

## **The Development of Li- Battery in China and Its Application in E-bike Industry**

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Since 1990s Lithium battery (LiB) has been applied in more and more fields, ranging from mobile phones, laptops, digital cameras and digital videos to e-bikes and e-cars. The new battery enjoys a rapid development in the past decade thanks to its uniqueness. Statistics show that the application of Lithium Battery as rechargeable battery is only second to Lead-acid Battery. LiB's market share increased rapidly and exceeded that of the Ni-MH and Ni-cad in 2003 when their market shares declined.

Concerning the development of batteries, the industrialization of the Lead-acid battery began 100 years ago. Ni-Cad enjoys a history of 50 years. And Ni-MH started no earlier than LiB. While the old types of batteries are replaced by the new ones, one of the fundamental improvements lies in the increase of energy density.

In terms of energy density, LiB has so far reached 100-200Wh/kg while Ni-MH 60-80 Wh/kg. Both batteries enjoy market advantage from the perspective of environmental protection, but LiB boasts higher energy density. Besides, LiB has the highest initial *electrode* voltage--1.8 times as high as that of Lead-acid and 3 times as high as that of Ni-MH and Ni-Cad. That is to say, to reach the same voltage, fewer LiB cells are needed to enhance the consistency of the pack. Moreover, from the perspective of battery's life span, LiB has been considered as a high quality product thanks to its no memory effect, no pollution and low initial discharge. However, LiB has a relatively higher cost, which is determined by the production process rather than the material cost. The material of Ni-MH costs more than that of LiB. But the production requirement for the Lithium Battery is higher than any other battery, leading to a higher investment on LiB production. Its cost can only be reduced through mass production.

Now the most promising field related to batteries is hybrid vehicles. The price of a hybrid car newly made by Toyota has reached \$20,000 in the USA market and as many as 300,000 units have been sold. Next year it will be put into production in China and then sold in Chinese market. The high fuel cost makes it difficult for China to develop its automobile market. If fuel can be replaced by electricity, E-cars and hybrid cars will have a rapid development. It goes without saying that it is very important to replace oil with electricity.

When a car is at its idle speed or drives with heavy load, the efficiency of the engine is very low and may produce more waste gas. If a battery is installed in the car, the engine can relax for a while at the idle speed. The battery can not only keep freewheels working but keep the car moving smoothly. When heavily loaded, the car can get extra power from the battery. Consuming the same amount of fuel, the hybrid car can run further as the fuel-driven one. And the hybrid car emits less waste gas than the fuel-driven one. Battery proves to be very significant to the car as the hybrid design will neither change the layout of the old system nor change people's driving habit.

Toyota will soon endorse with Faw-volkswagen on the issue of developing hybrid cars in China. Volkswagen Shanghai and GM Shanghai will also participate in this field. In China, the most important application of battery lies in buses. The pollution caused by the taxi equals to that by ten private cars while the pollution produced by buses equals to that by 100 private cars. And it cannot be an excuse to restrict the development of the public transportation. The only way to solve the problem is to promote green buses. The efficiency of the Mitsubishi hybrid rises by 43%, leading to much less energy consumption. That is why batteries enjoy a world wide research at present.

The Japanese government supports the development of Lithium Battery used in cars. After ten years' research, the battery used as the only energy in the car can reach 1000 charge cycles. But it is very difficult to popularize the battery driven car due to a lack of battery recharge stations. In comparison, the hybrid car will be more popular. The requirement of life span for a hybrid car is about 15 years.

The development trend of LiB is to make it cheaper, safer and more original. The quality index increases with its development. The improvement of the material is the basis of enhancing its price/performance. Reports show that many people are concerning about the safety of Lithium Battery. What if the battery causes accidents? Earlier e-cars did cause several accidents, which had much to do with the choice of material and the design of battery. In the compression test of this year's "863" serial testing, some of the Ni-MH batteries exploded, blaming to the poor battery design. Actually, with reasonable designs and rigorous production, the batteries should have passed the safety test. Compared with Co-Li, Mn-Li is much safer with 500 charge cycles. Japanese government has solved the problem at the cost of 1 billion dollars and China too, by and large has solved the problem.

Is there any predictable development of Lithium battery? Can we make it more capable to meet the needs of electric buses? For the well developed small sized Lithium battery, its potential can be further explored to reach a promising 250 Wh/kg. Within five years, the cost of each W/h can be cut down to 1 RMB. That is to say, the battery cost of a 360 W/h e-bike will be 360 RMB. At present, the cost of LiB is lower than that of Ni-MH and is close to that of Ni-cad. Whether we can make it better depends on the development of technology. For example, The Mn-Li can reach 10 to 20 A/h, which can meet the needs of hybrid cars and e-bikes. At present, the only material to reach the standard of 100A/h falls on *phosphoric acid iron lithium*, whose conduction level needs improving.

It is the rapid development of batteries that promotes the development of Chinese electric bicycle industry. The Lithium Battery adopted by e-bikes can be charged 500 times and can be put into practical use, as a 3 kg Li-battery may cover 40 kilometers. But can a Lithium battery be used on bicycles? Can it be used to its full play? It would depend on materials, motors and the whole piece. Anyway the expansion of e-bikes in China provides a good opportunity for the development of e-cars.