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Research News

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HUMMING RIGHT ALONG: **For Immediate Release**

COMBUSTION PROCESS FROM V-1 BUZZ BOMB **November 10, 1989**

BOOSTS EFFICIENCY OF INDUSTRIAL PROCESSES **Color/B&W Available**

The same combustion process used to power the V-1 "Buzz Bomb" during World War II is today gaining more peaceful applications improving industrial process equipment.

Pulse combustion, the cyclical burning of fuel in a field of sound waves, gave the dreaded V-1 rocket its name. Today, however, pulse combustion poses concerns for aerospace engineers -- who call it unstable combustion -- because its presence can damage modern jet engines, ramjets and rocket motors.

not so great for most aircraft,

But for ground-based heaters, furnaces and dryers, engineers find pulse combustion desirable because it boosts energy efficiency and reduces the production of air pollutants, making pulse combustion one of the most important areas in combustion research today.

new res center

At the Georgia Institute of Technology, aerospace engineers have launched a $2 million research center they hope will provide a better understanding of pulse combustion and lead to the development of new applications such as industrial drying. Tech's Center for Pulse Combustion is sponsored by the Gas Research Institute, though support for projects also comes from the U.S. Department of Energy and other sponsors.

"Nobody fully understands the fundamental processes which control pulse combustion, and that is what we will be exploring in the Center," explained Dr. Ben T. Zinn, professor of aerospace engineering at Georgia Tech. "This could open up a whole new field of applications for pulse combustion."

Most combustion devices produce steady burning -- essential to the stability of rocket motors and jet engines. But in pulse combustion, fuel burns in a series of rapid pulses, which can vary from 50 to several hundred per second. The pulsations produce an audible acoustic field which sustains the burning process and alters it in ways combustion engineers find highly desirable.

For reasons outlined on back p. at (*)

"The sound waves propagate in all directions, and modify the combustion process," he explained. "When it acts on the combustion process, it causes the combustion to be oscillatory. You have a feedback system."

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Through physical processes not well understood, the pulsations boost the burner's combustion efficiency, reduce nitrogen oxide emissions, transfer heat more efficiently, and permit the burning of fuels that are normally difficult to use. Pulse combustors can use a wide variety of both liquid and solid fuels, including coal, Zinn noted.

advantages of PC

While the V-1 used by the Germans may have been the first practical use, pulse combustion now forms the basis for several extremely successful models of residential furnaces which offer efficiency rates as high as 96 percent. Because of their self-pumping capabilities, pulse combustion furnaces need no chimney.

In addition to heating applications, Zinn and other researchers are studying pulse combustors for drying food products, chemicals and other materials such as kaolin. Pulses of hot gases 50 to 60 times per second may accelerate the drying process, speeding up production lines.

"One instant the gases will be moving one way, and the next instant the gases will be moving back," he explained. "There is a lot of evidence that when this happens, many processes which involve heat transfer and mass transfer will be much more efficient. Transport mechanisms of heat, mass and momentum are the three fundamental processes which control almost all industrial processes."

The new Center will use an $180,000 imaging system which uses lasers and intensified video to generate color pictures of combustion processes. The system was funded by the Department of Energy and Georgia Tech.

"We'll be able to get maps of temperatures and reaction rates," said Zinn. "We'll be able to look at small portions of the combustor and be able to deduce where combustion is taking place."

An aerospace engineer by training, Zinn sees some irony in putting to work a problem that has long plagued engineers: "I've always been interested in finding some place I could use this phenomena I've been fighting. When I am learning how to get rid of it, I am learning how to use it. It's an interesting synergism."

Many pulse combustors are essentially pipes with one end open and the other closed by flapper valves. A combustible mixture is first admitted into the combustor, then ignited by a spark plug. The resulting combustion process increases the pressure within the combustor, causing the flapper valves to close and forcing the hot combustion gases to move in the opposite direction toward the open exhaust pipe.

The inertia of the gases leaving the combustor decreases the combustor pressure to a level lower than the pressure upstream of the flapper valves, causing them to open and admit new charges of fuel and oxygen. The decrease in combustion pressure also reverses the flow in the exhaust pipe and returns some hot combustion products to the combustor, where they react with the new fuel mixture to repeat the cycle -- without need for a new spark.

The dimensions of the combustor pipe, the fuel used and the location of the combustion process within the pipe all affect the pulsations.