New process can convert human-generated waste into fuel in space

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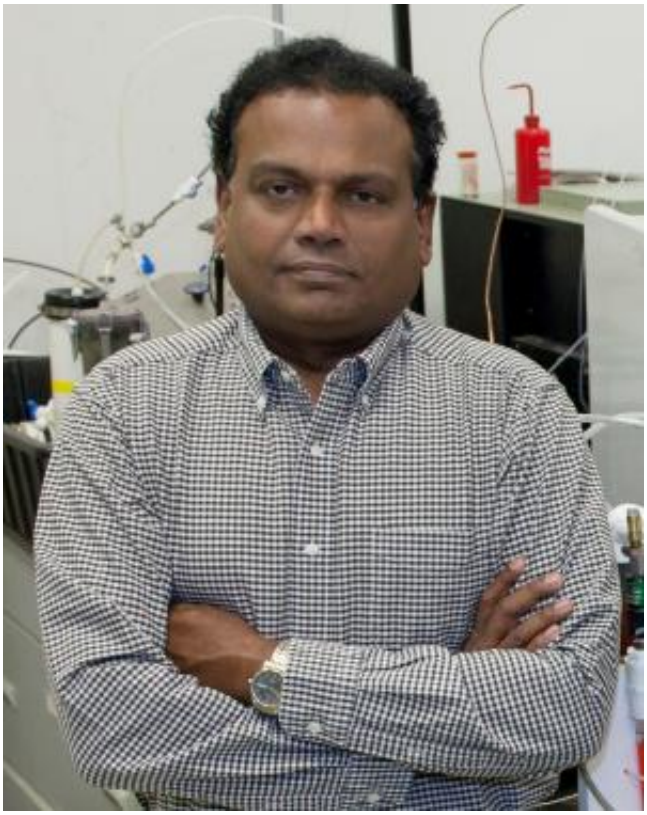

NASA hopes to eventually build a base on the moon to launch missions to other planets, including Earth. University of Florida researchers have designed a process that converts human waste into methane to be used as fuel that can propel spacecraft from the moon back to Earth. Pratap Pullammanappallil, a UF associate professor in agricultural and biological engineering, seen here standing in his Gainesville lab, worked with a former graduate student on the research. Credit: Amy Stuart

Human waste may have a new use: sending NASA spacecraft from the moon back to Earth.

Until now, the waste has been collected to burn up on re-entry. What's more, like so many other things developed for the space program, the process could well turn up on Earth, said Pratap Pullammanappallil, a University of Florida associate professor of agricultural and biological engineering.

"It could be used on campus or around town, or anywhere, to convert waste into fuel," Pullammanappallil said.

In 2006, NASA began making plans to build an inhabited facility on the moon's surface between 2019 and 2024. As part of NASA's moon-base goal, the agency wanted to reduce the weight of spacecraft retuning to Earth. Historically, waste generated during spaceflight would not be used further. NASA stores it in containers until it's loaded into space cargo vehicles that burn as they pass back through the Earth's atmosphere. For future long-term missions, though, it would be impractical to bring all the stored waste back to Earth.

Dumping it on the moon's surface is not an option, so the space agency entered into an agreement with UF for ideas. Pullammanappallil and then-graduate student Abhishek Dhoble accepted the challenge.

"We were trying to find out how much methane can be produced from uneaten food, food packaging and human waste," said Pullammanappallil, a UF Institute of Food and Agricultural Sciences faculty member and Dhoble's adviser. "The idea was to see whether we could make enough fuel to launch rockets and not carry all the fuel and its weight from Earth for the return journey. Methane can be used to fuel the rockets. Enough methane can be produced to come back from the moon."

NASA started by supplying the UF scientists with a packaged form of chemically produced human waste that also included simulated food waste and packaging materials, Pullammanappallil said. He and Dhoble, now a doctoral student at the University of Illinois, ran laboratory tests to find out how much methane could be produced from the waste and how quickly.

They found the process could produce 290 liters of methane per crew per day, all produced in a week, Pullammanappallil said.

Their results led to the creation of a process that uses an anaerobic digester. That process kills pathogens from human waste, and produces biogas – a mixture of methane and carbon dioxide.

In earth-bound applications, that fuel could be used for heating, electricity generation or transportation.

Additionally, the digester process breaks down organic matter from human waste. The process also would produce about 200 gallons of non-potable water annually from all the waste. That is water held within the organic matter, which is released as organic matter decomposes. Through electrolysis, the water can then be split into hydrogen and oxygen, and the astronauts can breathe oxygen as a back-up system. The exhaled carbon dioxide and hydrogen can be converted to methane and water in the process, he said.

The study was published last month in the journal Advances in Space Research.

Provided by University of Florida