Belmopan flow battery technology

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A commonplace chemical used in water treatment facilities has been repurposed for large-scale energy storage in a new battery design by researchers at the Department of Energy"s Pacific Northwest National Laboratory. The design provides a pathway to a safe, economical, water-based, flow battery made with Earth-abundant materials. It provides another pathway in the quest to incorporate intermittent energy sources such as wind and solar energy into the nation"s electric grid.

The researchers reported in Nature Communications that their lab-scale, iron-based battery exhibited remarkable cycling stability over one thousand consecutive charging cycles, while maintaining 98.7 percent of its maximum capacity. For comparison, previous studies of similar iron-based batteries reported degradation of the charge capacity two orders of magnitude higher, over fewer charging cycles.

Iron-based flow batteries designed for large-scale energy storage have been around since the 1980s, and some are now commercially available. What makes this battery different is that it stores energy in a unique liquid chemical formula that combines charged iron with a neutral-pH phosphate-based liquid electrolyte, or energy carrier. Crucially, the chemical -- called nitrogenous triphosphonate, nitrilotri-methylphosphonic acid, or NTMPA -- is commercially available in industrial quantities because it is typically used to inhibit corrosion in water treatment plants.

Next-Generation Flow Battery Design

Organic Redox Flow Battery

Phosphonates, including NTMPA, are a broad chemical family based on the element phosphorus. Many phosphonates dissolve well in water and are nontoxic chemicals used in fertilizers and detergents.

"We were looking for an electrolyte that could bind and store charged iron in a liquid complex at room temperature and mild operating conditions with neutral pH," said Senior Author Guosheng Li. "We are motivated to develop battery materials that are Earth-abundant and can be sourced domestically."

Here is an exclusive Tech Briefs interview -- edited for length and clarity -- with Li.

Tech Briefs: What was the biggest technical challenge you faced while developing this battery?

Li: The primary technical challenge in developing this battery lies in identifying a novel Fe-complex with electrochemical properties suitable for use as an anolyte. Discovering an appropriate Fe complex with a

nitrogenous phosphonate is nontrivial, as most of Fe complexes reported to have the appropriate redox potential are also prone to rapid degradation.

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