Moon's Helium-3 Could Power Earth

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Researchers and space enthusiasts see helium 3 as the perfect fuel source: extremely potent, nonpolluting, with virtually no radioactive by-product. Proponents claim its the fuel of the 21st century. The trouble is, hardly any of it is found on Earth. But there is plenty of it on the moon.

Society is straining to keep pace with energy demands, expected to increase eightfold by 2050 as the world population swells toward 12 billion. The moon just may be the answer.

"Helium 3 fusion energy may be the key to future space exploration and settlement," said Gerald Kulcinski, Director of the Fusion Technology Institute (FTI) at the University of Wisconsin at Madison.

Scientists estimate there are about 1 million tons of helium 3 on the moon, enough to power the world for thousands of years. The equivalent of a single space shuttle load or roughly 25 tons could supply the entire United States' energy needs for a year, according to Apollo17 astronaut and FTI researcher Harrison Schmitt.

Cash crop of the moon

When the solar wind, the rapid stream of charged particles emitted by the sun, strikes the moon, helium 3 is deposited in the powdery soil. Over billions of years that adds up. Meteorite bombardment disperses the particles throughout the top several meters of the lunar surface.

"Helium 3 could be the cash crop for the moon," said Kulcinski, a longtime advocate and leading pioneer in the field, who envisions the moon becoming "the Hudson Bay Store of Earth." Today helium 3 would have a cash value of $4 billion a ton in terms of its energy equivalent in oil, he estimates. "When the moon becomes an independent country, it will have something to trade."

Fusion research began in 1951 in the United States under military auspices. After its declassification in 1957 scientists began looking for a candidate fuel source that wouldn't produce neutrons. Although Louie Alvarez and Robert Cornog discovered helium 3 in 1939, only a few hundred pounds (kilograms) were known to exist on Earth, most the by-product of nuclear-weapon production.

Apollo astronauts found helium 3 on the moon in 1969, but the link between the isotope and lunar resources was not made until 1986. "It took 15 years for us [lunar geologists and fusion pioneers] to stumble across each other," said Schmitt, the last astronaut to leave footprints on the moon.

For solving long-term energy needs, proponents contend helium 3 is a better choice than first generation nuclear fuels like deuterium and tritium (isotopes of hydrogen), which are now being tested on a large scale worldwide in tokamak thermonuclear reactors. Such approaches, which generally use strong magnetic fields to contain the tremendously hot, electrically charged gas or plasma in which fusion occurs, have cost billions and yielded little. The International Thermonuclear Experimental Reactor or ITER tokamak, for example, won't produce a single watt of electricity for several years yet.

Increases production and safety costs

"I don't doubt it will eventually work," Kulcinski said. "But I have serious doubts it will ever provide an economic power source on Earth or in space." That's because reactors that exploit the fusion of deuterium and tritium release 80 percent of their energy in the form of radioactive neutrons, which exponentially increase production and safety costs.

In contrast, helium 3 fusion would produce little residual radioactivity. Helium 3, an isotope of the familiar helium used to inflate balloons and blimps, has a nucleus with two protons and one neutron. A nuclear reactor based on the fusion of helium 3 and deuterium, which has a single nuclear proton and neutron, would produce very few neutrons -- about 1 percent of the number generated by the deuterium-tritium reaction. "You could safely build a helium 3 plant in the middle of a big city," Kulcinski said.

Helium 3 fusion is also ideal for powering spacecraft and interstellar travel. While offering the high performance power of fusion -- "a classic Buck Rogers propulsion system" -- helium 3 rockets would require less radioactive shielding, lightening the load, said Robert Frisbee, an advanced propulsion engineer at NASA's Jet Propulsion Laboratory in Pasadena California.

Recently Kulcinski's team reports progress toward making helium 3 fusion possible. Inside a lab chamber, the Wisconsin researchers have produced protons from a steady-state deuterium-helium 3 plasma at a rate of 2.6 million reactions per second. That's fast enough to produce fusion power but not churn out electricity. "It's proof of principle, but a long way from producing electricity or making a power source out of it," Kulcinski said. He will present the results in Amsterdam in mid July at the Fourth International Conference on Exploration and Utilization of the Moon.

Size of a basketball

The chamber, which is roughly the size of a basketball, relies on the electrostatic focusing of ions into a dense core by using a spherical grid, explained Wisconsin colleague John Santarius, a study co-author. With some refinement, such Inertial Electrostatic Confinement (IEC) fusion systems could produce high-energy neutrons and protons useful in industry and medicine. For example, the technology could generate short-lived PET (positron emission tomography) isotopes on site at hospitals, enabling safe brain scans of young children and even pregnant women. Portable IEC devices could bridge the gap between today's science-based research and the ultimate goal of generating electricity, Santarius said.

This fall, the University of Wisconsin team hopes to demonstrate a third-generation fusion reaction between helium 3 and helium 3 particles in the lab. The reaction would be completely void of radiation.

"Although helium 3 would be very exciting," says Bryan Palaszewski, leader of advanced fuels at NASA Glenn Research Center at Lewis Field, "first we have to go back to the moon and be capable of doing significant operations there."

Economically unfeasible

Indeed for now, the economics of extracting and transporting helium 3 from the moon are also problematic. Even if scientists solved the physics of helium 3 fusion, "it would be economically unfeasible," asserted Jim Benson, chairman of SpaceDev in Poway, California, which strives to be one of the first commercial space-exploration companies. "Unless I'm mistaken, you'd have to strip-mine large surfaces of the moon."

While it's true that to produce roughly 70 tons of helium 3, for example, a million tons of lunar soil would need to be heated to 1,470 degrees Fahrenheit (800 degrees Celsius) to liberate the gas, proponents say lunar strip mining is not the goal. "There's enough in the Mare Tranquillitatis alone to last for several hundred years," Schmitt said. The moon would be a stepping stone to other helium 3-rich sources, such as the atmospheres of Saturn and Uranus.

Benson agreed that finding fuel sources in space is the way to go. But for him, H2O and not helium 3 is the ideal fuel source. His personal goal is to create gas stations in space by mining asteroids for water. The water can be electrolyzed into hydrogen or oxygen fuel or used straight as a propellant by superheating with solar arrays. "Water is more practical and believable in the short run," he said.

But proponents believe only helium 3 can pay its own way.

"Water just isn't that valuable," Schmitt said. Besides the helium, a mining process would produce water and oxygen as by-products, he says.