Research on the Performance of Accumulators Driven by an Electronically Controlled Hydraulic Vehicle

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Abstract. In order to study the performance of an accumulator during the start up of an electronically controlled hydraulic vehicle, theoretical analysis and establishment of a 1/4 vehicle experimental platform for experimental verification were conducted, in order to study the performance characteristics of the hydraulic circuit during driving. Control experiments show that the accumulator does not affect the acceleration performance and the torque of the hydraulic motor when an electrically controlled hydraulic vehicle is driven. The accumulator can be used as an auxiliary power component to absorb partially wasted energy during driving to improve the energy utilization efficiency. The energy absorbed by the accumulator during driving can increase the maximum speed; the use of the accumulator can alleviate the hydraulic shock at the entrance of the hydraulic motor.

1. Introduction
An electronically controlled hydraulic vehicle is mainly composed of an engine, a hydraulic pump, a hydraulic motor, an accumulator, electronically controlled components and various hydraulic valves. The basic principle diagram is shown in Figure 1.

1. Electric control unit 2. Hydraulic variable pump / motor 3. Engine 4. Accumulator 5. Variable hydraulic pump 6. Wheel 7. Charge pump
Figure 1. Schematic diagram of the overall technical solution.
An electronically controlled hydraulic vehicle is directly driven by the engine hydraulic pump, the hydraulic pump transmits energy to the hydraulic motor through hydraulic pressure, each wheel is driven by a hydraulic motor independently, and the vehicle is controlled by an electronic control unit and a hydraulic valve[1,2]. Electronically controlled liquid-drive vehicles use hydraulic transmission instead of traditional mechanical transmission to achieve stepless speed regulation.

The accumulator is used as an auxiliary component in the electronically controlled hydraulic vehicle. The accumulator plays a role of buffering and damping in the hydraulic system, absorbs the shock vibration brought by the hydraulic system, and stores its energy, and brakes the vehicle[3,4]. When braking, the brake energy can be recovered and stored in the form of hydraulic energy. When the vehicle starts or accelerates, the hydraulic energy stored in the accumulator releases the stored energy to help the car start or accelerate and improve the performance of the car. The function of the accumulator is mainly to store the pressure energy of the oil[5]. A large amount of hydraulic oil is provided in a short time to absorb the shock of the hydraulic pressure and maintain the pressure of the system.

2. Experimental platform construction

Based on the overall structure of the electronically controlled hydraulic vehicle, a 1/4 vehicle experimental platform was built. The hydraulic circuit diagram of the experimental platform is shown in Figure 2.

![Hydraulic Circuit Diagram](image)

1. Accumulator 2. Handle-type two-position four-way switching valve 3. Accumulator safety valve 4. inverter motor 5. Suction filter 6. Hydraulic oil tank 7. Variable piston pump 8. Fine filter 9. Solenoid relief valve 10. Proportional reversing speed regulating valve 11. Variable plunger motor 12. Magnetic powder brake and inertia flywheel

Figure 2. Hydraulic circuit diagram of the experimental bench.

The test bench uses an electric motor instead of the engine in the vehicle as the power source to drive the hydraulic pump, and control whether the accumulator is connected to the hydraulic circuit through the hydraulic valve 2. The relevant sensors are installed in the test bench to test the related parameters such as flow rate, speed, torque and pressure, related software collect data in real time, and finally use the drawing software to draw a graph of related parameter change.

3. Experiments and analysis

In order to study the specific role of the accumulator in the hydraulic circuit, a comparative test was used for verification. The test variable was set to the presence or absence of the accumulator connection. The parameters of the hydraulic circuit were compared to analyze the role of the accumulator when the hydraulic circuit was driven. The target speed of the hydraulic pump in the experiment was set to 550 rpm, and the changes of various parameters in the hydraulic circuit were
studied. Through experiments, changes in the speed and torque of the hydraulic motor, changes in the flow rate and changes in the inlet pressure of the hydraulic motor were obtained.

Figure 3. Speed change of hydraulic motor.       Figure 4. Torque change of hydraulic motor.

Figure 5. Flow change of hydraulic circuit.

Figure 6. Pressure change curve of hydraulic motor inlet.

As is shown in Fig.3, the comparison chart of the speed of the hydraulic motor that the use of the accumulator does not affect the acceleration performance of the hydraulic motor. In the driving of the hydraulic circuit, the role of the accumulator is to absorb the hydraulic oil provided by the hydraulic pump during driving and store The excess hydraulic energy releases energy when the pressure of the hydraulic system decreases, thereby making the speed of the hydraulic motor greater than the stable speed.

Fig.4 shows the torque comparison chart of the hydraulic motor, it can be seen that the use of the accumulator has a small effect on the torque of the hydraulic motor. The torque of the hydraulic motor is related to the acceleration during driving. The accumulator will only affect the change in the speed of the hydraulic motor. Has an effect on the torque of the hydraulic motor.

It can be seen from Fig.5 that the flow change fluctuates greatly during driving when the hydraulic circuit connected with the accumulator. The flow change in the hydraulic circuit without the
accumulator is relatively stable, mainly due to the storage and release of hydraulic oil through the accumulator, the process causes fluctuations in flow changes in the hydraulic circuit. When the accumulator stores hydraulic oil, the flow in the hydraulic circuit decreases; the release of oil from the accumulator increases the flow in the hydraulic circuit, and the speed of the hydraulic motor increases.

From Fig.6, during the acceleration of the hydraulic circuit with the accumulator, the pressure fluctuations at the inlet of the hydraulic motor are relatively gentle, and the pressure fluctuations at the inlet of the hydraulic circuit without the accumulator are more obvious. The experimental results show that the accumulator can relax the hydraulic pressure when driving. Pressure fluctuations at the motor inlet are beneficial to improve the stability and service life of the hydraulic motor.

4. Conclusions
According to the structure of an electronically controlled hydraulic vehicle, the related theoretical analysis of the accumulator was carried out. According to the electronically controlled hydraulic vehicle, a 1/4 vehicle hydraulic circuit test bench was built. The role of accumulator in electronically controlled hydraulic vehicles when driving:

1) The use of the accumulator does not affect the acceleration performance during driving, and the accumulator has a small influence on the torque of the hydraulic motor during driving.

2) The use of the accumulator can absorb part of the energy lost during driving and improve energy utilization efficiency. The energy absorbed by the accumulator as an auxiliary power element during driving can increase the maximum speed of the hydraulic motor.

3) The accumulator can alleviate the pressure shock at the inlet of the hydraulic motor during driving and reduce the pressure fluctuation.

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