Gabon flow battery technology

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 iron-based battery exhibited remarkable cycling stability over 1,000 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.

"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."

Flow batteries can serve as backup generators for the electric grid. Flow batteries are one of the key pillars of a decarbonization strategy to store energy from renewable energy resources. Their advantage is that they can be built at any scale, from the lab-bench scale, as in the PNNL study, to the size of a city block.

In the near term, grid operators are looking to locate battery energy storage systems (BESS) in urban or suburban areas near energy consumers. Often, city planners must grapple with consumer safety concerns. The type of aqueous flow battery reported here could help alleviate safety concerns.

"A BESS facility using the chemistry similar to what we have developed here would have the advantage of operating in water at neutral pH," said Author Aaron Hollas. "In addition, our system uses commercially available reagents that haven"t been previously investigated for use in flow batteries."

The team reported that its initial design can reach energy density, a key design feature, up to nine watt-hours per liter (Wh/L). In comparison, commercialized vanadium-based systems are more than twice as energy dense, at 25 Wh/L. Higher energy density batteries can store more energy in a smaller square footage, but a system built with Earth-abundant materials could be scaled to provide the same energy output.

"Our next step is to improve battery performance by focusing on aspects such as voltage output and electrolyte concentration, which will help to increase the energy density," said Li. "Our voltage output is lower than the typical vanadium flow battery output. We are working on ways to improve that."

For more information, contact Karyn Hede at This email address is being protected from spambots. You need JavaScript enabled to view it.; 509-375-2144.