Weak flames ignite hope for clean engines

Scientists are burning to know how to make engines that generate more energy and less pollution. Now they have space, literally, to figure it out.

During the 16-day space shuttle mission that ended last week, researchers studied how flames behave when freed from gravity's influence. Scientists will use the information collected in space to improve models of combustion and soot formation, which should help engineers design more efficient engines and ways to control pollution, NASA investigators say. The findings may also lead to increased fire safety in future spacecraft.

Flames in the orbiting laboratory are easier to analyze than their earthbound counterparts. Gravity complicates the study of combustion by causing air currents that rip apart certain types of flames and obscure some of the basic properties of fire. For example, flames on Earth stretch out into a familiar teardrop shape. Because there is no up or down in space, flames there form spheres, which are simpler to study.

In one set of experiments, mission specialists ignited hydrogen gas that was too dilute to burn on the ground. The lean fuel mixtures, studied in a cylinder roughly 30 centimeters in diameter, generated unusually cool flames with about one-hundredth the power of a common match flame, says project scientist Karen J. Weiland of NASA's Lewis Research Center in Cleveland. These weak flames float as isolated balls instead of engulfing an entire gas-filled enclosure. With denser fuels, fires propagate because the fuel and oxygen contact each other frequently and react. In dilute mixtures, the molecules encounter each other less often, and the flame just sits—waiting for the reactants to reach its surface, explains Robert J. Santoro of Pennsylvania State University in State College.

Scientists measured physical and chemical properties of the flames in order to improve their models of how fires burn and go out. Understanding why flames die is critical for improving the gas turbine engines that generate electricity at power plants and that propel planes through the sky, says Santoro. Engineers use air to cool jet engines and thus reduce toxic emissions, "but if you add too much air, the flame goes out," says Santoro. "That's not good at 30,000 feet. If we understood flame extinction, we could get close to the limit—but safely."

Studies of the weak flames could also help reduce pollution. At low temperatures, burning does not generate nitrogen oxides—some of the key molecules that produce smog.

The scientists also studied another pollutant—soot. Good models of soot formation would enable engineers to predict how different engine designs affect emissions. "You could find out which ones perform best without taking the huge financial risk involved in actually making the engine and seeing what happens," says Santoro.

To simulate the kind of soot-forming combustion used in furnaces and diesel engines, mission specialists forced gas fuels through a tube into the experimental cylinder. In fires of this type on Earth, the gas fuels shoot out at high speeds, generating flames that flicker wildly, says Gerard M. Faeth, an aerospace engineer at the University of Michigan in Ann Arbor who conceived the project. Furthermore, the soot forms in regions too tiny to measure, he says.

In the space laboratory, it's possible to "slow these processes down, spread them out, and have time to observe them to completion," he says. Scientists simulate low-gravity conditions on Earth by conducting experiments in free-falling chambers, but only for seconds—until the chamber hits the ground.

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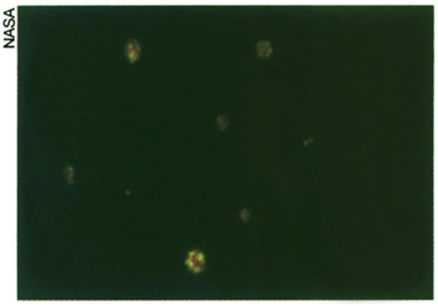

In this colorized infrared image, flames approximately 5 to 15 millimeters in diameter float in the space shuttle laboratory.

Faeth reports that there have been some surprises in space. "Fires may be more dangerous in space than on Earth," he says, a conclusion consistent with results from experiments on a previous shuttle flight (SN: 2/22/97, p. 119). In the latest tests, Faeth says, "the flames are bigger, spread quicker, and produce soot more easily than predicted." *—E. Strauss*

Wordy tots ignore some speech sounds

Infants usually begin to speak shortly after their first birthday, long before they graduate from toilet training. Unlike the latter feat, however, the leap to word learning depends on a lack of attention to detail, according to a new study of babies' linguistic capabilities.

Specifically, 14-month-old infants disregard certain sounds in words, thus freeing up mental resources for attempts at learning word meanings. Meanwhile, 8-month-old babies, fanciers of speech sounds but not words, notice acoustic niceties that elude slightly older kids.

The decline in the amount of acoustic detail perceived by speech-ready infants appears analogous to a previously documented drop in youngsters' ability, at about age 1, to discern speech sounds from outside their native tongue, contend Christine L. Stager and Janet F. Werker, both psychologists at the University of British Columbia in Vancouver.

Although fledgling word learners restrict the details of what they hear in order to establish links between words and appropriate objects, they probably regain an ear for specific speech sounds by age 3, Stager and Werker suggest in the July 24 NATURE. By that time, kids have grasped the basics of word learning and can devote more attention to syllabic subtleties, the investigators theorize.

In a test of 64 infants, all 14 months old, each child sat on a parent's lap and looked at a flashing red light on a computer monitor. Youngsters then became familiar with two repeatedly presented pairs of stimuli. Each duo consisted of a spoken nonsense label ("dih" or "bih") and one of two colorful shapes shown on the monitor. Sharp declines in time spent looking at a shape indicated that a pairing had become familiar (and relatively boring) to the child.

At that point, the tots looked just as briefly at new presentations of each shape paired with the sound previously associated with the other shape. They apparently failed to notice the switch, Stager and Werker say.

Comparable responses emerged when 16 14-month-olds who had learned one of the label-object combinations were then exposed to the same shape paired with a similar-sounding label. In the same experiment, however, 16 8-month-olds looked much longer at shapes upon hearing a novel label.

The younger group made no attempt to attach meanings to labels and thus paid greater attention to the new sounds, the researchers propose.

A further session found that 14-month-olds notice label switches that involve dissimilar sounds, such as "lif" and "neem." They also recognize switches of "bih" and "dih" if the sounds are paired with checkerboard patterns that are unlikely to be perceived as distinct objects in need of naming, the scientists found.

"Infants are very good at identifying particular speech sounds by 7 months of age," notes psychologist Peter W. Jusczyk of Johns Hopkins University in Baltimore. "But these results suggest that they soon shift their attention to the problem of word meanings and experience a temporary loss in the ability to perceive speech sounds." *—B. Bower*