

Test Paper of Wuhan University of Technology (A)

2018-2019 Academic Year, 1st Semester, Course: Structures and Theory of New Energy Vehicle, Closed-book Exam

Time: 120 mins, 32 class hours, 2.5 credits, Total Points: 100, Percent in final evaluation result: 60%, Date: December 2018

No.	I	II	III	IV	V	VI	VII	VIII	IX	X	Total
Full score	10	20	15	20	15	20					100
Score	4	12	7	20	7	10					60

Score 4

I. Fill in the blanks (2 points*5=10 points)

- The conventional methods of charging accumulators mainly include: constant-current charging method, stepped current charging method, constant-voltage charging method, and 恒压限流法 etc.
- The main methods of recovering braking energy of electric vehicles include: hydraulic energy storage and electrochemical energy storage.
- The drive motors commonly used in new energy vehicles include: DC, asynchronous motors, AC asynchronous motors, permanent magnet brushless motors and switched reluctance motors.
- Four directions of vehicles as defined in "Made in China 2025" include: X, fuel-efficient vehicles, fuel-cell vehicles and intelligent and connected vehicles.
- The key technologies of electric vehicles include: battery and management technology, motor and control technology, vehicle control technology, and vehicle lightweight technology.

得分
Score

12

II. Single-choice questions (2 points * 10=20 points)

- What is the wrong description about SOC of batteries? (D)
A. Prevent battery from overcharge and overdischarge
B. Serve as a low-battery current limiting threshold
C. Serve as a threshold of vehicle control strategy
D. Serve as an important basis for measuring battery quality
- What's the fuel used by the positive pole of hydrogen cell? (B)
A. O₂ B. H₂ C. Methyl alcohol D. Ni(OH)₂
- Which of the following options can be expressed as the speed characteristic of a shunt (separately) excited DC motor? (B)
A、 $n = \frac{U - R_a I_a}{C_e \Phi}$ B、 $n = \frac{U - 2\Delta U - 2I_a R_a}{C_e \Phi}$
C、 $s = \frac{n_1 - n}{n_1}$ D、 $n = n_0 + \Delta n$
- In order to obtain a high-voltage power battery, the single battery can be: (A)
A. Connected in series B. Connected in parallel
C. Connected in series or parallel D. None of the above
- Which of the following instruments in traditional vehicles is not installed in electric vehicles? (C)
A. Voltmeter B. Power meter C. Engine tachometer D. Battery capacity indicator

11. What is the fuel cell most widely applied in fuel-cell electric vehicles? (C)

- A. AFC B. SOFC C. PAFC D. PEMFC

12. Which of the following components is excluded from the power assembly of a series hybrid electric vehicle? (D)

- A. Engine B. Generator C. Drive motor D. Control motor

13. What is the main evaluation index of vehicles' dynamic performance? (A)

- A. Starting acceleration performance and climbing performance
B. Battery performance and motor performance
C. Climbing performance and motor performance
D. Motor performance and starting acceleration performance

14. What is the function of accumulators in hybrid electric vehicles? (C)

- A. Provide auxiliary power supply for BMS
B. Transmit kinetic energy of automobiles to the accumulator through the traction motor
C. To be charged and discharged in a nonperiodic manner
D. To increase power

15. What's the wrong description about the reaction mechanism of fuel cells? (D)

- A. The chemical energy in the fuel can be converted into electric energy directly without burning.
B. The chemical energy can be converted into electric energy through electrochemical reaction.
C. In fact, it's the inverse process of water electrolysis.
D. Water will be generated and electric energy will be released through physical reaction between hydrogen and oxygen.

得分
Score

III. Short-answer questions (5 points * 3 = 15 points)

16. What are the main requirements of electric vehicles for power batteries? (5 points)

Solution: ① Low cost
② Long service life
③ Large specific power
④ High specific energy

17. What are characteristics of permanent magnet synchronous motors? (5 points)

18. What are the advantages of fuel-cell electric vehicles? (5 points)

Solution: ① Save energy
② without pollution
③ 行驶稳定
④ without noise

得分 Score	20
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IV. Fill in the blanks according to the figure (10 points*2=20 points)

19. Please fill in the following table in combination with characteristics of power battery for electric vehicles. (2 point*5=10 points)

Table 4.1 Technical Performance of Three Kinds of Power Batteries

Technical performance	Lead acid battery	Nickel metal hydride battery	Lithium ion battery
Operating voltage (V)	2	1.2	3.6
Specific energy (Wh/kg)	40	65	105-140
Specific power (W/kg)	150-200	160-230	250-400
Charge and discharge life (times)	500-700	600-1200	800-1200
Self-discharge rate (%) (monthly)	3	30-35	6-9
With/without memory effect	With	With	Without
With/ without pollution	With	Without	Without

4/0

20. Please fill in the blanks in the figure below according to the characteristics of the series-parallel hybrid electric vehicles (PSHEV). (2 points*5=10 points)

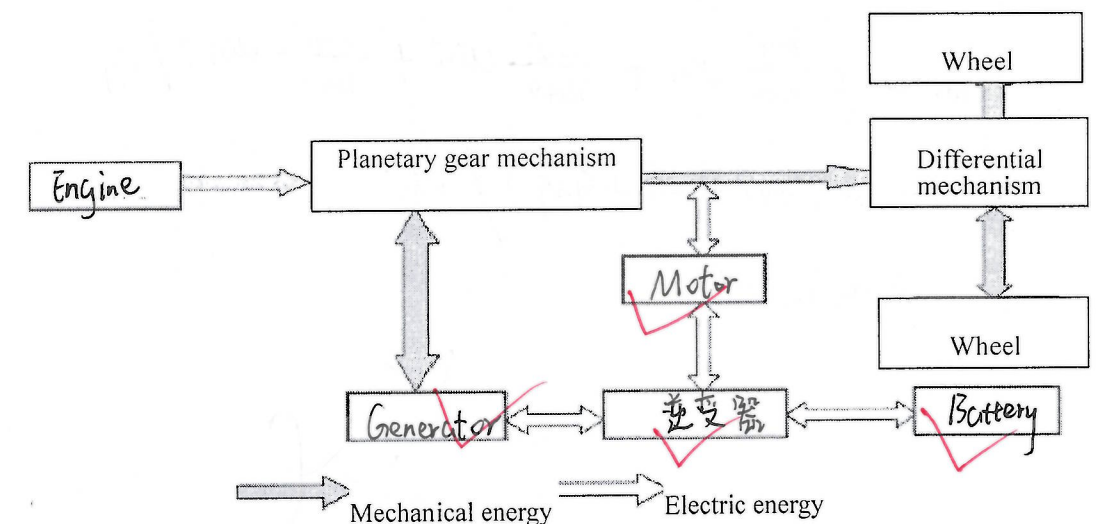


Figure 4.1 Diagram of Power Flow of PSHEV

Diagram of Power Flow

得分
Score

V. Calculation and analysis questions (15 points*1=15 points)

21. The relevant data of a full electric vehicle are as follows:

The gross vehicle mass (m): 1,150 kg; coefficient of air resistance (C_D): 0.3; windward area (A): 2.58 m²; rolling resistance coefficient (f): 0.015; transmission efficiency (η_T): 92%; tyre radius (r): 0.305 m; maximum speed ($u_{a_{max}}$): 120 km/h; overall efficiency of motor and motor controller ($\eta_m \eta_{mc}$): 90%; total voltage of power battery pack (V_b): 342 V; allowed discharge depth (DOD): 90%. It is required that when the speed (u_{ai}) is 10 km/h, the maximum gradability (i) shall be 30%; when the speed (u_{as}) is 40 km/h, the mileage (S) for which the vehicle can travel at a constant speed shall be 150 km.

(1) Please work out the motor power P_{mi} (kW) required to reach the specified maximum gradability. (5 points)

Solution:

$$P_{mi} = \left(\frac{mgf}{3600} ua_i + \frac{C_D A}{76140} ua_i^3 + \frac{mgi}{3600} ua_i \right) / \eta_T$$

$$= (0.47 + 0.01 + 9.39) / 0.92$$

$$= 10.73 \text{ kW}$$

+

(2) Please work out the motor power P_{ms} (kW) required to make the vehicle drive at the constant speed (ua_s) of 40 km/h. (5 points)

Solution:

$$P_{ms} = \left(\frac{mgf}{3600} ua_s + \frac{C_D A}{76140} ua_s^3 \right) / \eta_T$$

$$= (1.88 + 0.65) / 0.92$$

$$= 2.75 \text{ kW}$$

+

(3) Please work out the battery capacity C_b (Ah) required to enable the vehicle to travel for the specified mileage under the allowed discharge depth. (5 points)

Solution:

$$C_b = \frac{1000 [P_{ms} / (\eta_m \eta_{mc})] (S / ua_s)}{V_b \cdot DOD}$$

$$= 37.28 \text{ Ah}$$

The reference formulas are as follows:

Motor power required to reach the specified maximum gradability

$$P_{mi} = \left(\frac{mgf}{3600} ua_i + \frac{C_D A}{76140} ua_i^3 + \frac{mgi}{3600} ua_i \right) / \eta_T$$

0.47 0.01 9.39 0.828

Motor power required to make the vehicle drive at the constant speed (ua_s) of 40 km/h

$$P_{ms} = \left(\frac{mgf}{3600} ua_s + \frac{C_D A}{76140} ua_s^3 \right) / \eta_T$$

1.88 0.65

Battery capacity required to enable the vehicle to travel for specified mileage

$$C_b = \frac{1000 [P_{ms} / (\eta_m \eta_{mc})] (S / ua_s)}{V_b \cdot DOD}$$

3.6 3.75H
342 0.9

得分	
Score	

六、综合论述题（每题 20 分，共 20 分）

VI. Comprehensive essay-type questions (20 points*1=20 points)

22. Combined with the course content of "Structure and Principle of New Energy Vehicle" and according to the development trend of key technologies of new energy vehicles at present, please discuss the following topic:

Topic: Roadmap of the development of new energy vehicles.

Requirements: 300-350 words.

In the future, new energy vehicle will make great progress in the field of HEV and EV. The key technologies of EV like battery and management, motor and control technology, vehicle control technology, vehicle lightweight technology will develop quickly. Then they will be applied on the vehicle. However, in the field of fuel-cell vehicle, because it is very difficult to produce and store H₂, I think it will not be achieve in the short time. So, fuel-cell vehicle will develop slowly.

As the core of other kinds of new energy vehicle, I do not think they have good future compared with others. I insist most people will use HEV or EV in five years.

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