Altitude valve for railway suspension control system

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Abstract. With the variation of people and material during vehicle service, the gravity of vehicle could be unbalanced. As a result it might cause accident. In order to solve this problem, altitude valve is assembled on board. It can adjust the gravity of vehicle by the intake and outlet progress of the spring in the altitude valve to prevent the tilt of vehicles.

1. Introduction

Recently, with the the rapid development and continuous improvement of people’s living standard and railway field, higher requirements on the performance of the vehicle suspension system are concerned, especially the characteristics of comfort and stable. So the air suspension has been widely used in various vehicles. Comparing with the common leaf spring suspension, air suspension can not only prolong the service life of vehicle but also increase the comfort for whole vehicle. The altitude valve is an important part of air suspension system, which is used to ensure specified height of vehicle under any static loads. And the advantages of air spring can only appear with the using of altitude valve. Controlling the height of vehicle is a key technology for air suspension design. Better understanding of the dynamic characteristics of altitude valve is needed for the future development of air suspension products.

Altitude valve plays a very important role in vehicle suspension control system. At present, the anti dust devices on the exhaust position of altitude valve are not protected seriously. After several time in service, dust, fly ballast, greasy dirt, moisture will enter into the inter structure of altitude valve from the complex environment due to the failure of anti dust devices. The external dirt enter into the altitude valve body will not only lead to the short service life of altitude valve but also influence its’ performance. To solve those problems, our company designed a serious protective solution on the exhaust position of altitude valve based on the existing products. It can surely prevent the entrance of external dirt and improve the reliability of vehicle suspension control system.

2. Description of structure and operating principle

The structure of altitude valve is shown on Figure 1. It is composed of entrance(input)1 and 3, exit(output)4, exhaust. The control principle of the general altitude valve is: vehicle body drops when the loading of vehicle is increased, compress the air spring, control rod is pushed upward, the rotation of eccentric wheel leads the top rod to open the inlet/outlet valve, compressed air in the cylinder goes to air spring through a throttling channel. When the altitude of vehicle is recovered, control rod returns to balanced position, valve in inlet side is closed, compressed air is cut. Vehicle body lifts when the loading of vehicle is decreased, the actions of air spring is opposite referring to foregoing situation, control rod moves downward, valve in inlet/output side is opened, air in air spring goes to atmosphere through a throttling channel and valve.
50. output piston, 51. spring, 52. valve gate body, 53. small sealing ring, 54. valve gate rubber, 55. riveting pressure valve gate, 56. rod, 57. O ring, 58. eccentric shaft, 59. body, 60. output guide ring, 61. baffle, 62. oscillating bar assembly, 63. O ring, 54a. rubber surface, 55a. valve mouth, 56a. rod conical surface.

A. enter chamber for entrance 1 and 3, B. transfer chamber, C. action chamber of rod, D. output chamber.

**Figure 1** Structure Diagram

If the weight on board is increased during vehicle service, the altitude of vehicle will drop. Then the oscillating bar assembly 62 turns to intake position, eccentric shaft 58 turns together with the rotation of oscillating bar assembly 62. Then rod 56 moves upward and jack-up valve gate rubber 54, so there is no longer connection between the rubber surface 54a and valve mouth 55a. Next, the air flow in entrance chamber A goes to transfer chamber B through channel 104, the air flow in transfer chamber B goes to exit 2 or 4 by channel 102 or 103. Then the exit 2 or 4 delivers air flow to the spring to ensure that the vehicle altitude is in suitable position. Then the rod and oscillating bar assembly turns to initial position, valve mouth 55a connects to the rubber surface 54a, entrance A and transfer chamber B are cut-off again.

If the weight on board is reduced during vehicle service, the altitude of vehicle will rise. Then the oscillating bar assembly 62 turns to output position, eccentric shaft 58 turns together with the rotation of oscillating bar assembly 62. Then rod 56 moves downward, so there will be a sealing surface due to the connection of rod conical surface 55a and rubber surface 54a. Next, the air flow in exit B goes to transfer chamber B through channel 102 or 103, the air flow in transfer chamber B goes to chamber D by channel 104 or 105. Eventually the air flow vents from exhaust to ensure that the vehicle altitude is in suitable position. Then the rod and oscillating bar assembly turns to initial position, rod conical surface 56a connects to rubber surface 54a, exhaust chamber D and transfer chamber B are cut-off again.

3. Research and development process
Considering the performance of altitude valve referring to it’s dynamic model, we need to solve the problem: 1) how to control the recovery’s time of vehicles. During parking process, the passengers get
on and off, so the static load is changed, body needs to take a certain time to recover to original altitude. The certain time is called the recovery’s time of vehicles. 2) how to decrease the consumption due to the vibration of vehicle body during running. The performance of altitude valve needs to be taken into account are shown as following:

(1) Non inductive zone test
(2) Sucking angle test
(3) Sealing test
(4) Air flow test
(5) Durability test
(6) Vibration test
(7) High/low temperature test
(8) Salt resistance test

In order to remain the high temperature resistance of the internal components, we choose high/low temperature resistance diaphragm with a certain wear resistance. And we invited an expert to manufacture this kind of rubber according to the requirements.

In order to meet the design’s requirement of sucking angle, we did accuracy calculation for it. Seriously controlling the progress of key components.

CAE analysis is done to simulate the output side’s air flow and time of each angle. Check whether the cooperating structures is reasonable or not.

Research the wear resistance of copper ring and rotational shaft. On the one hand, researching the materials used for those two components, on the other hand, choosing different grease.

The new altitude valve is developed basing on the existing general altitude valve in our company. It improves the structure of original altitude valve and adds protective solutions to prevent the entrance of dirt. It can improve the service life obviously and reduce the cost of maintenance.

In order to remove the clearance between internal exhaust device and valve body, a groove for O ring is designed on the output guide ring. In this way, external dirt can’t enter into valve body.

In order to ensure the smooth ventilation during exhausting progress and sufficient protection in the progress of non ventilation. On the premise of non influence on air flow during ventilation period, we reduce the diameter of exhaust hole as far as possible according to the calculation of air flow delivery. And we add a diaphragm on the exhaust hole. The diaphragm could be pushed when the altitude valve is under ventilation status and it can prevent the entrance of external dirt when it does not vent.

In order to eliminate the squeal when altitude valve is venting, the selection of diaphragm’s hardness is vital. The protective capability will be diminished significantly if the diaphragm is too soft. In the meanwhile, it will lead to the screaming and unsmooth ventilation if the diaphragm is too hard. Our company has tested several types of diaphragm in different hardness, eventually, we select the best solution from the test results.

The advantages of the altitude valve is shown as following:

(1) Impact structure, easy maintenance
(2) Suitable response speed, to ensure that it won’t work due to a slight vibration of vehicles.
(3) Good sucking/exhausting performance at each angle
(4) Easy assembly and maintenance of the internal parts of valve body
(5) Applying stainless steel bolts and so on
(6) No obvious noise during exhaust
(7) Good protective performance

4. Conclusion
The altitude valve is a fully new product which was developed in a short time by Ruili group ruian auto parts co., LTD., referring to the market-oriented and user-oriented. It can adapt to flexible environment applications due to the high protective solutions. The external dirt can’t enter into the body so that the product can achieve longer service life. The development progress improves the quality, performance and reliability of altitude valves in our company, so as to achieve win-win
between our company and customers, and it creates good economic benefits for company.

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