Engineer devises ways to improve gas mileage

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(PhysOrg.com) -- Last summer, it was very expensive to fill up a gas tank when the gasoline price hit close to four dollars a gallon. Transportation by road or air consumes fuel, which not only increases our vulnerability to foreign imports but also is a source of greenhouse gas emissions that will impact adverse change in climate and global warming.

A mechanical engineer at Washington University in St. Louis is developing techniques that will lessen our monetary pain at the pump by reducing the drag of vehicles — planes, autos and trucks. Drag is an aerodynamic force that is the result of resistance a body encounters when it moves in a liquid or gaseous medium (such as air). Reduction in drag means less fuel would be required to overcome the fluid resistance encountered by the moving vehicle.

Working with undergraduate and graduate students, Ramesh K. Agarwal, Ph.D, the William Palm Professor of Engineering at Washington University in St. Louis, has successfully demonstrated that the drag of airplane wings and cars/trucks can be reduced by employing the active flow control (AFC) technology. The idea behind the AFC is to deploy actuators on the surface of these vehicles to modify the flow in a way that the overall resistance is reduced. Using computational fluid dynamics software, Agarwal has found that the actuators modify the flow, which results in drag reduction, which in turn reduces the fuel amount needed.

"The most promising actuators are the so called synthetic jet or

oscillatory jet actuators which are embedded in the surface of the body (an airplane wing for example), and essentially perform injection and suction of the fluid from the surface in a periodic manner," said Agarwal. He has demonstrated that the transonic drag of an airplane wing can be reduced by 12 to 15 percent with the incorporation of three-ounce actuators, about 20 to 30 spaced optimally on the surface of the wing.

"We use the genetic algorithms and artificial neural net algorithms to optimize the placement of actuators." Agarwal said. His students have recently applied the concept on cars and trucks and have achieved 15 to 18 percent reduction in drag by placing the actuators on the back surface of these vehicles. Although the technology has not yet been deployed on any commercially available vehicle, it is being researched and investigated by airplane and automobile companies worldwide.

"There are approximately 100 million cars and trucks on the road in the United States alone and hundreds of millions more worldwide. Similarly there will be a substantial increase in air transportation worldwide. The AFC technology can therefore play an important role in fuel conservation and reduction of greenhouse gas emissions," said Agarwal, one of the most decorated engineers in the United States and a fellow of ten national science and engineering societies including the American Association for Advancement of Science, American Physical Society, American Society of Mechanical Engineers (ASME), American Institute of Aeronautics and Astronautics (AIAA) and the Institute of Electrical and Electronics Engineers.

Agarwal will receive the James B. Eads Award from the Academy of Science of St. Louis on April 30, 2009. It is the latest of several distinguished awards he has received in just the past three years. An internationally renowned scholar who is considered a leading authority in aerodynamics and computational fluid dynamics, he has been the

recipient of almost all the major national and international awards in these fields.

In 2007, he received the Gold Award from the Royal Aeronautical Society of U.K., an award given to fewer than five Americans in more than fifty years. In 2008, he received the "Aerodynamics Award" for outstanding contributions to Aerodynamics; it is the highest national award given by the AIAA in Aerodynamics. In 2008, he was also the recipient of William Littlewood Award given jointly by AIAA and SAE (Society of Automotive Engineers). Established in 1971, the award has only been given twice to a member of academia including Agarwal. It is normally given to CEOs and senior executives of aerospace companies worldwide. He received the "Fluids Engineering Award" in 2001 from ASME; the highest national technical award given by ASME in fluid dynamics.

Agarwal is also working for the United States Air Force on development of techniques to predict heat transfer and to design improved thermal protection systems for the next generation of space access vehicles.

Provided by Washington University in St. Louis (news : web)