UCSD researcher's "microgravity" flame studies will be conducted in 1996 aboard space shuttle

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UCSD RESEARCHER'S "MICROGRAVITY" FLAME STUDIES WILL BE CONDUCTED IN 1996 ABOARD SPACE SHUTTLE

The behavior of fire, mankind's oldest and perhaps least understood tool, may yield some of its long-held mysteries during a series of experiments selected by NASA to take place aboard the space shuttle in 1996.

Designed by researchers at the University of California, San Diego and Princeton University, the experiments are expected to be conducted during two separate shuttle missions that year.

The scientists believe that experiments in the near-zero, or microgravity, conditions of space will shed light on the extremely complex chemical and physical processes that surround a given flame.

"The idea is that without the influence of gravity, we should be able to more accurately and more thoroughly measure these phenomenon than we have ever done before," said Forman Williams, director of UCSD's Center for Energy and Combustion Research and co-principal investigator of the shuttle experiments with Frederick Dryer, a professor of mechanical and aerospace engineering at Princeton.

Williams noted that a better understanding of flame behavior ultimately could lead to the design of better furnaces or engines that burn fuel with increased efficiency and decreased pollution.

"People burn fuel droplets in furnaces, in engines, in stationary power plants," said Williams, "and they all would like to improve performance and reduce emissions. That's where we are headed."

At least 300 chemical reactions are involved in the life cycle of a flame, each providing the potential for combustion or extinction. These reactions, in turn, are affected by a series of fluid dynamic processes including diffusion, heat conduction and viscosity.

One of the more novel approaches to the study of combustion involves research in microgravity laboratories. The objective is to remove perhaps the most confounding and frustrating variable from 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. Microgravity quells these flows and their complications, while placing the spotlight on weaker forces obscured by the action of gravity.

To create microgravity conditions on earth, several large "drop towers" have been constructed in this country at NASA's Lewis Research Center in Cleveland. Here, near-zero gravity is achieved by simply dropping combustion packages from a tall tower or into a deep pit. The five-second Drop Tower, for example, is built underground and is about the same height as the Washington Monument. Its name is derived from the amount of time it takes for an object to drop from the top to the bottom. The largest drop tower in the world, which achieves 10 seconds of microgravity, is located in Hokkaido, Japan.

Microgravity studies from drop towers have provided valuable insights into combustion behavior. But such experiments, by nature, are frustratingly short-lived.

To extend the lifetime of these experiments beyond a few seconds, researchers like Williams are turning to the virtual weightlessness of outer space and the orbiting space shuttle.

As outlined in the NASA proposal, Williams envisions studying the combustion of large, fuel droplets consisting of two pure fuels--important for the study of practical fuels ranging from diesel to rocket.

Among other things, Williams hopes to learn more about the burning stages of the droplet under a variety of temperature and chemical conditions; again, the twin goals are increased fuel efficiency combined with lower emissions of pollutants.

"These are fundamental studies," Williams said. "We're trying to understand and describe such items as the burning rate of fuels and things like soot production and extinction conditions for droplets."

Williams said he expected typical space shuttle experiments to involve droplets as large as 5 millimeters with each test burn lasting as long as 50 seconds. The largest droplets previously tested in land-based experiments have been between 1.5 to 2 millimeters in diameter, with test burns lasting up to 10 seconds in the Japanese drop tower.

"A droplet eventually will extinguish when it gets small enough," said Williams. "So larger droplets mean longer-lasting flames that are easier to study and may exhibit different chemistry."

The experiments will be conducted in a space laboratory built into the space shuttle bay. Researchers at UCSD and Princeton will be able to monitor the shuttle experiments via a television hookup to a ground-based station.

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