Charging into the fast lane!

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Road transportation makes up to 20% of all global emissions. Electric cars are one of the many ways we can help the environment. But there are a few features that electric cars are lacking. **THINK***'s gets in touch with* ***Dr Robert Camilleri*** *(Institute of Aerospace Technologies, University of Malta) to find out how they plan to lead the way!*

In this busy world, the human race is constantly on the go, and technology has had to keep up! Items like our phones and laptops are constantly being used, from work to entertainment purposes. Research has had to develop batteries that can keep up with this 24/7 lifestyle. In today's world, some of the latest phones on the market can be charged halfway in just 30 minutes. But what about larger electrical devices, say, electric vehicles?

Typically it takes around 8–14 hours to fully charge an electrical vehicle, possibly longer for larger cars. As much as we all want to do our bit to tackle climate change, this charge time is a drawback, especially when compared to the few minutes it takes to fully fuel a petrol car.

However, this might be about to change. To find out more, we sat down and talked about all things battery with Dr Robert Camilleri, lecturer within the Institute of Aerospace Technologies (University of Malta) and the principal investigator on the NEVAC (Novel Evaporative Cooled Technology) research project.

HOW DOES FAST CHARGING WORK?

Before we can understand how fast charging works, we need to see how batteries function. A battery is a device that stores energy in chemical form and converts it into electrical energy. There are two ends, each made of different metals: the anode and the cathode. In between these two points is a chemical called the electrolyte that allows electrons to flow through a separator and generate electricity when the battery is attached to a device.

Secondary batteries, such as lithium-ion batteries, can do this process reversibly; i.e. their chemical reactions can be reversed by applying

an electrical current to the cell. This regenerates the original chemical reactions so they can be used, recharged, and used again multiple times. However the charging process is associated with a speed (or rate) at which the battery cell can do this process safely. Fast charging requires that a higher current is pushed into the battery cell, thus making the reaction faster (hence fast charging). Since this conversion is not 100% efficient, charging often generates heat. Therefore, one of the major limitations of fast charging is thermal management of the battery.

As Camilleri explains, 'when batteries have a high current pushed through them, they generate a significant amount of heat. If this is not dissipated, the battery temperature increases. Beyond a certain temperature threshold, there is a risk of batteries experiencing what is known as *thermal runaway*.' Thermal runaway is when the batteries experience a chain reaction in which more energy is released. This causes the electrolyte to break down into flammable gasses, which eventually catch fire or explode.

SWEATING THOSE BATTERIES

NEVAC uses *evaporative cooling* as the thermal management system. This cooling system uses the concept that every liquid has a unique boiling point, and once this temperature is reached, the liquid turns into gas. The process of turning the liquid into gas requires a lot of heat and energy. NEVAC takes advantage of this principle, making it able to absorb a large amount of heat, which prevents the battery cells from overheating.

The system is designed so the electric batteries sit in a pool of dielectric liquid (one that is safe for electronics) that boils at 35°, the comfort temperature for lithium-ion batteries. When the batteries have a high current passed through them, they heat up. The heat is absorbed by the liquid, causing it to reach its boiling point and evaporate into gas, effectively transporting the heat away from the batteries. The battery system is sealed to prevent loss of the coolant in its liquid or gaseous state. The gas is then condensed back into its liquid form, ensuring that the system is self-sustaining.

NEVAC has two advantages, Camilleri says: 'One: we are able to extract a lot of heat when a high current is pushed through the battery. This enables the possibility of fast charging without suffering from battery overheating, and two: the liquid always boils at the same temperature, therefore despite the battery being made of thousands of cells, they will all be maintained at the same temperature. Keeping the gas within the system was very important and was easier said than done!'

Dr Robert Camilleri
Photo by James Moffett

Camilleri and his team have proved that with the NEVAC design batteries can stay cool whilst fast charging. The team has demonstrated that the system prevents thermal runaway. ABERTAX, a manufacturer for advanced battery accessories and project partner, have developed a technology demonstrator for independent review in Germany. The team are now in the process of patenting key features of the technology and hope that they can attract the interest of car manufacturers. The key question is, will we be seeing this tech in commercial electric vehicles soon? Camilleri is optimistic, 'I'm very hopeful. We've just concluded the NEVAC project (3 years!). We have successfully proved the concept and built a technology demonstrator. The results are very promising. I believe there is a real opportunity to maximise on the findings made. The dream is for this to be in a Tesla car one day!'

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