

Development Status of Electric Vehicles

Heliang Zhou¹, Feng Wei², and Liqing Sun³

¹ EV Committee, China Electrotechnical Society

² EV Committee, China Electrotechnical Society, cesexpo@163bj.com

³ Beijing Institute of Technology, sunlq@bit.edu.cn

Abstract

A drive of EV R&D in China began years ago. The participants have achieved a lot in filed of both whole vehicle and key components. The paper presents the R&D status of electric vehicle in China for reference, which includes pure electric vehicle, hybrid vehicle and fuel cell vehicle as well as the key components such as motor and propulsion system, battery and MEMS and the test base and standards will be also included in the paper.

Keywords

electric vehicle, R&D, whole vehicle, key components, standards

1. INTRODUCTION

The electric vehicle has attracted the automobile industry all over the world again on account of environment protection and energy crisis. After three cycles of up and -down, the electric vehicle is now getting unprecedented recognition. Every country is striving for further development.

In the past 30 years, American has invested 200 billion dollars in the parallel hybrid electric vehicle (PEV), the hybrid electric vehicle (HEV) and the fuel cell electric vehicle (FCEV). 5,700 electric vehicles, 2,000 hybrid electric vehicles and 320 electric or hybrid or fuel cell passenger cars have been developed and manufactured. Japan has invested huge capital in hybrid electric vehicles and development and marketing is greater than other countries except the USA.

Our Chinese auto industry has entered an era of fast development, the number of automobile enterprises increase by two digits per year. The number of autos possessed by China is close to 50 million, and the environment protection center of state forecasts that 64 percent of atmosphere pollution is due to automobile emission. The electric vehicle R&D began a little bit late in China. More money than ever was invested in the field of EV in the 8th-five-year-plan and the 10th-five-year-plan aiming at developing the electric vehicle and achieving a great breakthrough in key component technologies, system integration and over-all vehicle technologies, building up a technology platform for fuel cell vehicle manufacture and realizing mass production of HEV and promoting electric vehicle's commercializing in a special region. The newly developed EV products must get the approval of the national level.

The specialist committee of electric vehicle, China Electrotechnical Society has visited Japan and Korea two times, having attended AEVC-2, EVS19 and the international environment and transportation symposium and visited Hyundai Motor corp., Korea automobile research institute, Korea Instrument institute, Seoul university, Japan Toyota corporation and other corporations such as Japan GS battery Co., having a thorough review of over-all vehicle, propulsion system, energy management, battery, charge technology as well as correlative parts and product technology, energetic discussions and idea exchanging were performed, the over-all development status of electric vehicles can be summarized as follows,

2. DEVELOPING STATE OF FOREIGN COUNTRIES

2.1 New characteristics of EV development

Most EV sales have been stopped in America, such as EV1, Chrysler EPIC, Ford Baker Postal Vehicle, Honda EV plus, Chevy-s10, Ford Ranger-EV and Nissan Altra. At present, only Toyota RAV4EV and Ford Ranger EV are still on sale. In Japan, the integration of EV and ITS has become a new way of utilization and commercialization of the current electric vehicle.

Up to 30th September 2003, four ITS/EV projects have been launched in Japan.

2.2 Outstanding achievement in HEV sale

Toyota and Honda are the only two automobile manufacturers which can mass produce and sell HEVs.

American and Japanese automobile enterprises have begun a competition in the field of HEV market, and the total market is forecasted to scale to 1 million in three to five years.

In HEV development, Hyundai Motor Corp succeeded in yielding Avante, Verna and Click HEV following 1999, 2000 and 2002.

Japan has done great work in the following aspects: first, having improved PRIUS, a HEV car which began mass production and sale in market in 1997, the first commercialized HEV in the world. After improvement, vehicle performance index increased. The fuel economy received a big increase, fuel consumption per kilometer reaching 4.5litre, fuel saving up to 50 percent, CO₂ emission decreasing to 50 percent, CO, HC and NO_x emissions according to EURO 4. Secondly, CROWN light HEV was introduced, in which there is no change in the traditional vehicle chassis driving system, a small ISG (integrated start generator) engine replaces traditional generator, at the same time fitted with battery and electric control system. Because ISG has big power, engine idle is canceled, energy regeneration functioned, energy saving is close to 15 percent and an improvement in emission index was achieved.

2.3 Great expectation in Fuel cell vehicle all over the world

Hyundai Motor Corporation developed a fuel cell vehicle on the basis of the Santa Fe vehicle type. Light material and an aluminum chassis were adopted so the over-all vehicle mass was only 1,615kg, moreover 75kw protons barter membrane fuel cell and 65kw induction motors were applied. In November 2002, Hyundai Motor Corporation united with the Hawaii government in developing electric vehicles. Until now, there have been 15 Santa Fe fuel cell vehicles in testing circulation. Toyota corps introduced the first fuel cell vehicle in 1996, and now there are improved FCHV-4, FCHV-4 and FCHV-BUSI. The output power of the fuel cell vehicle is increased 4 times to 90kw, maximum speed is over 150km/h, cruise range is up to 250km. As far as the fuel cell vehicle is concerned, Honda's FCX is the latest type, previously GM Autonomy, Nissan XTERRA, VW Bora Hy motion, Daimler Chrysler NECAR and THINK Focus FCV and so on.

2.4 Two end in dimension in R&D trend

To miniaturize the electric vehicle, especially pure EV, has become a develop trend all over the world. Moreover, up to 316 (including 90 HEV passenger cars, 6 fuel cell vehicles) have been developed, such as AVS-battery ENOVA, BENZ FC Citaro Bus, E-battery BUS, Toyota FC-Bus, Orion Hybrid Series VII and Nova RFS FC-bus, AVS hybrid 35 and so on. At the same time, some concept cars such as Estima, Dualnote, Liberty TTR, Acura DN-X, Durango TTR, GMC Sierra, Ram7 and so on are under going development.

3. NATIONAL DEVELOPING STATE

3.1 Vehicle integration

3.1.1 Pure electric vehicle

As the undertaking enterprise of the 863 electric vehicle special projects, Beijing Institute of Technology succeeded in developing two BFC6110-EV luxurious passenger buses, two BK6120-EV low floor EV buses after the success of the BJD6100-EV bus as well as the AK6110-EV economical EV bus and 8-metre mid-size bus. The two buses first mentioned have basically finished approval tests and the two buses last mentioned have begun small mass production. Maybe by the end of the year the bus fleet will run along 121 line and in Beijing Miyun electric vehicle demonstration area. Shandong Black Leopard Company has developed a new light pure electric vehicle. The large-scale production of the vehicle will become a new economic increase point of the Company. Tianjin Qingyuan Electric Vehicle Ltd has also developed pure electric sedans and has passed related approval experimentation.

3.1.2 Hybrid electric vehicle

Domestic hybrid electric vehicle research and development teams led by FAW, Dongfeng and Chery have also made fast progress in the whole vehicle. The hybrid electric bus prototype, developed by Dongfeng EV Corp., has been put into trial operation in Wuhan City.

3.1.3 Fuel cell vehicle

The fuel cell vehicle special project led by Beijing and Shanghai's R&D teams have also made great progress. Tsinghua University and Beijing Bus Head Office have worked together to develop the fuel cell electric city bus prototype and they have finished related tests. Shanghai's Super No.1 is China's first generation of fuel cell hybrid power car prototype. It employs the fuel cell power platform that has absolute Chinese IPR. It reduced the gap between China and the world advanced level greatly.

3.2 Technology of key components

3.2.1 Motor and control system

Beijing Institute of Technology invented an all-new traction motor automatic control mode and designed thulium a variable flux motor and drive system. Its characteristics are DC serial actuation motor's low velocity large torque and better automatic weakening magnetism performance. It basically meets electric vehicle's ideal power requirements. The technology has won an invention patent and the motor and propulsion system has begun small batch production.

The Institute of Electrical Engineering mainly studies motors and their control. During the "ninth five", it initiated an electric vehicle electric drive technology's study in time and undertook the important technology key

project of National Department of Technology and Chinese Academy of Science. It cooperated with Dongfeng Automobile Group and developed the first fuel cell electric vehicle with independent knowledge property right in China successfully. At the same time it established the largest electric vehicle electric system R&D laboratory in China and possesses an electric vehicle electric system experiment platform including AC asynchronous motor and DC-DC converter.

As the largest motor and generator devices manufacturer in China's northwest district, Lanzhou Motor Factory supplies excellent generators, motors, generator sets and control devices to our electric vehicle industry.

3.2.2 Battery

Entrusted by 863 Plan Electric Vehicle Whole Group of National Department of Science and Technology and according to (2002 Electric Vehicle Important Special Project High Power Battery Performance Test Criterion) established by it, the Northern 201 Institute and Tianjin Power Source R&D Center made a concentrated test evaluation on the NiMH and lithium ion power battery, which were developed by Beijing Institute of Technology, Beijing Colored Metal Study Head Institute and so on. The experiment result shows that through the implementation of 863 Project, China's battery study made great achievements and laid the foundations for China's electric vehicle industry's development.

3.2.3 Multi-energy management and whole vehicle control

The overall network comprehensive control and energy management is one of the key technologies of electric vehicle industrialization. It mainly solves two problems: one is how to manage the electric vehicle's limited energy most effectively and realize the minimum efficiency of the electric vehicle; the other is how to solve the problems during the electric vehicle's operation, such as failure diagnosis, high voltage safety, and enhancing the electric vehicle's reliability.

To solve the above two problems, comprehensive network system structure made up of a local management system, a whole vehicle information management system and a communication extending interface was employed and the electric vehicle's synthetic control was achieved successfully.

The battery management system is part of the vehicle information communication system and the basis of solving the electric vehicle's charging safety, use safety and increasing the range. Because the number of batteries on most electric vehicles is large, the batteries adopt group use and management modes. So the emphasis of battery management is developing battery management

module. The whole vehicle's dynamics model, battery's energy model, motor's energy model, air conditioner's energy model and road status model are constructed according to large amounts of experiment data and simulation study. According to material traffic line, the range can be forecasted.

3.3 Demonstration testing base and standardization demonstration area construction

The National Electric Vehicle Experimentation and Demonstration Zone was put into practice normally on June 9, 1998. The special zone has finished tasks such as discussing the social condition and supporting the environment by promoting and applying electric vehicles in China. It also carries on experiments with partners from abroad and supplies the base of decision made for China to develop electric vehicles. Hybrid electric vehicles should be the emphasis to develop.

The Beijing 121 electric bus has been in good status since July 2001. Its total range is over 60,000km. At the end of this year, Beijing will put 20 electric buses on the road for demonstration in all.

To study green Olympic sports traffic project's feasibility and implementation methods, Beijing City established Miyun electric vehicle demonstration area in Miyun, Beijing. Beijing management center of electric vehicle demonstration operation was established and it is in charge of the area's daily management work. It manufactures the electric vehicle in the area then promotes it to the 2008 Olympic Game.

On March 27, 2003, the fuel cell bus commercialized demonstration item (Beijing and Shanghai) was initiated in Beijing. Fuel cell bus system technology targets will be designed according to Beijing and Shanghai's zones and resource characteristics. And global bidding and hydrogen-gassing station will be built for 12 fuel cell buses. The planned total range is 1,600,000km.

3.4 Improvement of the standard system

At present, aimed at pure electric vehicles, the following recommended standards are publicized: safety requirements ((1) electric vehicle safety requirements the first part :on board energy storage set, (2) electric vehicle safety requirements the second part: function safety and failure protection, (3) electric vehicle safety requirements the third part: personnel electric shock), charging system (the joint requirement of electric vehicle with AC/DC power, electric vehicle AC/DC charging machine (station) and so on. Aimed at hybrid electric vehicles, some standards and statutes have been audited and are expected to be the recommended standard to be implemented in the first half of next year.

3.5 The construction of test bases

In the first term of 863 electric vehicle special project's sub item, a large sum of money was given to Beijing Northern Vehicle Institute and Tianjin Power Test Center for support and related devices were purchased, installed and debugged. And the battery samples were tested.

To overcome the deficiency of current electric vehicle electric drive test technology, national 863 established electric vehicle motor and control system test base wholly. Beijing Institute of Technology undertook the above work. Adopting modularized design method and providing a kind of experiment measurement sets perform electric vehicle electric drive tests. The test system can simulate the drive forces including vehicle's inertia and could implement electric vehicle electric drive's complete performance test and evaluation.

The loading devices adopt electric backset dynameters, mechanical dynameters, mechanical inertia and brake mechanism are in series, of which mechanical dynameters, mechanical inertia and brake mechanism are united to be one.

References

www.chinaev.com
www.sae-china.org

(Received November 15, 2003; accepted January 15, 2004)