Research on Dynamic Characteristics of Oil and Gas Suspension Cylinder

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Abstract. Aiming at the complex dynamic characteristics of oil and gas suspension cylinders, the simulation model of oil and gas suspension cylinder is established based on AMESim software, and the model is used to simulate the oil and gas suspension cylinder. The main factor in the output characteristics of the cylinder hanging paper focuses on the impact analysis of changes in the characteristics of the nonlinear stiffness characteristics and damping characteristics of the suspension cylinders.

1. Introduction
In recent years, with the development of the automobile industry, vehicle comfort have increasingly become the object of attention. The main element affects the impact of the car is the car's comfort suspension system, the authors used a hydraulic simulation software AMESim oil and gas suspension modeling simulation analysis can shorten the research cycle, saving research costs.

Computer simulation is an important analytical tool, is a common form of computer simulation researchers, designers. Computer simulation can be intuitively reflects the structural member, the system design and reduce the cost of the experimental design, shorten the development cycle. Cylinder suspension directly affect the performance of the carrier vehicle performance, driving comfort, ride comfort and off-road performance. This article will use the simulation model to establish AMESIM suspension cylinder, and analyze dynamic characteristics.

This paper is based on the suspension system of the 35t dump truck. The system is a stand-alone passive suspension system, and the suspension cylinder is an oil-gas hybrid suspension cylinder. The main parameters affecting the oil and gas derived suspension performance; analyze the impact of oil and gas suspension parameters of the suspension of oil and gas properties, while laying the foundation for troubleshooting suspension of oil and gas.

2. Basic theory of oil and gas suspension
Oil may be independent suspension spring may also be non-independent suspension, it is a gas as elastic medium, the liquid medium as a power transmission, not only has good buffering ability, but also has a damping effect for the use of buses and heavy vehicles.

Oil spring in a closed container charged with compressed gas and oil, gas and gas spring is typically an inert gas, usually nitrogen selected. Spring means acting to achieve compressibility of said hydrocarbon by a gas spring. Hydrocarbon spring as an elastic medium with an inert gas, used as a
power transmission fluid medium, typically a gas spring and a hydraulic shock absorber cylinder equivalent thereof.

Depending on the structure, and gas spring form of a single air chamber is divided into three, two and two chamber pressure type.

Advantages:

1. Oil suspension with variable stiffness, can ensure a good car ride comfort. In particular, the site and the mine car, its road conditions and loading conditions are very harsh. With oil suspensions, the impact can be significantly alleviated, reducing turbulence, thereby improving the working conditions of the driver and improve the average speed;

2. Small longitudinal dimension and gas spring, is advantageously disposed on the vehicle overall, some candle using a dump truck independent suspension, the steering wheel angle can reach 45 °, greatly reduces the turning radius of the car;

3. Changing the cylinder oil pressure in the working chamber of the inflatable air chamber can be obtained different variable stiffness so that the main components of oil and gas spring may be in general different tonnages automobiles.

Disadvantages:

1. processing is not easy;(2) Difficulties in maintenance;(3) high manufacturing costs;(4) Additional control components such as hydraulic, electronic, and electrical are required to assist.

Hydro-pneumatic suspensions are commonly used in vehicles that operate in harsh environments, such as large tonnage engineering vehicles used in mining sites. The use of the oil and gas suspension can mitigate the impact and reduce the bumps, thereby reducing the loss of the loaded material, improving the ride comfort and increasing the speed of the driving, and substantially contributing to the engineering efficiency.

3. Introduction to AMESim

Imagine AMESim first introduced by the French company in 1995 and in 2007 was acquired by the Belgian company LMS. AMESim more than one complex system modeling and simulation platform disciplines, Siemens in 2012 to 680 million euros acquisition of Belgian software company LMS International.

Figure 1. AMESim operation interface diagram

AMESim is a multidisciplinary field of complex systems modeling and simulation platform. Users can create complex system models multidisciplinary field on this single platform, and simulation.
can also be studied steady-state and dynamic performance of any component or system on this platform on this basis. It enables engineers to quickly achieve the ultimate goal of modeling and simulation: analysis and optimization of design engineers to help customers reduce development costs and shorten the development cycle.

LMS ImagineLab AMESim allows users freed from the tedious mathematical modeling in order to focus on the physical design of the system itself. Existing libraries are: mechanical library, the library control signal, hydraulic library (including pipe model), hydraulic Component Design (the HCD), power transmission library and so on. As a major tool in the design process, AMESim also has a rich interface with other software packages.

4. Suspension established oil and gas Cylinder Model

4.1. Oil and gas suspension cylinder parameters

This article is suspended and gas cylinder model is based on a former oil and gas design 3500kg tipper suspension cylinders built. Some of the main parameters of the basic model shown in Table 1.

| Parameter name                        | Amount       |
|---------------------------------------|--------------|
| Car motherboard quality                | 3500kg       |
| Hydraulic cylinder piston outer diameter | 80mm         |
| Push rod outer diameter               | 45mm         |
| dead volume                           | 25cm³        |
| gas precharge pressure                | 8.9Mpa       |
| accumulator volume                    | 3L           |
| Wheel quality                         | 50kg         |
| spring rate                           | 180000N/m    |
| damper rating                         | 5000N/(m/s)  |

4.2. Simulation model construction

Experimental simulation model shown in Figure 2, the basic principle of the test: changing the valve by changing the loading direction of the loading cylinder, generating positive and negative forces in two directions, so as to drive the gantry uprights along the hydropneumatic suspension vibration, vibration process, the output force oil suspension obtained by measuring the force sensor, the cylinder and piston relative displacement obtained by the displacement sensor, the displacement curve obtained by fitting the mathematical expression of the relationship between displacement and time. Deriving the displacement and obtaining the relative velocity can simulate the characteristic curve of the vehicle body speed of the oil and gas suspension.

First fix the parameter values in Table 1, and then change the size of any one of them as needed. This can effect of different operating parameters or structural parameters of the working oil suspension properties, and nonlinear changes in the recording speed of the vehicle body under different operating conditions.

The resulting test data are displaced with respect to the cylinder and the piston of the pneumatic cylinder curve over time. Are discrete data obtained in this experiment. The test data is first preprocessed to remove the effects of noise. Non-characteristic curve dynamics virtual prototype simulation is required force and displacement. In this paper, Excel and simulation software are used to directly draw the discrete data, and the curve of the displacement and force is fitted by the least square method of curve fitting. The non-characteristic curves of the oil and gas suspension cylinders before and after treatment will be shown in the next chapter.
5. Analysis of nonlinear response characteristics of oil and gas suspension cylinders
The characteristics of the suspension cylinder are mainly composed of elastic characteristics and damping characteristics. Suspension cylinders is determined by the characteristics of the suspension cylinders of an inert gas, such good elastic properties of the vehicle with good ride comfort. Shock absorber damping characteristics of the suspension depends on the characteristics of good damping characteristics to the vehicle with good damping properties. Cylinder suspension characteristics need to match each other, so that energy consumption can be quickly, quickly dampen vibration, play a good damping buffering function. Set cylinder suspension and damping element is an elastic member integrally pneumatic cylinder acts as a gas compression spring element, oil flows through the orifice generates a damping force acts as a damping element.

By changing an initial parameter, the corresponding speed response is obtained. Drawing the simulation results into a graph can visually discover the effect of each parameter on the response speed.

5.1. Simulation model construction
Change suspension damping characteristics: N/(m/s)
Set the suspension damping to 5000 7000 9000 11000.

5.2. Change the outer diameter of the hydraulic cylinder piston: [mm]
Set the hydraulic cylinder piston outer diameter to 80mm, 75mm, 70mm, 65mm.
5.3. Change the initial inflation pressure of the oil and gas suspension: Mpa
The initial inflation pressure of the oil and gas suspension is set at 6.9Mpa, 8.9 Mpa, 10.9Mpa, and 12.9Mpa.

5.4. Change the initial inflation pressure of the oil and gas suspension: L
Change the accumulator rated inflation volume to 2.5L, 4L, 5.5L, 7L.
5.5. Test summary

The greater the suspension damping, the smaller the body response and the faster the body returns to a smoother speed. The larger the outer diameter of the hydraulic cylinder piston, the greater the response of the body, and the faster the body returns to a smoother speed. The greater the initial inflation pressure of the oil and gas suspension, the greater the body response and the slower the recovery of the vehicle body. The larger the volume of the accumulator body in response to the rated inflation slightly smaller, faster body righting.

6. Conclusion

Amesim plays a very important role in the study of oil and gas suspension and can efficiently study the nonlinear characteristics of related parameters. This paper mainly analyzes the AMESim of the oil and gas suspension cylinder, and analyzes its technical parameters and important characteristics. By simulation cylinder suspension characteristic curve can be seen, cylinder suspension having good elastic characteristics and damping characteristics in compression and recovery process. Further theorized that more cylinder suspension leaf spring has obvious advantages, can solve the failure rate of the vehicle structural formula leaf spring leaf spring, ride comfort is poor, insufficient driving comfort defects.

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