Vortex Control on Engine Nacelle Strake and Other Vortex Generators

This technology offers a system for controlling fluid flow over surfaces. It has a decreased peak cycle temperature that has the potential to reduce CO_2 emissions and aircraft noise.

Technology ID

BDP 8102

Category

Cleantech/Energy Efficiency
Selection of Available Technologies

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What is the Problem?

Fuel is the largest direct operating cost for airlines. Furthermore, the emissions of CO_2 are a growing environmental concern, and the water vapor emissions at high altitude may also play a role in the Earth's radiation budget and climate. If the aerodynamic drag of an aircraft is reduced, the engine thrust and consequently emissions can also be reduced. A significant component of the total drag is friction on the outer layer of the aircraft. On large aircraft, the boundary layers between the aircraft and the passing air are almost completely turbulent (rough air flow), having relatively large skin friction coefficients. Decreasing the coefficient by transitioning to smooth air flow (laminar flow) at the boundary layer could decrease drag. In many other devices, a relatively high heat transfer coefficient in turbulent boundary layers limits the performance of the device. For example, heat transfer to the turbine blades can limit efficiency of modern aircraft turbine engines, because the turbine blades overheat in operation. As another example , rocket nozzles must be cooled to prevent melting. The cooling mechanism adds weight, complexity, and failure modes to these rocket engines. Consequently, in many applications it is desirable to delay the turbulent flow by maintaining the laminar flow at the wall as long as possible. In many cases, transition from a laminar flow to a turbulent flow is accompanied with vortex formation and movement close to a solid wall. Controlling these vortices can enable the preservation of laminar air flow.

What is the Solution?

The solution is a system for controlling fluid flow over surfaces. This system includes a surface influenced by a fluid flow moving across the surface, a vortex generator disposed proximal to the surface for altering a vortex pattern within the fluid flow across the surface, and a controller for activating the vortex generator to alter the vortex pattern. The vortex generator can be comprised of one or more fluid injectors, each injecting a fluid jet into the fluid flow driven by air pressure. The fluid injectors can be mounted along a leading edge of a strake, where the strake is disposed on an engine nacelle and the surface comprises an aircraft wing surface. Activation can occur under open or closed loop control with sensors. In addition to an application on engine nacelle strakes, active vortex control could also be implemented in a system that would help in reducing skin friction by relaminarization of the turbulent boundary layer.

What is the Competitive Advantage?

External structures on airplanes are engineered to reduce drag, but these structures eventually lead to turbulent air flow. With some conventional technologies in engines, excess diluent air must be added into the hot combustion gasses to prevent melting of the blades. As a result, the peak cycle temperature of these turbines is reduced, thus lowering their thermodynamic efficiency and fuel economy. Total aircraft drag could be reduced, potentially by as much as a factor of two, which would lead to the aforementioned reductions in fuel consumption, CO_2 emissions, as well as aircraft noise.

Patent Information:

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