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SPACE

Natural Gas Rockets

METHANE-FUELED ENGINES GO ON THE ASCENT **BY STEVEN ASHLEY**

Most people know natural gas as home-heating fuel, but methane may soon be powering spaceships into orbit and beyond. Rocket researchers worldwide are now working on engines that burn methane rather than conventional liquid propellants.

During the past half a century, engineers have generally opted to use hydrocarbons, such as kerosene, or hydrogen itself, along with oxygen liquefied at low temperature, as chemical propellants. But kerosene and hydrogen have drawbacks, according to David Riseborough of C&Space in Seongnam, South Korea. "Burning kerosene produces soot, which deposits coking residues on engine surfaces, causing blockages and reusability problems," he says. Hydrogen, meanwhile, requires costly cryogenic storage that can be hazardous to operate and large, insulated tanks that take up space and weight.

Because any failure nearly always spells catastrophe, rocket designers tend to be conservative and stick with well-tested equipment and propellants. In recent years, however, innovators have been investigating alternative fuels, including methane. Methane is relatively benign, which has implications for crew safety and operability in space or on planetary surfaces. When burned, it yields less soot than kerosene and offers superior propulsion performance. In particular, the fuel exhibits a higher specific impulse, a measure of fuel efficiency that describes how much momentum a given weight of propellant can impart.

Although methane's specific impulse lags that of hydrogen, it presents some advantages. Liquid methane is more stable and boils off less rapidly. Further, methane storage vessels need less insulation, a feature that helps to minimize system weight. In addition, at –163 degrees Celsius, liquid methane is closer in temperature to liquid oxygen (–183 degrees C) than liquid hydrogen (–253 degrees C), which eases handling and vehicle design. Another plus for methane is that future Mars astronauts might be able to synthesize it "in situ" from the Red Planet's mostly carbon dioxide-based atmosphere, which would help reduce the size and weight of their spacecraft. In the nearer term, NASA's Orion mission may employ methane to propel the lunar lander's ascent from the moon's surface or the crew capsule's return to Earth.

With funding from NASA, a few companies are amassing engineering experience with methane rockets. Last December, XCOR Aerospace, a rocket maker in Mojave, Calif., ground-tested a 7,500-pound-thrust liquid-methane/liquid-oxygen rocket motor, reports XCOR's Richard Pournelle. A competing company, KT Engineering in Huntsville, Ala., expects to conduct its initial test-firing of a methane engine this year.

In March 2006 engineers at C&Space tested a methane/oxygen motor that delivers 20,000 to 30,000 pounds of thrust. Designed with help from Russian specialists to lift half-ton satellites into low Earth orbit for $2,000 per pound (about 20 percent of today's launch costs), the system could also power suborbital tourist flights or serve as a second-stage booster. "We believe that methane could allow quicker, aircraftlike launch turnarounds," Riseborough explains.

Despite the high hopes, success is by no means assured. The Galaxy Express, a satellite booster with a methane-fueled second stage developed by the Japan Aerospace Exploration Agency and a joint commercial venture, has been delayed by cost overruns in the hundreds of millions of dollars.

LOOKING FOR LESS MESS

Bulletproof reliability is key to rocket scientists. That is why they usually choose so-called hypergolic liquids, such as hydrazine and nitrogen tetroxide, to fuel reaction-control thrusters—small rockets that maintain the attitude of vehicles in space. Hypergolics ignite when the two components come into contact; hence, these rocket motors are dependable and simple to control, needing only two valves. But the toxic fuels are hard to handle and contaminate the vicinity of the burn. Several firms, including Orion Propulsion in Madison, Ala., and Orbital Technologies in Madison, Wis., have developed small methane-fueled rockets (producing 100 pounds of thrust and less) that avoid the safety problems of hypergolics.

SHOCK-WAVE CONES emerge in the rocket plume of XCOR's methane-fueled engine, ground-tested last December. Such engines may power future spaceflight operations.

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