Research on acceleration performance of fuel vehicles and electric vehicles based on Advisor

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Abstract—In this paper, through the analysis of the theoretical knowledge of the vehicle, the differences between the fuel vehicle and the electric vehicle in terms of power performance, as well as the influencing factors are compared. Through the use of advisor simulation analysis, it is found that the acceleration performance of the electric vehicle in the early stage is better than that of the fuel vehicle, and it has better effect when it is used in the city.

1. INTRODUCTION

With the policy encouragement of the Chinese government to new energy vehicles and the improvement of the people's environmental protection awareness, the technology of electric vehicles is increasingly mature and stable, and the use of electric vehicles in China has been increasing.

Electric vehicles have the following advantages: energy saving and money saving, the cost of daily running 100 kilometers is about 12 yuan, about 21% of the fuel consumption of fuel vehicles; maintenance costs are low; the speed limit in urban areas of China is less than 70km/h, and there are many traffic lights, the car often needs to start and stop, the electric vehicle does not consume electricity when waiting for traffic lights, and has strong acceleration ability at medium and low speeds; the motor vibrates when working Motion and noise are much smaller than the engine. Disadvantages: electric vehicles have not long endurance, long charging time, and not enough charging facilities.

However, with the rapid development of electric vehicles, some of them have more than 500km of electric vehicle mileage, and the electric vehicle mileage produced by other automobile manufacturers is also increasing; fast charging can reach 80% of the total battery in about 30 minutes, and the Chinese government is also making great efforts to layout charging facilities. More electric vehicles are also in the process of lightweight and miniaturization, which can meet the traffic needs of urban work and work, and alleviate the congestion to a certain extent. Therefore, electric vehicles will be more popular and popular in the Chinese market. The main content of this paper is to analyze and compare the acceleration advantages of electric vehicle at medium and low speed.
2. Basic Theory

2.1. Driving Force of Automobile
In the driving process of the vehicle, the effective torque sent by the engine or motor transmits the torque on the power wheel through the transmission system. Since the transmission system is equipped with a transmission, reducer, etc., the corresponding transmission ratio and mechanical transmission efficiency shall also be calculated. The relationship between the fuel vehicles using the automatic speed converter is as follows:

\[ T_t = T_{eq} i_g i_T \eta_T \]  

Among them, \( T_t \) is the effective torque of the engine, N\cdot m; \( i_T \) is the transmission ratio; \( i_g \) is the main reducer transmission ratio; \( \eta_T \) is the mechanical efficiency of the driveline.

Therefore, the driving force of the car is:

\[ T_r = \frac{T_{eq} i_g i_T \eta_T}{r} \]  

Among them, \( r \) is the radius of the car's driving tires, m.

Because electric vehicles do not use gearboxes, they directly use motors to drive differential. Therefore, in the case of electric vehicles, \( T_{eq} \) is the torque of motors, and \( i_g = 1 \).

2.2. Rolling Resistance of Automobile
In the process of driving, there will be resistance between the tire and the ground, which is called rolling resistance, the formula of rolling resistance coefficient is:

\[ F_f = W f = mg f \]  

Among them, \( W \) is automobile gravity; \( f \) is rolling resistance coefficient; \( m \) is the weight of the car, kg; \( g \) is the acceleration of gravity.

2.3. Air Resistance of Automobile
In the range of common driving speed, the air resistance is:

\[ F_w = \frac{1}{2} C_d A \rho u_a^2 \]  

Where, \( C_d \) is the air drag coefficient; \( A \) is the windward area, m\(^2\); \( u_a \) is the driving of the car when there is no wind, m/s; \( \rho \) is air density. Generally, values are used 1.255 N\cdot S\(^2\)\cdot m\(^{-4}\). So air resistance can be expressed as:

\[ F_w = \frac{C_d A \rho u_a^2}{1.632} \]  

2.4. Climbing Resistance of Car
In the process of driving, there will be uphill running state, so the resistance generated when uphill becomes uphill resistance. Climbing resistance can be expressed as:

\[ F_i = G \sin \alpha \]  

When the car is tested on the flat road, there is no climbing resistance, so the climbing resistance is ignored on the flat road.

2.5. Acceleration Resistance of Automobile
When the vehicle accelerates, it needs to overcome the inertia force when the mass accelerates, that is, acceleration resistance.
Where, $\delta$ is the conversion coefficient of vehicle rotating mass. Because fuel vehicles have more rotating parts than electric vehicles, therefore, the conversion coefficient of rotating mass of fuel vehicles is larger than that of electric vehicles; $m$ is vehicle mass, kg; $\frac{du}{dt}$ is the driving acceleration, m/s$^2$.

2.6. Vehicle acceleration time

The acceleration ability of a car can be evaluated by the acceleration it can generate when driving on a good level road. Due to the constant change of acceleration value, it is not easy to measure. In practice, acceleration time is often used to evaluate the acceleration ability of the vehicle. According to the car driving equation:

$$F = \delta m \frac{du}{dt}$$

(7)

$$t = \int_{u_1}^{u_2} \frac{\delta m}{M_i \frac{k}{m} \frac{\delta m}{r} - mgf - C_d \frac{A u^2}{2}} \, du_a$$

(8)

It can be seen from the calculation formula that the acceleration time of the electric vehicle will be small due to the small, high transmission efficiency, no more gearbox, and large motor torque.

Fuel vehicles need to increase the amount of fuel injection to improve the engine speed, so there will be a delay in time. The motor used in the electric vehicle changes the speed by changing the voltage, and the aging is very fast.

To sum up, electric vehicles are faster than fuel vehicles in improving the speed of power system, and higher than fuel vehicles in transmission efficiency. Therefore, the initial speed-up capacity of electric vehicles is stronger than fuel vehicles, and the energy loss will be smaller. At high speed, the energy required by the electric vehicle is affected by the increase of resistance, motor and voltage, and the power consumption.

3. Comparison of vehicle parameters and simulation

In this paper, the same vehicle parameters are used, and the differences between fuel vehicles and electric vehicles are shown in Table 1.

Table 1. Parameter comparison between fuel vehicle and electric vehicle

| Project      | Fuel vehicle | Electric vehicle |
|--------------|--------------|-----------------|
| Curb weight  | 1320kg       | 1348kg          |
| Power        | 83kw(Engine) | 100kw(Battery)  |
| Transmission | 5-speed      | 1 speed         |
In order to improve the effectiveness of the comparison, the models used in this paper are the same models produced by the same automobile manufacturer, one is driven by the automobile engine, the other is driven by pure electric drive, the car body, electrical appliances, chassis and other accessories are the same, the difference is that the fuel drive and pure electric drive.

The data of the two vehicles are changed in advisor software, and then the acceleration and power simulation of the two vehicles are carried out. Figure 1 shows the relationship between speed and torque of fuel vehicles, and Figure 2 shows the relationship between emissions and time (s) of fuel vehicles. Figure 3 shows the relationship between speed and torque of electric vehicle, and Figure 4 shows the relationship between emissions and time (s) of electric vehicle.
The simulation results are shown in Figure 1 and table 2.

Table 2. Comparison of acceleration time of two kinds of cars

| Project     | Fuel vehicle① | Electric vehicle② |
|-------------|---------------|-------------------|
| 0-50km/h    | 4.5s          | 2.8s              |
| 0-100km/h   | 10.9s         | 6.5s              |
| 0-137km/h   | 21s           | 12s               |
Table 3. Comparison of acceleration time of two kinds of cars

| Project          | Fuel vehicle① | Electric vehicle② |
|------------------|---------------|-------------------|
| Energy consumption | 8.6L/100km    | 13.2kw·h⁻¹/100km  |

Through the simulation analysis and comparison, we can find the characteristics of the driving motor and the fuel engine. Electric vehicles have no emissions, but the power of electric vehicles is generated through energy.

The initial acceleration performance of electric vehicles is better than that of fuel vehicles, and the acceleration time is relatively less.

The fuel consumption of fuel vehicles is 8.6l in one hundred kilometers, and the price is about 60.2 yuan; the power consumption of electric vehicles is 13.2kwh, and the price is about 11.88 yuan. The comparison shows that the 100 km economy of electric vehicles is relatively good.

4. CONCLUSION

Electric vehicles have strong acceleration ability in the early stage, poor acceleration ability in the later stage, and the maximum speed is not as high as that of fuel vehicles. However, when they are used in urban areas, electric vehicles have better performance.

At present, fuel vehicles still have a certain amount of market, each technology is relatively mature, and the price is relatively moderate. Electric vehicle technology is still in the climbing period. At present, the advantages of electric vehicle have begun to show, good acceleration performance, no waste of electric energy in parking time, energy conservation and environmental protection, and low noise. The disadvantage is that the endurance mileage is not long enough, and the charging time is longer than the refueling time of fuel vehicles. However, with the development of science and technology, the endurance mileage of electric vehicles has been increasing, the fast charging time is also shortening, and the vehicle manufacturing cost is also decreasing. More automobile manufacturing enterprises and Internet enterprises are developing electric vehicles, so the future of electric vehicles is still bright.

ACKNOWLEDGEMENT

Supported by Hainan Provincial Natural Science Foundation of China(project number: 518QN256) and Hainan College of Economics and Business Foundation of China(project number: hnjmky2019703).

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