WHY THE ELON MUSK CHOICE OF BATTERY IN THE TESLA IS THE WORST DECISION IN ENGINEERING HISTORY

Scientists have long understood that a lithium-metal anode would theoretically pack in more energy. In fact, the first lithium-ion cells that oil giant Exxon developed in the 1970s contained lithium-metal anodes. (Exxon was working on batteries then because it worried that oil might run out one day.) Single-use lithium-metal batteries were commercialized about the same time and they are used even today in specialized applications, such as deep-sea drilling.

Commercializing rechargeable lithium-metal batteries is a bigger challenge. In the 1980s, Moli Energy, a Canadian startup, was the first to succeed. But some of its batteries started catching fire, and the company had to issue a recall. The incident led to legal action and Moli Energy was forced to declare bankruptcy.

The use of lithium metal in rechargeable batteries creates three big problems. First, it reacts with everything: water, oxygen, and even nitrogen (all of which are present in the air around us), making it more likely to catch fire.

Second, lithium's reactivity means it suffers side reactions with the battery's liquid electrolyte, which is itself an energy-rich

medium. These undesirable reactions reduce the amount of lithium available and worsen the battery's life with every charge-discharge cycle.

Third, when a lithium-metal battery discharges, lithium ions separate from the surface of the anode and travel to the cathode. When the battery is charged the same ions travel back and deposit onto the anode as lithium metal. But instead of forming a nice smooth coating on the anode, lithium metal has the tendency to generate "dendrites," chains of lithium atoms growing from the surface of the anode, which look like the roots of a tree. The dendrites grow bigger with each charge-discharge cycle, eventually reaching the cathode and causing the battery to short, leading to fires.

As the industry struggled through these problems in the late 1980s, Sony invented the graphite anode. Though less energy-dense, it suddenly made lithium batteries a lot safer and more reliable. Since then, graphite anodes have remained the mainstay of the industry.

Nearly 30 years later, however, we are brushing up against the limitations of the graphite anode.