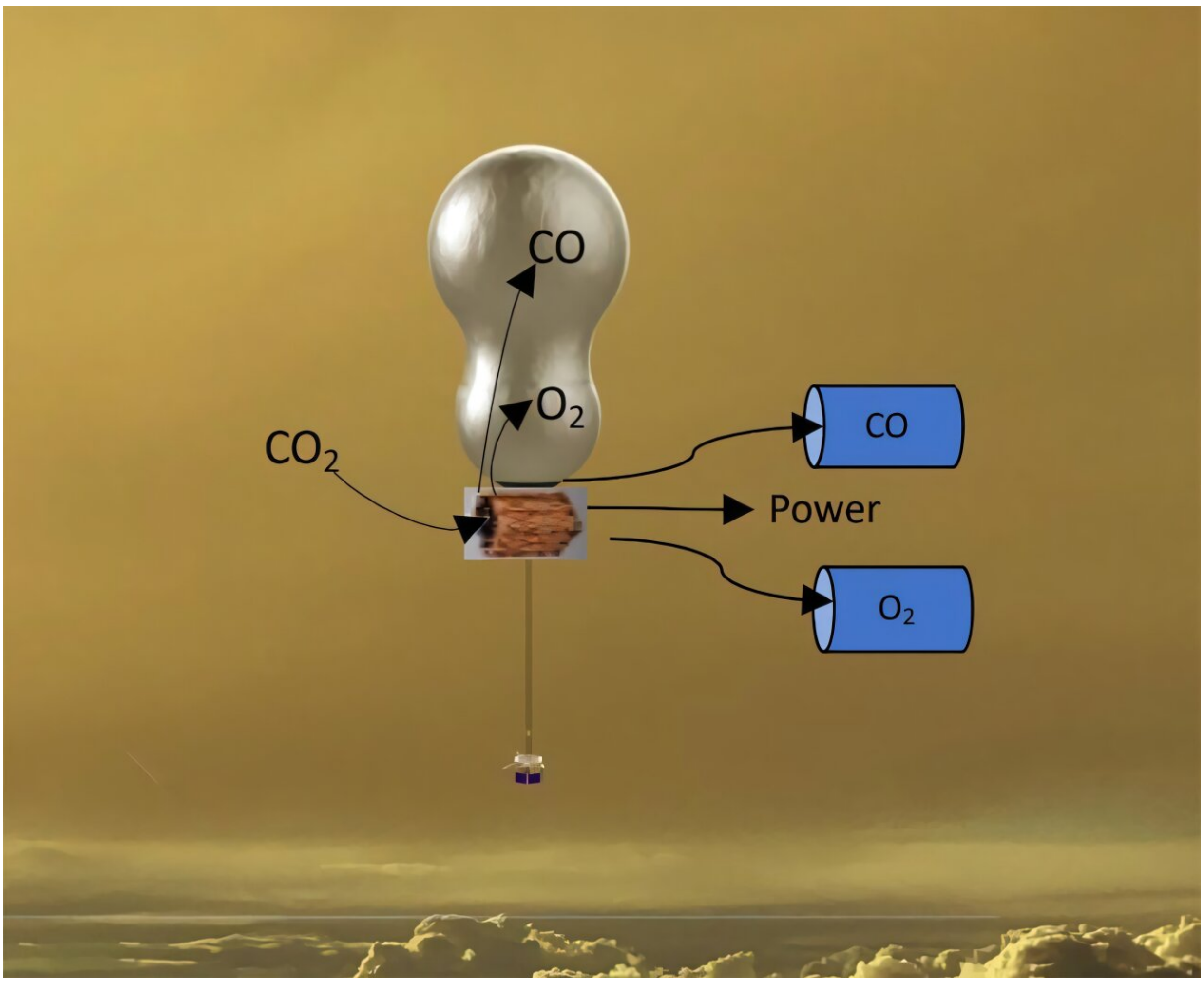
A balloon mission that could explore Venus indefinitely

January 30 2025, by Andy Tomaswick



Artist concept highlighting the novel approach proposed by the 2025 NIAC awarded selection of Exploring Venus with Electrolysis (EVE). Credit: NASA/Michael Hecht

Sometimes, the best innovative ideas come from synthesizing two previous ones. We've reported before on the idea of having a balloon explore the atmosphere of Venus, and we closely watched the progress of the Mars Oxygen ISRU Experiment (MOXIE) as part of the Perseverance rover on Mars.

When you combine the two, you can solve many of the challenges facing balloon exploration of Venus' upper atmosphere—the most habitable place in the solar system other than Earth. That is the plan for Dr. Michael Hecht, the principal investigator of the MOXIE system and professor at MIT, and his team for the Exploring Venus with Electrolysis (EVE) project, which recently received as NASA Institute for Advanced Concepts (NIAC) Phase I grant as part of the 2025 NIAC awards.

Current ideas for balloon missions to Venus face two challenges. First, the buoyant gas they must use to stay afloat leaks out over time, limiting the mission duration. Second, they must carry large amounts of batteries to ensure their electronics (and, in some ways, the gases) can endure Venus's 50-hour night cycle. If the gases inside the balloon get too cold, they depressurize, decreasing the balloon's altitude.

Using a system akin to MOXIE would solve both of those problems. MOXIE famously created oxygen on Mars by splitting carbon dioxide in the atmosphere into carbon monoxide and oxygen by using a process called solid oxide electrolysis (SOE). Despite that project coming to an end, it showed the proof of concept that where there is carbon dioxide, we can make oxygen, even on other planets.

There is plenty of carbon dioxide in Venus' upper atmosphere—in fact, that is primarily what the atmosphere there is composed of. Notably, both carbon monoxide and oxygen, the components the SOE process creates, are lighter than the carbon dioxide they're created from. In other words, in Venus' atmosphere, the outputs of the SOE process are buoyant.

But that's not all—in an interview with Fraser, Dr. Hecht describes another advantage of using the SOE system. "When people ask me how MOXIE works, I always describe it as a fuel cell running backwards," he said. But, during the Venusian night, "you could take some fraction, maybe 10% of the carbon monoxide and oxygen that you made during daytime and run it through the instrument backwards to get power at night."

Not only would EVE get an unlimited amount of buoyant gases from the SOE process, but it would also essentially get unlimited electricity, even without sunlight and without the need for heavy batteries that would otherwise weigh it down. Other advantages include using carbon monoxide as a propellant for other powered aircraft for which the balloon could serve as a base station. Plenty of ideas come to mind when exploring the use cases of this platform.

Doing this process on Venus has some added advantages as well. Given the thickness of the atmosphere, especially compared to Mars, the SOE system in Venus' atmosphere would just need a fan rather than the miniaturized compressive pump used in the MOXIE system on Perseverance. Also, since Venus is much closer to the sun, during the daytime, there will be abundant solar power to power the system, whereas on Mars, solar power is still an option, but the Perseverance rover ran off a radioisotope thermal generator instead.

Venus does have some unique challenges, though—there is also sulfuric acid, though not much of it, in the atmosphere. Dr. Hecht mentioned the need for a protective coating, like Teflon, on the components that would be exposed to the atmosphere. He didn't seem worried about the mass increase either, mentioning, "How much mass is in your nonstick pan from the Teflon coating?"

However, a balancing act has to happen with the SOE process itself. Dr. Hecht mentions in his NIAC proposal the goal of a 75% conversion efficiency between CO_2 and Oxygen/CO. If aiming for more than that—say 100% efficiency— some of the CO created as part of the process is also electrolyzed, and the instrument becomes clogged with pure carbon (i.e., soot).

However, at the 75% efficiency range (which admittedly is about 3 times more efficient than MOXIE was), the buoyancy of the oxygen and a combination of the leftover CO_2 and CO is about equal, so you could split the two gas streams into separate chambers and have equal buoyancy, without tipping it one way or another.

Overall, this seems like an eminently practical solution to a problem with a long-standing idea in the future of Venus exploration. But why stop there? Dr. Hecht also mentioned that such a system would theoretically work on Titan and on other planets and moons with thick atmospheres. As EVE moves through the NIAC phases and the team starts detailed technical work on it, humanity will get closer to a technology that could revolutionize the exploration of our nearest planetary neighbor.

Provided by Universe Today

Citation: A balloon mission that could explore Venus indefinitely (2025, January 30) retrieved 30 January 2025 from https://phys.org/news/2025-01-balloon-mission-explore-venus-indefinitely.html