New silencer technology may make jet engines run quieter in the future

June 23 2004

Researchers at Ohio State University have developed a silencer technology that creates electrical arcs to control turbulence in engine exhaust airflow -- the chief cause of engine noise. The university has applied for a patent on the design.

With the flip of a switch, pilots could turn the silencers -- called plasma actuators -- on and off, reducing noise around commercial airports or military airstrips, said Mohammad Samimy, professor of mechanical engineering.

He and his colleague, Igor Adamovich, associate professor of mechanical engineering, demonstrated the technology in a series of laboratory tests. They used laser light to illuminate a simulated engine exhaust stream, and studied how different arrangements of actuators affected the flow.

They tested the actuators using two types of air streams, one simulating the exhaust from a commercial aircraft, and another simulating that of a high-speed military aircraft. Typical large commercial aircraft, such as the Boeing 747, fly at mach 0.85, or 0.85 times the speed of sound, while modern military aircraft can top mach 2.

The tests showed that the plasma actuators succeeded in manipulating turbulence structures in the airflow.

All jet aircraft could benefit from the technology, Samimy said.

Until recently, noise was a problem only for commercial airports, which are often surrounded by residential areas. But as populations spread around the United States, military airports have also started to feel pressure to reduce noise heard by neighboring communities, he explained.

The most important factor in silencing an aircraft during takeoff -- when the jet engine is the loudest -- is controlling exhaust airflow, Samimy said. The high-speed airflow provides thrust for the plane, and also creates most of the noise.

“One has to reduce the noise while not adversely affecting the thrust – that is the challenge. When the development of the actuators is complete, they will meet the challenge,” he said.

Samimy studies turbulence as part of his work with fluid dynamics, one of the most complex areas of study in science and engineering. Flow control is a multidisciplinary subject, which draws researchers from various engineering disciplines such as mechanical, aeronautical, and electrical.

By analyzing images of fluid flows, Samimy and his colleagues can gather a wealth of information which can be used in controlling the flow. For instance, they can tune the newly developed plasma actuators to match certain frequencies in the flow, and optimize noise reduction.

This project grew out of Samimy’s work for NASA in the 1990s. There he worked on structural modifications at the trailing edge of the exhaust system called tabs or chevrons -- zigzag-shaped cutouts at the nozzle exit that introduced longitudinal turbulence structures into the exhaust flow and so affected the mixing and noise characteristics of the engine. Some of the most recent aircraft engines contain chevrons.

While chevrons reduce noise, they lower fuel efficiency. Chevrons are only needed during takeoff and landing, but they are permanent fixtures of the engine and cannot be disengaged at cruise altitude to increase fuel efficiency.

“I wanted to design actuators that could turn on and off, and exploit instabilities in the flow,” Samimy said. “Plasma actuators are those kinds of actuators.”

Plasma actuators developed for noise mitigation could also provide an additional level of stealth for modern military aircraft, Samimy said. Pilots could fire the electrical arcs in certain patterns to mix the very hot exhaust gas with outside air, significantly reducing the heat signature that shows up on infrared tracking systems.

Source: researchnews.osu.edu/