

Matching Analysis of Power System of Extended-Range Electric Vehicle

Yuefeng Lei

School of Hyundai Automobile, Rizhao Polytechnic, Rizhao, China

lshjff@126.com

Keywords: Matching Analysis; Power System; Electric Vehicle; Dynamic Calculation

Abstract. This paper mainly studies the dynamic matching calculation and main parameter design of the whole vehicle. A practical design scheme for power system of pure electric vehicle is proposed and determined. According to the requirements of dynamic performance, the main parameters of the transmission system are designed and matched by using the knowledge of automobile theory. Through the simulation of the design scheme, the dynamic calculation of the scheme is carried out. The matching analysis of power system of extended-range electric vehicles is carried out in this paper. The power performance of pure electric vehicle is analyzed. In the process of power analysis, the data of maximum speed, gradient and acceleration are mainly analyzed, and the simulation results are analyzed. The simulation results show that the method proposed in this paper is effective and reliable.

Introduction

Electric Vehicle (EV) is an available technique and it can solve the energy crisis and environment pollution. As EV is the 0-emission vehicle powered by vehicle battery, many researches of the EV are springing up all around the world, and EV has developed into the small-scale production for business[1-2]. The developments of EV depend on the development of a variety of sciences and techniques, especially for the dynamic performance and driving range improvements, and costs reduction[3-5]. In consideration of development cost and time, the establishment of simulation model can contribute to the performance analysis of EV.

The generation of electric vehicles is accompanied by more and more serious energy problems and environmental problems in the world[6]. The car as the representative of the vehicle is accelerating with the advance of human society[7], the need for a solution to the demand of human development and natural environment restricts the development of today's society, and electric vehicles as the representative of the new energy vehicles is undoubtedly one of the most attractive approaches focus.

Transmission simulation software applied in this paper can establish pure electric vehicles and the whole car parameters and simulate the running of the electric vehicle in different working conditions[8-9]. The performance analysis and the design of the transmission system can improve the design, optimization and related parameters of transmission system. Compared with the traditional power system parameter design method, the system has many effective advantages greatly improved the efficiency, such as more accurate modeling and analysis results.

Matching Analysis of Power System of Electric Vehicle

In a pure electric vehicle, the battery provides the operating energy for the motor, and the power output of the motor passes through the transmission system to the wheel[10]. Therefore, all driving conditions should be calculated to meet the performance requirements of a pure electric vehicle.

Starting from the analysis of the force condition of the electric vehicle running, the driving equation is set up, which is the basis for analyzing the driving performance of the electric vehicle. The dynamic output characteristics of the drive system are directly related to the dynamic performance of the vehicle. The power output of the drive system should meet the dynamic requirements of the vehicle. When the electric vehicle is matching parameters, the driving dynamics model of electric vehicle must be first established, and the balance need to be analyzed between power and power in the process of electric vehicle driving.

According to the balance of the force, the driving equation of the car is

$$F_t = \sum F \quad (1)$$

In formula (1), F_t represents the driving force and $\sum F$ represents the sum of driving resistance.

The external force driving the vehicle is not only related to the traction force provided by the vehicle drive system, but also related to the contact state between the road and the wheels. Its value is shown in formula (2).

$$F_t = \frac{T_t}{r} \quad (2)$$

In formula (2), T_t represents the effect and torque on the driving wheel and r represents wheel radius.

Since the electric motor is driven by the motor, the T_t is transferred from the motor to the wheel by the motor output torque in the electric vehicle. The transmission system of total transmission ratio is i , the mechanical efficiency of transmission system is η_t , and the output torque of the drive motor is T_{tq} .

$$T_t = T_{tq} \cdot i \cdot \eta_t \quad (3)$$

When the car is running at the same speed on a horizontal road, it is necessary to overcome the rolling resistance from the ground and the air resistance. When the car runs up the slope, it is also necessary to overcome the slope resistance. It is also necessary to overcome the acceleration resistance when the car is speeding. So the total resistance in the driving process is

$$\sum F = F_f + F_w + F_i + F_j \quad (4)$$

In formula (4), F_f refers to the rolling resistance, F_w refers to air resistance, F_i refers to slope resistance and F_j refers to acceleration resistance.

When the vehicle runs, the driving force and the driving resistance not only are balanced, but the power of the motor and the driving resistance power of the vehicle are always balanced. That is to say, at every moment of vehicle running, the power P_e emitted by the motor is always equal to the sum of the power consumed by the mechanical transmission and the power consumed by all the motion resistances. In a pure electric vehicle, P_e is the output power of the motor. The power consumed by the motion resistance of the vehicle has the rolling resistance power P_f , the air resistance power P_w , the gradient resistance power P_i and the acceleration resistance power P_j . That is:

$$P_e = \frac{1}{\eta} \cdot (P_f + P_w + P_i + P_j) \quad (5)$$

According to the above deduction, the equilibrium equation in the course of vehicle driving can be obtained as follows

$$P_e = \frac{T_{tq} \cdot n}{9550} \quad (6)$$

For pure electric vehicles, P_e is motor output power (kW) and n is motor output speed (RPM).

The main reference design parameters of the transmission system are shown in Table 1.

Table 1 The reference design parameters for transmission lines

Transmission parts	Design parameters	Design value
Battery	Rated voltage (V)	100
	Rated discharge capacity (Ah)	200
	Windward area (A/m^2)	2
Others	Air resistance coefficient C_D	0.5
	Wheel rolling radius (r/m)	0.3

Table 2 The dynamic requirements

Maximum speed	50 km/h
Acceleration performance	<10s
Gradient	>20%

Simulation

Analysis of Electric Vehicle Simulation. In the cycle condition, the velocity (red), acceleration (blue) - time curve is shown in Figure 1.

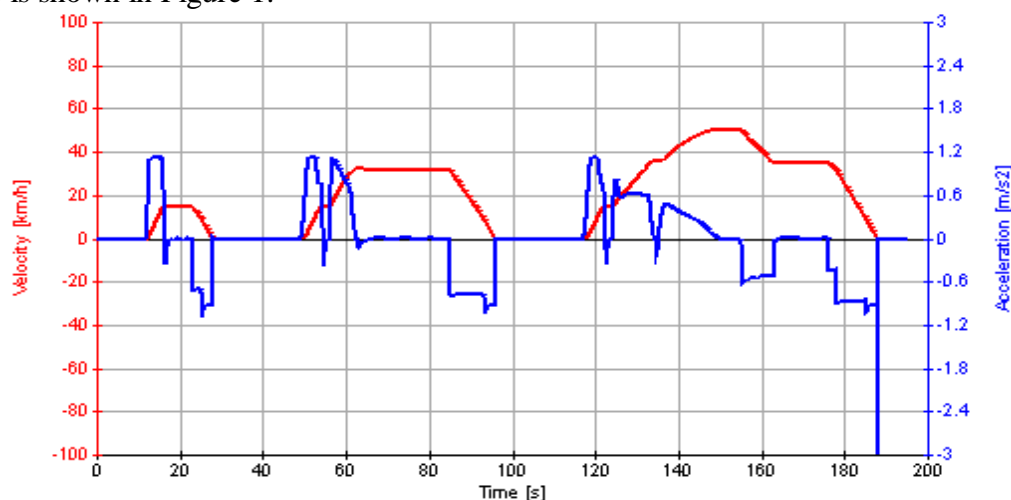


Figure 1. Finite The curve of velocity, acceleration - time

In the accelerated test, the results of the simulation experiments, such as maximum speed and acceleration time, are shown in Fig. 2.

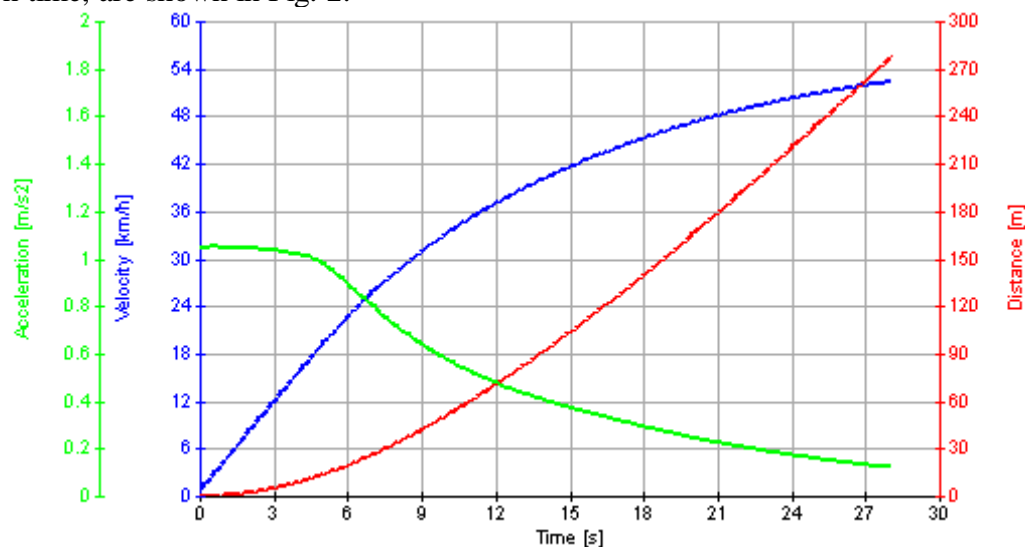


Figure 2. Finite The relation curve of acceleration (green), velocity (blue), distance (red) - time

Analysis of Motor Simulation. In the maximum climbing test, the torque, power, velocity and speed chart line, as shown in Fig. 3.

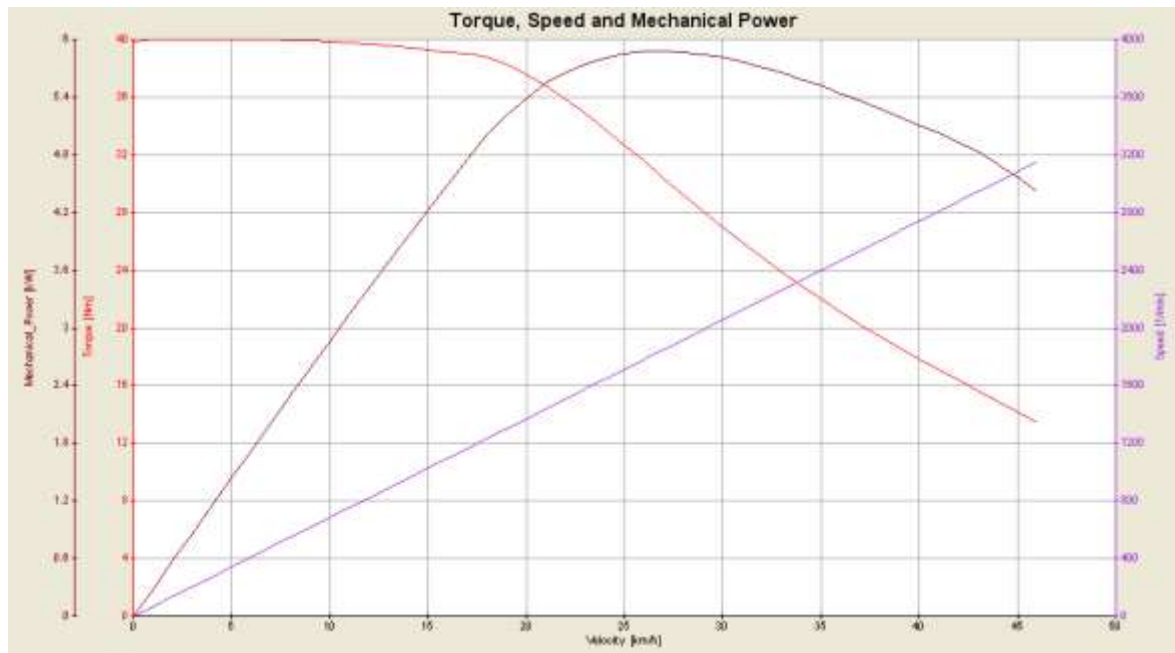


Figure 3. Finite Comparison of the evaluation results of traditional logistics supply chain and constructivist logistics supply chain

Summary

In this paper, according to the power requirement of the electric vehicle, the motor parameters which meet the dynamic requirements are obtained. According to the basic vehicle parameters, such as body weight, shape parameters, and some constants, such as air drag coefficient, surface friction coefficient, the motor's maximum torque at maximum speed, maximum torque, maximum power and other parameters can be calculated through the theory of automobile related calculation formula. When the external characteristic curve is at low speed, if high torque output cannot be maintained in a wide speed range, the dynamic performance of this type of electric vehicle can not meet the design requirements. So it is needed to select the motor again and design the original modified.

References

- [1] E. Abele, Y. Altintas, and C. Brecher. Machine tool spindle units, *Manufacturing Technology*, 59(2012), 781-802.
- [2] FJ Lin and CC Lee. Adaptive backstepping control for linear induction motor drive to track periodic references, *Electric Power Applications*, 147 (2013), 449-458.
- [3] E Vahabli, and S Rahmati, Application of an RBF neural network for FDM parts' surface roughness prediction for enhancing surface quality, *International Journal of Precision Engineering & Manufacturing*, 17 (2016) , 1589-1603.
- [4] D. Traor é and J. De Leon. Adaptive interconnected observer-based backstepping control design for sensorless induction motor, *Automatica*, 48 (2012), 682-687.
- [5] Griffiths HD, and Baker CJ. Passive coherent location radar systems. Part 1: Performance prediction. *IEEE Proceedings-Radar, Sonar and Navigation*, 152(2015), 153-159.
- [6] Howland PE, Maksimiuk D, and Reitsma G. FM radio based bistatic radar. *IEEE Proceedings-Radar, Sonar and Navigation*, 152(2015), 107-115.
- [7] H. Wang , J. Wang, and L. Zhong. Mismatched filter for analogue TV-based passive bistatic radar. *IEEE Proceedings-Radar, Sonar and Navigation*, 5(2011), 573-581.
- [8] Baczyk MK, and Malanowski M. Reconstruction of the Reference Signal in DVB-T-based Passive Radar. *International Journal of Electronics and Telecommunications*, 57(2011), 43-48.

- [9] BR Webb, SB Gallagher. Mapping Commonalities and Differences in Software Engineering and Graphic Design Approaches to Multimedia Systems Development, *Journal of Computer Information Systems*, 46 (2016), 87-98.
- [10] S Laing, and M Masoodian. A study of the influence of visual imagery on graphic design ideation, *Design Studies*, 45 (2016), 187-209.