pressure in chamber 12 and the load of spring.

Following is the operational principle of safety valve:

1) Open: entrance A gets air supply, when the pressure in chamber 12 is significantly greater than the load of spring, the safety valve opens and outputs compressed air from exhaust B and exhaust C. Otherwise the safety valve does not open.

2) Close: Safety valve outputs compressed air from exhaust B and exhaust C while opening, when the pressure of system releases to a specified value (relate to the opening value of safety valve), safety valve closes and the exhaust air is no longer discharged.

3. Research and development process

The safety valve applies for air supply system of railway vehicle should meet the requirements of wide climate, long time in idle, high vibration and high reliability.

A. Suitable material for spring and reasonable design parameters for body and sealing element helps the safety valve to achieve the high reliability and good performance. Key characteristics for safety valve are the designs of spring and sealing surface. The mechanical property and material influence the performance of spring a lot. We choose material 50CrSi with cataphoresis’s treatment and define other parameters according to calculation. In order to enhance the corrosion resistance of safety valve assembly, we do nickel plating for the body of safety valve. But the plating would lead to the deviation of the thread’s dimension. To solve this problem, we use a nonstandard thread gauge to control the dimension of thread before plating.

B. China railway has the characteristics of wide distribution and variable environments, e.g. The minimum temperature in the mid night of Heilongjiang is lower than \(-40^\circ C\) in the winter while the maximum temperature in the afternoon of Hainan is higher than \(+45^\circ C\) in summer. In order to meet the requirements of china railway, we developed a special rubber which has the characteristics of good aging resistance, good decline resistance and temperature resistance (\(-40\sim+80^\circ C\)). In the meanwhile, we are researching a kind of rubber which can survive at \(-50^\circ C\) for more serious conditions.

C. Normally, safety valve does not work but it must work once the pressure in the system exceeds the specified value. Considering that the rubber may stick to the safety valve body (surface D) due to long time in idle, the initial open pressure could grow a little. It is forbidden. Our company developed a coating on the surface of sealing element 10. The coating is mainly consist of Teflon. The laboratory test seems good.
Figure 2 sealing surface

D. We apply special anti vibration adhesive on clamp nut, so the clamp nut won’t be loose under vibration and we can still adjust the clamp nut manually if we need small modification on the open value of safety valve.

Figure 3 Anti vibration adhesive

Conclusion
This kind of safety valve has been mass installed on board. The reliability and performance is very ideal refer to the feedback from the market. It can surely protect the air supply system on board, thus to create a good economic benefits for the company.

References
[1] L.Q.Lu: Analysis of Technical Problems of Safety Valve [M]. Valve, 2008(2):29-31
[2] X.D.Zhang: Analysis of Safety Valve [J]. Sinkiang Chemical Engineering, 2009(04)
[3] C.Z.Guo, S.L.Zhu: Study on Numerical Simulation of Transient Pressure Relief of Safety Valve[J]. Fluid Machinery, 2012(2)
[4] Y.Q.Yang: Valve Design Manual [M]. Beijing: Machinery Industry Publisher. 1992
[5] D.X.Cheng: Mechanical Design Manual [M]. Beijing: Chemical Industry Publisher, 2007
[6] S.X.Zhang, C.W.Li, X.Zhang, Q.X.Li: Small Safety Valve, China Patent 201330325361.X.(2013)
[7] S.X.Zhang, C.W.Li, X.Zhang, X.Liu: Safety Valve, China Patent 201330333213.2.(2013)
[8] S.X.Zhang, C.W.Li, X.Zhang, Q.X.Li: A Kind of Safety Valve, China Patent 201320476300.8.(2013)
[9] S.X. Zhang, C.W. Li, X. Zhang, Q.X. Li: A Kind of Safety Valve with manual exhaustion, China Patent 201320485197.3.(2013)
[10] X. Zhang, X.B. Du, S.X. Zhang, Y.F. Lin: A Kind of Safety Valve, China Patent 201620905839.4.(2016)