Lithium Ion batteries and LiTHIUM BALANCE BMS successfully tested for 18 months in EVT 168 electric scooter

Niels Orla Fokdal's EVT 168 electric scooter performed poorly with Lead Acid batteries, travelling just 30 km per charge and needing new batteries every year. But after installing Lithium Ion batteries and the LiTHIUM BALANCE battery management system (BMS) the scooter now has 4 times the range, and after 18 months the batteries are still performing as new.

UPDATE: This article was originally published in early 2009, since then, Niels Orla Fokdal has continued to use the scooter without problems meaning that the scooter has operated reliably on one set of Li-ion batteries for over 3 years.

Niels Orla Fokdal and his EVT 168

Scooters with no emissions

Sales of electric bikes and scooters has seen phenomenal growth in recent years, driven in part by increasing sales of motorbikes and scooters in many parts of the world and in south east Asia and China in particular. These two wheelers provide efficient, low cost, personal transport. Scooters in particular are a growth market with their small wheels and tyres and full faired in bodywork making them more practical and safer than conventional two wheelers.

In Europe the scooter is typically something for teenagers, providing transport and recreation, but the combined effects of city congestion, fuel prices and the environmental impact of transport may yet give the scooter a bigger role in personal transport.

Scooters have two main failings, protection and emissions. As one would expect they offer little protection from the weather and although you are less likely to get your legs trapped underneath there is little comparison with a four wheeler or even a three wheeler. Scooters also fare very poorly in terms of tailpipe and noise emission. The two stroke internal combustion engines used to power many scooters emit high levels of unburnt or improperly combusted hydrocarbons. The low sales cost of a scooter make it uneconomic to add any form of exhaust gas treatment such as a catalytic converter with the necessary engine management regime. Electric scooters on the other hand have zero tailpipe emissions and low noise levels and are growing in popularity with huge sales in China, primarily.

Poorly performing Lead Acid batteries

The vast majority of electric scooters are powered by Lead Acid batteries for cost reasons although they have weight, performance and reliability issues in this application. Scooter batteries require "deep cycle" operation whereby the batteries are often run close to full discharge before being fully recharged. This is unlike a car battery, which rarely falls below 90% charge level. Deep cycle discharge can lead to rapid decay in battery performance if not properly managed.

Valve Regulated Lead Acid batteries used in this application, they are more expensive than your typical car battery, but tolerate many more deep discharge-recharge cycles.

In situations where performance and reliability take a higher priority than sales price, Lithium Ion batteries are an alternative to Lead Acid batteries as the following case illustrates.

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An EVT 4000 electric scooter was imported into Denmark in 2004 equipped with four 12volt Lead Acid batteries with a total capacity of 2.4kWh weighing 60kg. The scooter was foreseen for urban, personal transport. The initial range of the scooter was projected at less than 30km between charges but this was adequate.

After about 1000km the Lead Acid batteries were dead, unable to hold charge or run the scooter. So the battery pack was changed for another set of Lead Acid batteries. These ran for about a year during which time the range fell to around 2km, at which point the scooter was simply parked and forgotten about. The suspicion was the charger, but it could have been many things including the cold winters in Denmark which cause Lead Acid batteries to self discharge and suffer sulfation, which reduces their performance incrementally.

Resurrected with Lithium Ion batteries

In September 2007 the scooter was resurrected and equipped with a 48 volt, 4.3kWh Lithium Ion battery pack with integrated battery management system weighing 32kg and a dedicated charger. This revolutionized the performance of the scooter in the words of the owner, the estimated range went up to over 100km and single trips of over 70km were done without any noticeable drop in voltage levels or performance.

During the period from Sept 2007 until now (Feb 2009), the scooter suffered only one fault and that was a corroded fuse holder which was quickly diagnosed and fixed. It is left outside all year round and kept on trickle charge in the winter. The only maintenance activities have been to recharge it and pump the tyres!

BATTERY COMPARISON

	Before	After
Chemistry	Lead Acid	Lithium Ion
Capacity	2.4kWh	4.3kWh
Weight	60kg	32kg
Range per charge	30km	120km

The switch from Lead Acid to Lithium Ion pays for itself in terms of fewer battery replacements, easily within the life of the scooter and that is without taking into account the huge improvements in performance, usability and reliability.

Any reliable range over 60km will make an electric scooter a viable proposition for many. Coupled with the zero maintenance and fun performance electric scooters provide, we expect them to catch on.

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