Answers to burning questions sought aboard September 28 shuttle mission

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ANSWERS TO BURNING QUESTIONS SOUGHT ABOARD SEPTEMBER 28 SHUTTLE MISSION

Fire: it's perhaps mankind's oldest tool and yet, it's one of the least understood.

Now, in a novel experiment scheduled to take place aboard the September 28 mission of the Space Shuttle Columbia, a team of scientists led by a researcher from the University of California, San Diego hopes to shed light on some of the mysteries held within the wispy veil of a single flame of ignited liquid fuel.

New clues from such experiments might help scientists answer burning questions about how to increase fuel efficiency while lowering pollution. The studies also could lead to better ways of extinguishing flames under all kinds of conditions, from the catastrophic plumes of soot, smoke and heat of burning oil wells to the eery flickerings in the near-zero gravity of outer space.

"We will be burning fossil fuels for many years to come," said Forman Williams, director of UCSD's Center for Energy and Combustion Research and the shuttle experiment's principal investigator. "And it's becoming increasingly clear that, with less and less of it in the future, we will need to learn how to burn it more efficiently, cleaner and safer."

The purpose of burning fuels in space is to remove perhaps the most confounding and frustrating variable in flame studies--gravity.

Among other things, gravity is the source of complex, buoyancy-induced flows that promote turbulence and other instabilities in a flame by dragging down cold, more dense gases and particles while hotter, less dense matter rise. The low gravity or microgravity environment of space quells these flows and their complications, placing the spotlight on weaker forces obscured by the action of gravity.

Without gravity's influence, a flame's behavior turns somewhat bizarre. Its yellow glow turns a light blue or even a deep orange; the flame's tear-shaped form turns nearly spherical; clean air has replaced what was once a trail of smoke.

On earth, flame research is being conducted with the aid of "drop towers" where near- zero gravity is achieved by simply dropping combustion packages from a tall tower or into a deep pit. The largest such facility in the United States is the five-second Drop Tower located at NASA's Lewis Research Center. Its name is derived from the amount of time it takes for an object to drop from the top to the bottom.

Such experiments, by nature, are frustratingly short-lived.

For that reason, researchers like Williams have turned to the virtual weightlessness of outer space and the space shuttle.

The research team led by Williams will conduct a minimum of 24 separate combustion tests in a small "glove box" housed in the shuttle's microgravity laboratory. Designed and built by team members, the experimental package (about l' long, Y2 wide, 'A' deep) is constructed of aluminum with plastic windows on top and in front for viewing by attending astronauts and a color video camera. Across the top of the apparatus sits a thin thread composed of silicon carbide onto which droplets of liquid fuels are injected via a pair of opposing syringes. The droplet, in turn, is ignited by an electrical "hot wire."

"Silicon carbide has a melting point of nearly 3,000 degrees K.," said Williams. "It's also very strong. The fiber therefore makes as small an impact on the combustion as possible."

Two cameras are set up: one with special lighting available to snap the fuel droplet only; the other that records the image of the flame and droplet as well. Researchers will be able to monitor the results of the experiment via the color video camera from a remote communications link set up in at the NASA Space Flight Center in Huntsville, Ala.

The tests will take place during three, four-hour intervals beginning October 8. Each member of the team has designed his or her own test bums. As outlined, the tests--which can last 30 seconds to one minute each--range from the burning of a single pure fuel droplet under normal and breezy conditions (with the help of a small fan), to the burning of mixtures involving two fuels that bubble in the interior and burst, creating a small pop or micro-explosion.

"Micro-explosions are of interest in improving the cleanliness and efficiency of combustion of liquid fuels in furnaces," said Williams. "They also could lead to more efficient, more rapid burning of fuels that require less time to complete burning. So it's of interest to power production as well."

Williams has plans for yet another larger combustion experiment on the space shuttle, scheduled in 1997. During that mission, he hopes to bum fuel droplets under a variety of atmospheric pressure conditions.

Other members of the research team are: Frederick L. Dryer, Princeton University; Benjamin D. Shaw, UC Davis; Vedha Nayagam, of Analyx Corp., Cleveland, O.; Daniel --- Dietrich, of Sverdrup Technology Corp.; and John Haggard of NASA Lewis.

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