Research of Diesel-electromotor Parallel Operation Control Method on Combined Driver Rig

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Abstract

This paper outlines the application background and situation of control method for diesel-electromotor parallel running, compares the advantages and disadvantages of parallel operation methods including parallel governor method, single governor method, primary and subordinate governor method and power balance controller method. It presents that only the integrated use of these four methods in order to achieve satisfactory results.

Keywords

Control method for parallel operation, speed governor,power distribution.

1. Background

With the rapid development of China's electric power system and oil drilling industry for energy conservation, saving the cost of production increase awareness, more and more with three diesels prime mover, and gradually become powered by the power grid, an electric motor as the prime mover. In order to prevent the influence of the power outage on the drilling rig will only allow users in the two previous three diesels motor turns the other diesel engines for emergency use during power outage. But when the process of drilling a well mouth demanding needs of large displacement mud, especially when encountered in the process of drilling down from drilling and reaming Difficult,two electric motors and power can not meet the needs of the drilling site, then you by motor vehicles with diesel engines and to achieve a hybrid drive, drill resolve the shortcoming.

2. Control Method for Parallel Operation

The most commonly used control method for parallel operation are the following.

2.1 Parallel Governor Method

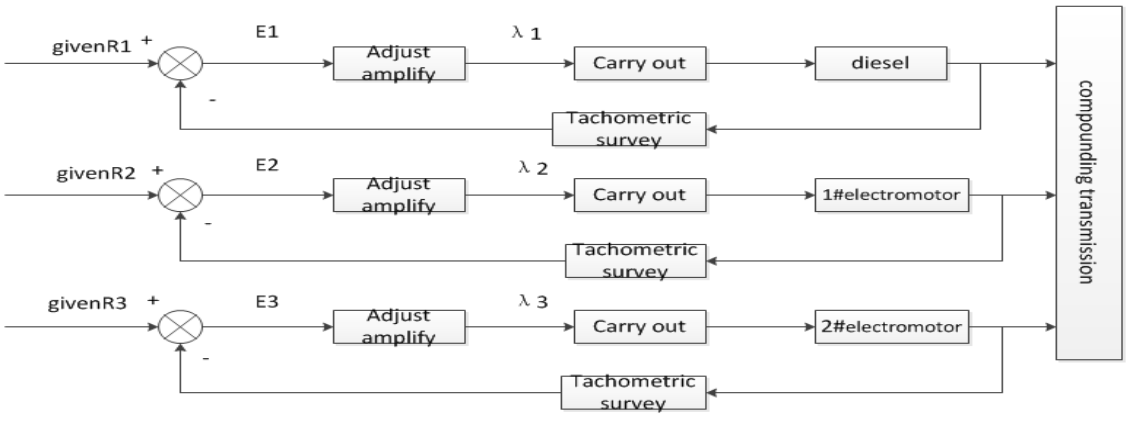

Fig. 1 Parallel governor parallel operation control block diagram

Parallel governor control method shown in Figure 1, the characteristics of this method are: diesel engine and two electric motors are provided with a governor. Three governors work with the stand-alone operation is identical, then the value given three governors should be the same. The advantages of this control method is simple equipment, without the need to add any additional equipment, the disadvantage is due to the optional speed performance less than three identical governor, leading to job insecurity, imbalance of power distribution, operational control difficult .This is the most primitive control manner in parallel operation, the controller is very simple, as long as the diesel engine and the motor speed reference signal can be consistent. In this way, the power distribution of three parallel operation of the machine depends on whether the equalizer governor steady unevenness δ, when the three machines with the same steady unevenness, namely:

$$\delta_A = \frac{|n_{A1} - n_{A2}|}{n_{Am}} = \delta_B = \frac{|n_{B1} - n_{B2}|}{n_{Bm}} = \delta_C = \frac{|n_{C1} - n_{C2}|}{n_{Cm}} \quad (1)$$

Where: nA1 as machine A empty speed during governor spring preload ; nA2 as machine A full speed during governor spring preload; nB1 as machine B empty speed during governor spring preload; nB2 as machine B full speed during governor spring preload; nC1 machine C empty speed during governor spring preload; nC2 as machine C full speed during governor spring preload.

$$n_{Am} = \frac{1}{2}(n_{A1} + n_{A2}) \quad n_{Bm} = \frac{1}{2}(n_{B1} + n_{B2}) \quad n_{Cm} = \frac{1}{2}(n_{C1} + n_{C2}) \quad (2)$$

In this case, the three machines balancing power adjustment when a load or speed changes occur, three machines can automatically maintain a balanced load distribution. However, if the requirements of power distribution according to three machines at a certain ratio, it is difficult to achieve.

2.2 Single Governor Method

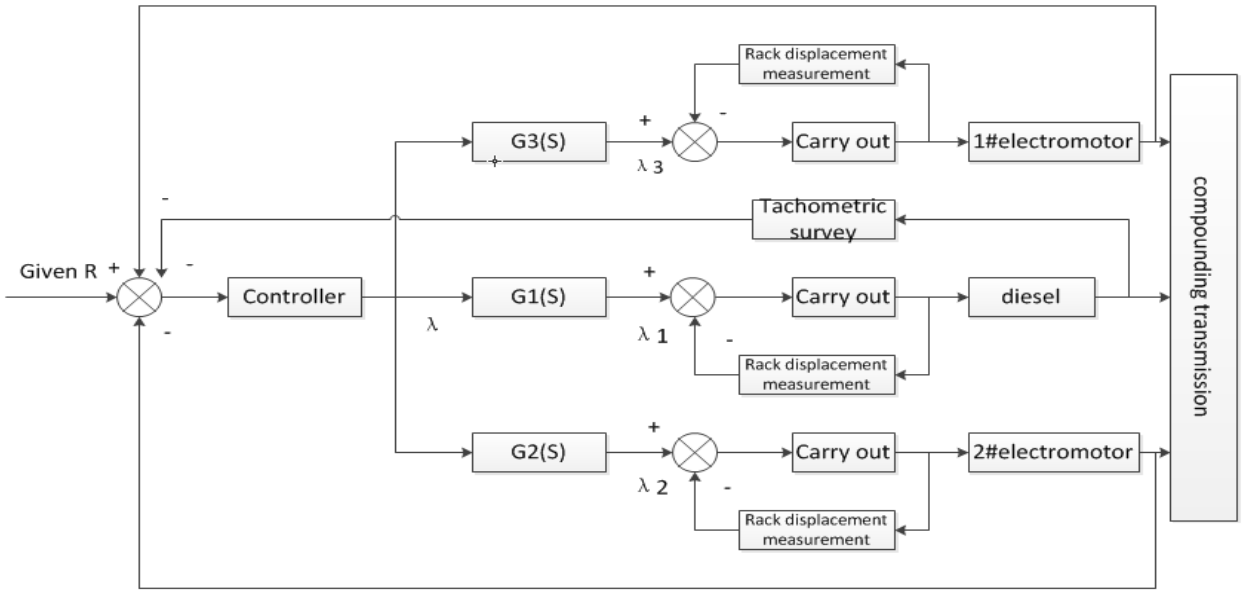

Fig. 2 Single governor parallel operation control block diagram

As shown in figure 2,the so-called Single governor method is using a governor to control the speed and throttle of diesel engine and electric motor , Thus parallel operation of diesel and two electric motors as a triple number of cylinders of a diesel engine. The three machines can be seen as a diesel engine, the power imbalance as a diesel engine power of each cylinder has the same as the case of differences.

Three machines in parallel operation, the speed control is the closed-loop control, the controller may take any of the three machines a speed of feedback. The power equalization control of three machines is open-loop control, the power balance control precision by precision actuators to achieve. Provided

that: the rack displacement correspondence between the three machines with a power output value is determined. In order to control the displacement of the rack in place, the actuator itself forms a small closed loop to ensure that the displacement control to meet the requirements.

Since monotonous speed control technology in the control process takes into account the relationship between throttle power curve of each machine, and therefore has the following advantages: ①Shaped or apply between different power machines and vehicle control; ②Just select a predetermined control software that can meet the prorated power requirements;③when the engine running for some time, the performance parameters of large changes, three machine power imbalance becomes large degree, as long as the timely determination and modify the clutch speed - torque - slip curve can still achieve satisfactory control effect.

2.3 Primary and Subordinate Governor Method

Primary and subordinate governor method is characterized by a diesel engine and two electric motors itself comes with a governor, also equipped with a diesel engine for an engine throttle position measuring means, and the signal is fed back to the governor. The principle of this control method is that the three main governor a governor, and the remaining two from the governor. The main work of the governor and stand-alone operation of the same; the governor must be corrected from the governor speed setpoint based on differences in the position of the main throttle governor output with its own governor output position, in order to achieve three machines power balance. In this case, three governor setpoint is not the same.

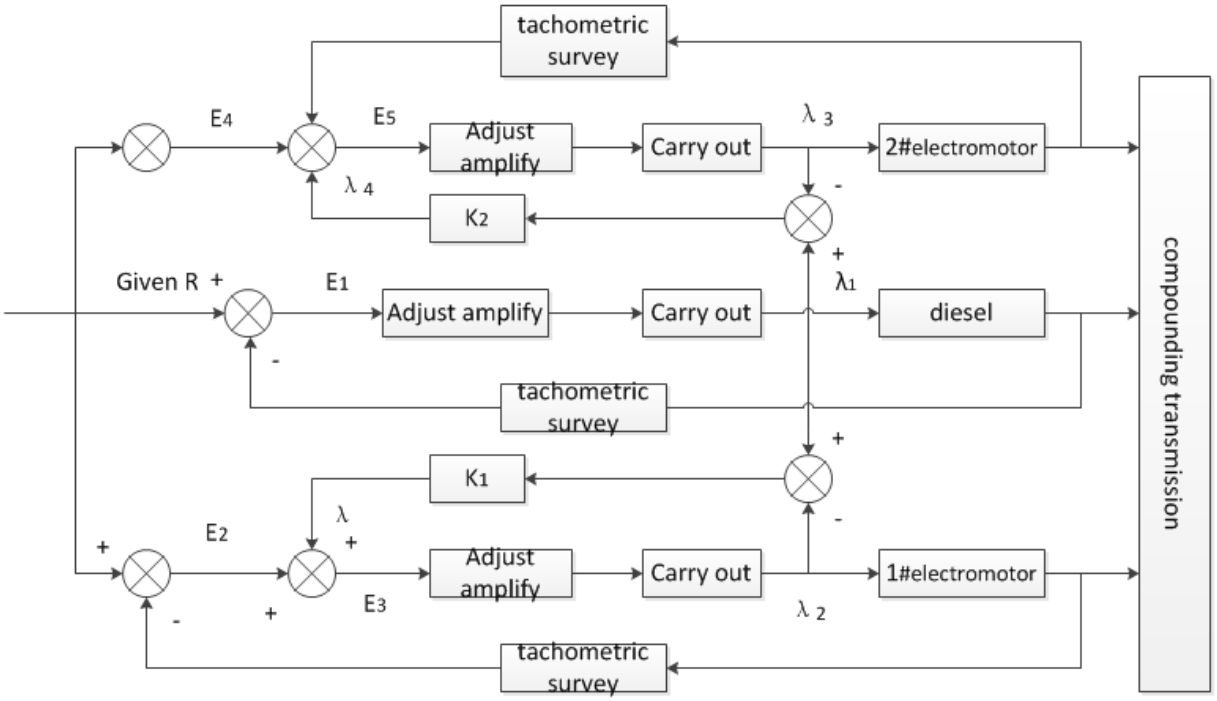

Fig. 3 Primary and subordinate governor parallel operation control block diagram

As shown in figure 3,the control of the diesel engine is a closed loop speed control system, the speed level by a given value R (car make) control.# 1, # 2 motor governor in addition to the existing closed-loop speed control functions, and the introduction of two machines rack displacement difference λ is controlled so that the # 1, # 2 motor unit rack displacement λ2, λ3 always follow λ1 changes, Quantitative analysis is as follows: When the three machines power distribution equilibrium (assuming that the same type of machine) and stable operation, that N1 = N2 = N3 (where: N1 is the diesel engine output power; N2 is motor 1# output; N3 is motor 2# output power), now widely used as an indirect feedback rack displacement signal power of the host, it is:

$$\lambda_1 = \lambda_2 = \lambda_3 \; ; \; \lambda = K_1(\lambda_1 - \lambda_2) = 0 \; ; \; \lambda_4 = K_2(\lambda_1 - \lambda_3) = 0 \; ; \; E_1 = E_2 = E_3 = E_4 = E_5 = 0 \quad (3)$$

The advantages of this control method are: three machines ensure balanced output torque loop response speed, steady-state and dynamic torque equilibrium effects are good, job stability and power imbalance than the law are tied governor improved. The disadvantage is the need for additional throttle position feedback mechanism; from the governor to propose higher requirements: requires not only can automatically correct speed setpoint from the governor, but the governor has requested from the rapid response capability. It does not solve the problem performance difference of three machines. If the clutch speed - torque - slip curve difference is too large, and the car will not be able to achieve the power imbalance is not more than 5% of the requirements. Second, when the diesel engine variable condition, if less dynamic performance from the governor or diesel oil, greater resistance from the governor control mechanism, although at steady state power imbalance can reach not more than 5% of the requirements but there may be circumstances exceed 5% of the power imbalance in the dynamic process.

2.4 Power Balance Controller Method

In the balance of power controllers can actually have three PID governors, when the three machines alone operation, three governors control the three machines; When the diesel engine and two electric motors parallel running, after completing the transfer of power to achieve the balance of power after optionally a governor to control the three machines, one of which is the host, and the remaining two from the machine. Governor of the host speed control, and throttle position from a given machine. The governor in the course of a certain percentage of a given three clutch speed - torque - slip curve, so that you can assign three machines require the same load, and ensure that the same three machines speed in parallel operation. When the three machines from the car and run to run separately, the control of the speed governor began to load transfer (redistribution of power). When complete load transfer, the three machines are controlled by the three governors.

Power balance controller method may accord clutch speed - torque - slip curve to control equalization control of single governor method for three machines. Diesel engine need to equip an engine throttle position measurement mechanism and the signal is fed back to the two governors. This control principle is: three governors are required by a given rotational speed differences between the three clutch torque converter to fix a given speed.

3. Conclusion

Based on the above four parallel operation control methods, we found that a single control strategy can not achieve satisfactory control effect, so the above four comprehensive parallel operation control strategies used in order to meet the control requirements become an inevitable choice.

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