The EU-funded ELUBSYS project developed a radically new approach to lubricating an aircraft’s turbine engines that reduces oil consumption. The innovation could result in more efficient jet engines that burn less oil and fuel – a boon for the airline industry and the environment.

Bearing chamber during brush seal test

That huge jet turbine engine under the wing of your long-distance airliner needs lubrication to run just like the more modest car engine. Yet keeping this complex power plant lubricated presents more of a challenge than most. Jet turbines revolve at up to 18,000 rpm (revolutions per minute) and internal temperatures can rise above 1127 °C while the outside air temperature drops to -60 °C.

Such engines also typically lose their oil-based lubricant to the atmosphere at a rate of around 30cl per hour. This loss represents a cost to the airline industry, and pollutes the environment.

Which is why researchers in the EU-funded ELUBSYS project developed a new way to cut oil loss from jet turbines, while promoting efficiency and reliability. The project’s innovative oil seal will also help reduce an airline’s operating and maintenance costs says project coordinator Vincent Thomas of Techspace Aero in Belgium. The innovation will also keep Europe’s aircraft manufacturers competitive and support future aircraft engine development.
Tests by the project partners indicate that the innovations introduced by ELUBSYS will reduce fuel consumption by about 0.8%, oil consumption by 60% and direct operating costs by 1%, Thomas says.

The challenge

“Aircraft engine turbines revolve at too high a speed for the classic rubberised oil-seals used in the car engine,” he adds. “The extremes of temperature and friction involved would destroy them. Yet aircraft engines need to stay lubricated like any other power plant.”

Currently, retaining lubricants inside the engine involves designing labyrinth-type seals within the bearing chamber, a method that has remained unchanged for some 30 years.

Inevitably however, some lubricant always escapes, for example through vent lines or other parts of the oil circulation system. To cut waste, the ELUBSYS research team tested and validated an innovative new design of oil seal that, although it does make direct contact with the revolving turbine shaft, is constructed from materials that are able to withstand the extremes of heat and friction found in a jet’s engine.

The new seal is known as a 'brush' seal. Made from carbon-fibre and Kevlar fibre, it makes direct mechanical contact with the turbine shaft in the same way as a paintbrush contacts a painted surface.

“This brush seal acts much more like the classic rubberised oil seal,” Thomas says. “The seal fibres are in direct contact with the revolving shaft, resisting oil leakage without any need for a pressurised incoming airflow.”

ELUBSYS’ researchers, who included aero-engine manufacturers MTU (Germany) and SNECMA (France), designed and built an experimental bearing housing for the new brush seal. They successfully carried out in-depth testing of the new oil seal for efficiency, the effects on oil temperature and lubricant longevity.

They also used modelling and test techniques to investigate heat-transfer processes within the bearing chamber, with the aim of optimising the cooling of the bearings and so further reducing overall engine weight. The search for greater lubrication efficiency led to a better approach for re-circulating the oil and a more efficient pump.

Next-generation aircraft engines will run at higher speeds, leading to greater temperature stresses on the lubricant. Maintaining engine safety and efficiency by checking the quality of that lubricant while in flight will be even more vital.

To this end the ELUBSYS team tested several new types of sensors in the laboratory to check oil degradation in real-time as a way of estimating when to replace used oil and improving aircraft maintenance efficiency.

Weight loss attraction

The project gained wide support from across the aerospace industry, notes Thomas. “It was because of the weight-saving potential,” he says. “If you lose a certain percentage of engine lubricant in flight, then you have to ensure that enough remains to keep the engine lubricated until landing. More efficient lubrication and better engine sealing means aircraft do not need to carry as much lubricant.”

Although the improved lubrication methods and the new seal have been extensively tested in an
experimental environment, they will still have to complete in-flight testing in order to meet European safety regulations. Even so, Thomas believes we are not far away from seeing a new generation of much cleaner aircraft engines.

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Project:
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