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Mineral Substitution and the Lithium-Ion Battery

Lithium Processing Plant, Catamarca, Argentina

Substitutes for Lithium in Batteries

by Dave Chambers, CSP2

Lithium-Ion batteries are a key component of many of the essential tools of modern day society, everything from watches, cell phones, computers, to electric vehicles (EVs). Lithium is the most important ingredient of the battery because of its ability to store-and-release electrical energy. Graphite (carbon) is the major component of the battery by weight, and nickel and cobalt are often minor constituents.

Lithium, graphite, nickel and cobalt are sourced primarily by mining. In the effort to counter global warming, and the switch to renewable sources of electrical energy, batteries play an important role not only for portable electronics and EVs, but also for large storage facilities that can store the power produced by solar and wind energy to meet the need for a fluctuating demand for electricity.

Looking at the lithium-ion battery, and the alternatives that exist for it, provides some interesting insight into alternative paths for meeting

Greenbushes hardrock lithium (spodumene) mine in Western Australia

energy storage needs, as well as addressing some of the issues that always arise when mining is required to produce raw materials demanded by society. The Thacker Pass lithium mine in northern Nevada, on lands important to several indigenous groups, is an example where mining for lithium is controversial.

CSP2 has recently reviewed several large lithium mining projects proposed for Serbia and Germany. Any mining project proposed for Europe will be contentious. Lithium extraction from brines, common in Latin American and the southwest US, is also controversial because of the water consumption and extensive land use involved.

Thacker Pass lithium mine in northern Nevada

But is there something that could be substituted for lithium in the lithium-ion battery?

It turns out sodium is a reasonable substitute for lithium in a battery. Sodium is more common than lithium, and is obtainable from more readily available and less controversial sources than lithium. From a battery standpoint, the "price" for using sodium is that it takes about 30% more sodium to provide the same amount of electrical power as lithium. That means a battery would need to weigh 30% more to produce the same amount of electrical power if sodium is substituted for lithium. That is not insignificant, but it is not a fatal flaw either.

In addition to avoiding many of the mining issues associated with sourcing lithium, are there any additional advantages in substituting sodium for lithium?

One of the significant liabilities of lithium-ion batteries is that they can burn spontaneously. This is particularly problematic for commercial aircraft, where there are numerous incidents annually of computer batteries catching on fire inflight. So far there have been no catastrophes, but it is only a matter of time before an incident gets out of control. Another advantage of a sodium-ion battery over a lithium-ion battery is that neither nickel or cobalt is required. This would eliminate the need to mine nickel and cobalt for battery use. Nickel and cobalt are sometimes sourced from areas where conflict is closely associated with their mining.

Sodium-ion batteries recharge faster than lithium-ion batteries, which is especially important for batteries in EVs. And, sodium-ion batteries are much less sensitive to cold than lithium-ion batteries, again a significant advantage for EVs, especially if you don't have a garage to park your car in the winter. Finally, sodium is less expensive than lithium, but this is less important than the advantages of sodium over lithium listed above.

(continued on the next page)

Lithium evaporation ponds

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The other major component of both lithium-ion and sodium-ion batteries is graphite. Similar to lithium, there are available substitutes for mined graphite. These substitutes include graphite from petroleum coke, and iron-phosphate, which already holds 30% of the EV battery market. And, most tantalizing, silicon, which is far superior electrically as an anode material than graphite, but still has some significant engineering problems to be worked out before it can be considered a viable substitute for carbon.

Lithium substitutes are just one example of the complexity of battery technology, and of reworking power generation to meet the new needs dictated by global warming and green energy sources in general. There are no glaring lessons to be garnered from looking at the substitutions available for the lithium-ion battery, but there are a couple of things to ponder further.

First, we should remain flexible in light of rapidly evolving technology. Performance characteristics, product costs, and associated environmental costs are changing rapidly. A strategy of proceeding hell-bent pursuing one technology, like lithium-ion batteries, that may become obsolete in the near future could be very costly from an economic, social, and environmental perspective.

Second, when considering which technologies to pursue in addressing climate change, policy makers do not appear to giving enough consideration to the social and environmental costs of mining. Those costs are real, and should be factored into the priority equation when considering which technologies will receive financial backing, and environmental exemptions, for meeting next-generation energy needs.

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From the Executive Director

Dave Chambers is the Executive Director of **CSP²**

Predictions about Trump administration actions on mining have been on the mark. The administration is negotiating with the owners of the Pebble mine on how to resolve ongoing litigation against the EPA and its designation that prohibits mining in Bristol Bay in order to protect fisheries. The administration is also fast-tracking critical minerals, a list which now includes coal and gold – a first.

Mining projects are being placed on the FAST-41 list of projects that will receive accelerated environmental review. Review requirements will vary by project, so we don't know as yet how these accelerated environmental reviews will be done, but indications are that some reviews could be as short as 30 days, instead of the normal 18-24 months for an EIS.

We should also closely watch the actions that Congress may take, because legislative changes are much more difficult to reverse once enacted. Changes to environmental laws will be difficult to reverse. And, there are already serious congressional proposals to sell public lands, which could ultimately turn into a giveaway to mining companies. Conservatives have long advocated for the disposal of public lands.

Over the decades I have watched conservatives play for the long-term. They said they were going to concentrate on taking over local and state politics, and place ideological judges in the courts, and they have done just that. Working on mining issues is also a long-term game. Mining companies work for decades on opening a mine, and if we hope to have an impact on that process we must be prepared to participate over the same period if we are to have an element of control over these proposals.

Most of the issues I work on are done in a reactive mode. We do not have the resources to be proactive. There is no Project 2025 for mining activists, for conservationists, or even for liberals. I see foundations that fund environmental issues sunsetting, and I ask myself why? Do they not believe they have the vision or wherewithal to sustain these efforts in the long-term? We really need a better model to protect long-term environmental values. But I ramble too much…

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