Drag Reduction in Turbulent Boundary Layer via Flow Control

Results in Brief

Towards more energy-efficient aircraft

An emphasis on reducing the environmental impact of aircraft means EU-funded scientists have been researching ways to reduce drag using an aircraft’s small, active components to make them more energy-efficient and reduce emissions.
Reductions in carbon dioxide and nitrogen oxide emissions from aircraft are directly related to an aircraft’s fuel burn, drag and aircraft weight. So reducing surface drag – which impedes forward movement during flight – will help reduce the environmental impacts of harmful emissions.

“It is not just the shape of the airframe but also some devices which act on the flow field that determines drag,” says DRAGY project coordinator Gabriel Bugeda, Professor of Civil and Environmental Engineering at the International Centre for Numerical Methods in Engineering (CIMNE), at the Technical University of Catalunya (UPC), in Barcelona, Spain.

Some of the most promising devices identified at the beginning of the project were analysed in laboratory experiments using numerical analysis based on new computational-simulation technologies to analyse flow structures.

“We analysed alternatives for drag reduction using active devices that require some energy to operate, such as rotating disks, pulsing jets and even riblets,” Bugeda says. Riblets are ribbed surfaces in the direction of airflow which can reduce resistance compared to smooth surfaces.

**Devices that can reduce drag**

Riblets, and other devices such as plasma actuators, where a small amount of air is injected into the flow field using plasma devices, can reduce drag. “These are the two most promising devices,” says Bugeda, adding that pulse jets, which inject a specific amount of fluid in a pulsating action rather than steady stream, and rotating discs, to inject additional momentum of fluid, also have potential.

“We arrived at the conclusion that some of these devices can produce up to 40 % surface drag reduction – so this is new – but it is still at a very low level of technological development,” notes Bugeda.

Nonetheless, with fuel costs at least 30 % of a commercial aircraft’s operating costs, it could represent a significant saving. “An aeroplane would have a large number of these devices distributed through the fuselage or the wing,” Bugeda explains. But there is also a payoff because: “These devices have some weight and need some energy to work and we have not yet evaluated the ‘cost’ of these, but it is nonetheless a significant finding.”

In addition to the engines and other parts of the aircraft, conventional configurations
are now close to full optimisation. “But we have confirmed in the laboratory that by looking at these devices, improvements can still be made,” Bugeda notes.

**Scaling up**

Scaling up is still a major challenge. “These devices act on the flow field in a very small area,” Bugeda notes. “It is not easy to extrapolate the results of these [laboratory scale] experiments to real-sized aircraft. So the experiments need to be as close as possible to real size, which is not always possible in the laboratory.”

As the project is a collaboration between European institutions and China, with the costs in China covered by the Ministry of Industry and Information Technology in Beijing, the project was able to take advantage of large-scale experimental facilities at Zhejiang University, Northwestern Polytechnical University, Peking University and Beijing University of Aeronautics and Astronautics.

For the numerical analysis, the main difficulty is the amount of computer power needed, Bugeda explains. “It is not yet market ready,” Bugeda says, noting that future collaboration projects would further develop such technologies for use in real aircraft.

**Keywords**

DRAGY, aircraft, China, drag, energy-efficient, emissions, riblets, aerodynamic, airflow, pulse jets, carbon dioxide, nitrogen oxide

---

**Project Information**

<table>
<thead>
<tr>
<th>DRAGY</th>
<th>Funded under H2020-EU.3.4.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grant agreement ID: 690623</td>
<td>Overall budget € 1 827 686,25</td>
</tr>
<tr>
<td>Project website</td>
<td>EU contribution € 1 827 686</td>
</tr>
<tr>
<td>Start date 1 April 2016</td>
<td>Coordinated by CENTRE INTERNACIONAL DE METODES NUMERICIS EN ENGINYERIA</td>
</tr>
<tr>
<td>End date 30 June 2019</td>
<td>Spain</td>
</tr>
</tbody>
</table>

---

Discover other articles in the same domain of application
Super-cool temperature for industrial processes with solar heat

Energy potential of concentrated solar power for Europe

Novel components to economically generate and store high-temperature solar heat

Last update: 8 November 2019
Record number: 411483

Permalink: https://cordis.europa.eu/article/id/411483-towards-more-energy-efficient-aircraft

© European Union, 2020