

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	2	10	12	20	9	18					71

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

1. The conventional methods of charging accumulators mainly include: constant-current charging method, stepped current charging method, constant-voltage charging method, and constant-voltage limit current charging.

2. The main methods of recovering braking energy of electric vehicles include: brushless DC motor machine energy, hydraulic energy storage and electrochemical energy storage.

3. The drive motors commonly used in new energy vehicles include: brush DC motors, AC asynchronous motors, permanent magnet brushless motors and switched reluctance motors.

4. Four directions of vehicles as defined in "Made in China 2025" include: lightweight fuel-efficient vehicles, fuel-cell vehicles and intelligent and connected vehicles.

5. The key technologies of electric vehicles include: battery and management technology, vehicle safe, vehicle control technology, and vehicle lightweight technology.

得分	10
Score	

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

6. 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

7. What's the fuel used by the positive pole of hydrogen cell? (A)

- A. O₂
- B. H₂
- C. Methyl alcohol
- D. Ni(OH)₂

8. 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. $n = n_0 + \Delta n$

9. 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

10. 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
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III. Short-answer questions (5 points * 3 = 15 points)

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

- | | |
|-------------------------------|--------------|
| ① high specific power | 高比功率 |
| ② high specific energy | 高比能量 |
| ③ simple structure, lightness | 结构简单, 质量轻 |
| ④ cheap | 价格低 |
| ⑤ safe | 安全性高 |
| ⑥ no exhaust. | 无排放, 环保, 绿色. |
| ⑦ working stable | 工作稳定. |

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

It use permanent as rotator, don't need the alternate elect.
It is a kind of synchronous motor, have the same phase.

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

- | | |
|--|---------|
| ① The efficiency of energy transfer is high. | 能量转化率高. |
| ② Simple structure. | 结构简单. |
| ③ Near to no exhaust. | 接近无排放 |
| ④ ~~working~~ lightness, small. | 质量轻. |

得分
Score

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

10

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)

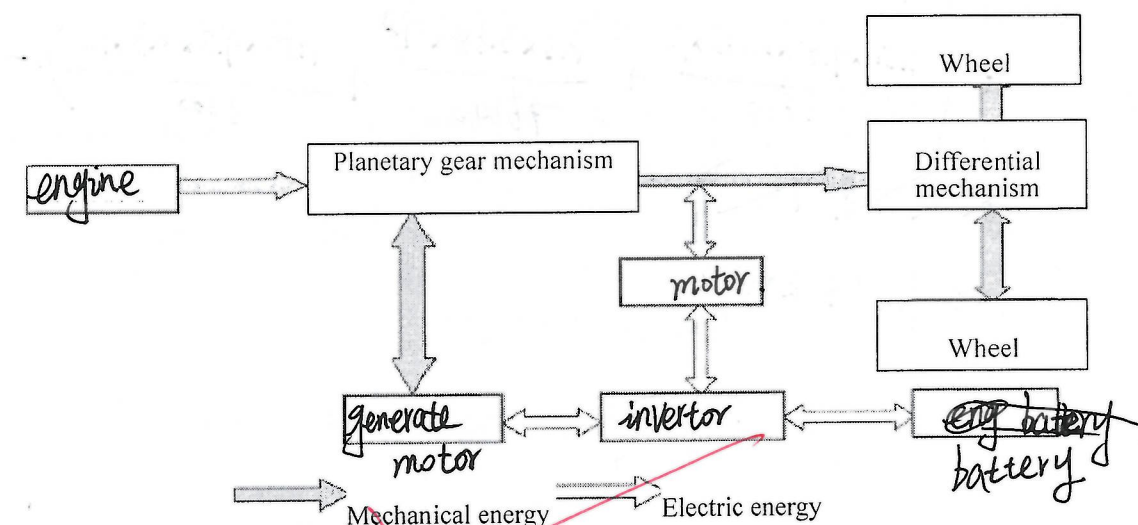


Figure 4.1 Diagram of Power Flow of PSHEV

10

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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_{a_i}) is 10 km/h, the maximum gradability (i) shall be 30%; when the speed (u_{a_s}) 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)

$$P_{mi} = \left(\frac{mgf u_{ai}}{3600} + \frac{C_D A u_{ai}^3}{76140} + \frac{mgi u_{ai}}{3600} \right) \cdot \frac{1}{\eta_T}$$

$$= \left(\frac{1150 \times 9.8 \times 0.015 \times 6}{3600} + \frac{0.3 \times 2.58 \times 10^3}{76140} + \frac{1150 \times 9.8 \times 0.3 \times 10}{3600} \right) \cdot \frac{1}{0.92}$$

$$\approx 10.73 \text{ kW}$$

+3

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

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

$$= \left(\frac{1150 \times 9.8 \times 0.015 \times 40}{3600} + \frac{0.3 \times 2.58 \times 40^3}{76140} \right) / 0.92$$

$$\approx 2.75 \text{ kW}$$

+3

(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)

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

$$= \frac{1000 [2.75 / 0.9] (150 / 40)}{342 \times 0.9}$$

$$\approx 37.23 \text{ Ah}$$

+3

The reference formulas are as follows:

Motor power required to reach the specified maximum gradability

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

Motor power required to make the vehicle drive at the constant speed (u_{as}) of 40 km/h

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

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

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

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 my opinion, electric vehicles is the final aim of the future.

But recently, electric vehicles has a few questions need to solve. Such as battery and management, vehicle control technology, and vehicle lightweight and so on. And the biggest problem is it couldn't be driven for a long travel. Its working distance is limited. The up limit of battery is hard to break.

Then ~~the~~ the hybrid vehicle is a good solution as a mid product. It has ~~the~~ both of electric vehicles' and tradition vehicles' benefits. For example, the motor work when vehicle's speed is low. With the speed up, engine is working. It makes engine and motor all working at the best working condition.

Since Japan has the best technique of hybrid vehicle, to avoid Japan catch all the market. Our government try to build up our own electric vehicle. To get some benefit in the future. So now it is a good chance to develop the electric vehicle.

We just wait the technique develop. If some key technique get break, the electric vehicle is more useful. Such as lineless charging or nuclear battery become true, we can develop a great step.

The fuel is ~~constant~~ limited, and it become more and more expensive. So we must give up the tradition engine vehicle in the future, and use the new power vehicle. And electric vehicle is the best choice.

Future is belong to electric vehicle.