Solid-State Batteries

Solid-state Batteries and Its Future?

Solid-state battery is in news for quite some time. Recently, shareholders of QuantumScape Corp, a California based battery start-up backed by Volkswagen AG have approved a multibillion-dollar pay package for Jagdeep Singh, its Chief Executive Officer given the company meeting certain performance milestones.

Before trying to understand the meaning of a solid-state battery, let's understand the meaning of a battery and a lithium-ion battery.

What is a battery?

A battery stores chemical energy and converts it into electrical energy. It has three basic parts:

1. Anode: It is negative end of a battery
2. Cathode: It is the positive end of the battery
3. Electrolyte: It transports ions i.e. the electrically charged atoms between the two ends of a battery.

What is a Lithium-ion battery?

Lithium-ion batteries are common these days and are an integral part of our lives. These batteries are used in wireless headphones, electric vehicles, smartphones, power tools etc. These batteries are composed of anode, cathode, separator and electrolyte. These use a liquid electrolyte solution. The separator keeps cathode and anode apart with liquid electrolyte solution.

What is a Solid-state battery?

A solid-state battery has the same components as that of a lithium-ion battery but it uses a solid electrolyte and not liquid. The solid electrolyte in a solid-state battery plays the role of a separator as well.

What are the uses of a solid-state battery?

Currently, solid-state batteries are used in devices like:

- Pacemakers
- Smart watches

But the current and on-going research on solid-state lithium metal batteries aims to be a game changer for the electric vehicle technology and speed up the shift away from fossil fuel-powered vehicles. Lower cost could make a big difference, given that at 30 per cent of the total cost, battery expenses are a key driver of the vehicle (EV) costs.

Advantages

- These batteries have a very high energy density (by eliminating the carbon anode) and can store more energy than lithium ion batteries.
- It will be able to undertake more charging cycles. Therefore, it can last longer.

- It can charge faster (will eliminate the need to have lithium diffuse into the carbon particles in conventional lithium-ion cells).
- These are likely to me safer and more stable to use than lithium-ion batteries.
- Will cost lesser than lithium batteries.

Who all are trying to make the solid-state batteries?

- Japan's Toyota Motor Corp is one of the front runners to mass produce solid-state batteries.
- Toyota has also teamed up with Japan's Panasonic Corp to develop these batteries with their Prime Planet Energy & Solutions Inc venture.
- Germany's Volkswagen has invested in the U.S. battery firm Quantum Scape Corp, which is backed by Bill Gates.
- Stellantis, which was formed by the merger of Italian-American automaker Fiat Chrysler and France's PSA, has a venture called Automotive Cells Co with Total Energies and a partnership with China's Contemporary Amperex Technology Co Ltd (CATL).
- Ford Motor Co and BMW AG have invested in startup Solid Power.
- South Korea's Hyundai Motor, which has invested in startup Solid Energy Systems to mass produce solid-state batteries in the year 2030.
- Samsung SDI Co Ltd, which is an affiliate of Samsung Electronics Co Ltd, is working on developing these batteries.

Future of solid-state batteries

- Experts say that currently, a solid-state cell costs about eight times more to make than a liquid li-ion battery.
- It is difficult to mass produce these batteries for EVs now and will take anywhere from three to five years. Reasons that hamper the mass production of solid-sate batteries include:
    - ✔ Difficult to design a solid electrolyte that is stable, chemically inert and still a good conductor of ions between the electrodes.
    - ✔ These are expensive to fabricate and are prone to cracking because of the brittleness of the electrolytes when they expand and contract during use.

Now we need to wait for a time in the future when these solid-state batteries will help in recharging the EVs in minutes and make a pacemaker last for half a century!