Testing Evaluation and Research of Electric Vehicle

Based on CAERI and Argonne Collaboration

Sponsored by China Ministry of Science and Technology

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Overview

Signing a cooperation agreement

Prius PHEV Testing at Argonne

The collaboration process

- CAERI and Argonne signed a strategic cooperation agreement
- Dr. Johnson and Dr. Wang were hired as senior advisers
- Two engineers have worked with Mr Duoba for eight months
- Mr Duoba visited CAERI and participated in the testing of Prius PHEV
 Index System

- Focus on “electric propulsion system”, reflect the characteristics of electric vehicle different from conventional vehicle
- Compatible with EV, HEV, PHEV, covering the performance evaluation index of vehicle level, system level, a total of 2612
Test and Evaluation Methods

1. Preparation
   - Vehicle analysis
   - The selection of evaluation index
   - Signal analysis
   - The determination of Test matrix

2. Test plan
   - Test outlines
   - Test rules
   - Test instructions

3. Test procedure
   - Level1 vehicle level
   - Level2 system level
   - Level3 strategy analysis level

- Single mode of multi-index monitoring
- The test matrix of single mode and multi initial conditions
- Level1, Level2, Level3
Results of Prius PHEV
Key Subsystem—Battery

- SOC range 16.4~85%, SOC > 65%, battery charging power reduced
- Max output power 37kW, max charging power 29kW, low temperature affects the charging and output performance of the battery
Strategy—Engine on/off at CD Mode

1. $P_{\text{req}}$ effect
   - $P_{\text{req}} > 37\, \text{kW}$, Engine on
   - $P_{\text{req}} < 20\, \text{kW}$, Engine off

2. SOC effect
   - SOC decline, more Engine on

3. Water temperature of engine effect
   - $T_{\text{water}} > 55^\circ \text{C}$, Engine off

- $P_{\text{req}} > 37\, \text{kW}$ or $\text{SOC} < 23.1\, \%$, engine on
- $P_{\text{req}} < 20\, \text{kW}$ or $T_{\text{water}} > 55^\circ \text{C}$, engine off
Strategy—Partial Braking

- $P_{bat} \approx 5\text{ kW}$ (partial braking 30N)
- $d_{acc} \approx -0.15g$ (partial braking 30N)
- rates: 7.96% (partial braking 30N)
  6.26% (partial braking 50N)
- $P_{brk\,req} = P_{reg} + P_{hyd}$
Strategy—Energy Saving

- Prius PHEV has the same engine operation point with Prius HEV during CS mode, but the output power of PHEV is lower.
- The regenerative braking capacity of Prius PHEV raises, (NEDC, Prius PHEV CS 3.42L/100km, Prius HEV 4.3L/100km, fuel efficiency raised 20.5%)
Strategy—Energy Saving: continued

- Active switching between HV/EV mode, engine warm-up according to $T_{\text{water}}$
- Compared to default setting, the fuel consumption of mode switching setting decrease by 7.35%
Conclusions

◆ Testing evaluation and research of electric vehicle is difficult but interesting.

◆ Prius PHEV is a typical example of energy saving and environmental protection. More samples of EV will be researched to focus on energy management, energy consumption, efficiency and strategy.

◆ The index system and test and evaluation methods are advised to be unified for collaboration and data sharing.

◆ Testing results can be utilized for the government as reference to make automotive industry policies and beneficial to the development of technology.

◆ Extend appreciation to ANL, especially Dr. Larry Johnson and Mr. Duoba, for their help and support during the Prius PHEV test.
Next step (CAERI & Argonne)

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◆ CAERI and Argonne have the same interest in Accord PHEV and the testing will focus on energy consumption, energy management and vehicle efficiency, etc.
Thank you!