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An innovative composite energy efficiency solution

By

Christian HUGUES
President
Minix

Minix is an innovative wing-tip device for land, sea and air applications that procures a net economic gain of 6% per aircraft in aviation and a 14% average annual increase in power production for wind or submarine turbines. This could be a boon for the owners of wind farms that have reached their end of warranty (usually the fifth year). After a series of tests, a license for the internationally patented invention was sold in the U.S. in July 2012.

Ever since the Wright brothers turned man's dream of flying into reality with their first successful flight in North Carolina in 1903, the airplane – from miniature to jumbo and at whatever speed – has been a source of fascination for all.

Induced drag

From the early stages of flight on, constant progress has been made in reducing various types of parasitic drag, but it has never been possible to significantly reduce induced drag and the wing-tip vortices associated with it.

Induced drag can never be completely eliminated, as it is associated with an aircraft's lift. It acccounts for 33 % of total drag at high velocity and for during climb, and for 70-80 % during take-off.Induced drag is inversely proportional to the square of the velocity, while parasitic drag (the other component of total drag) is directly proportional to the square of the velocity. Reducing drag by 1% can save airline companies millions of dollars in fuel consumption. More than 5% of global pollution is generated by the aviation industry.

Nature abhors a vacuum

Everything is governed by the forces and counterforces created by vacuum. Turbulence will form at the wing tip, no matter what barrier is placed there. With this conclusion as a starting point, Minix President Christian Hugues decided to delve into the problem, focusing research on a specific shape to reduce the helical movement of induced drag.

Mr Hugues started in 1997 by creating a rudimentary prototype equipped with tufts of red wool. He attached the prototype to the roof of his car, observing it and monitoring the changes through the vehicle's sun roof at high speed on the motorways. He noticed that the tufts of wool moved in the right direction.

After a number of wind-tunnel test series on 28 different prototypes, he finally obtained a very interesting result, and continued his research with five series of numerical tests on an airplane, where he achieved a net 6% gain for the entire aircraft.

Given the rising interest in the wind energy sector, he also did eight series of numerical tests on the American National Renewable Energy Laboratory's NREL wind turbine, obtaining a 14% average annual increase in energy efficiency, with lower vibration over the entire structure and no change in axial thrust.

Boeing 747 Vortex out of cloud

Since then, 14 patents have been filed, including two in the United States. In April and June 2012, real flight tests were done on Van's Aircraft RV4 and RV8 models, with even better results than with the laboratory and numerical wind tunnel tests.

Two other tests are scheduled for 2013 in Europe on RV7 and RV8 models.

How the Minix operates

This invention is based on three different kinds of pressure: the field pressure in front of the aircraft, the suction pressure generated on the upper surface (extrados), and the positive pressure generated on the lower surface (intrados).

The airplane's wing tip is continuous with the leading edge of the Minix, which has a droplet-shaped intake. This specific

Front part of MINIX (upper part) & RV8 Aircraft equipped with MINIX

shape causes a coanda effect and makes it possible to accelerate the airflow, direct it towards the interior of the cylinder, and control part of the rotational movement of the vortex as soon as it is created.

Once the relative wind enters the cylinder, 50% of the efficiency is already achieved. The acceleration of the air as it enters the cylinder's intake creates more of a negative pressure inside and captures some of the pressure eddying around the cylinder, through a helical slit along the entire length of the device's second half. This acceleration will force a number of mini-vortices out from the wing's trailing edge.
The results of the first real flight tests show net savings in the double digits.

Land, sea and air applications

Minix Technology has been conducting wind-tunnel, numerical and real flight tests on 28 different prototypes for the past 15 years. This new wing-tip device is now available for commercial aircraft, racers, gliders, ULMs, unmanned air vehicles, and helicopters (blades) (Some applications require additional testing).
There are also a number of applications in the marine sector, such as boat stabilizers, rudders, Lipp rotor blades, submarine fins and turbine blades, hydrofoil blades, hydraglider airfoils, and tidal turbine blades.
All sea and air applications share the same issues, as vortices (gaseous fluids) and cavitation (liquid fluids) behave in the same way (except for density): they cause drag and noise.
Ground applications include airfoil and Formula 1 race cars, onshore and offshore wind turbine blades, etc.
For Formula 1 type racing vehicles, where the speeds approach those of light aircraft at around 180 mph (about 289 km/h), the device is mounted in reverse to invert lift: the faster the car moves, the more it "grips" the road and creates less induced drag in increasing the speed.
For on- and offshore wind turbines, the problem is the same as for aircraft and cars, the only difference being that the wind is active rather than relative. This is because all productivity gain is based on Betz's limit, the consequence being a start-up with less wind and a constant annual output with less noise and mechanical wear, which is of interest to wind farm owners, since most of these farms have reached the end of warranty. The average length of these warranties is five years, creating significant cost/benefit problems for the owners. It has been announced that in the United States alone, $40 billion worth of wind turbines are currently at end of warranty. The Minix device can be retrofitted rapidly to all VAWT or HAWT turbines, so is a potential solution for this problem.

Pollution

In 2012, the global air transportation industry consumed more than 270 million metric tons of kerosene. To calculate the CO_2 pollution, all you have to do is multiply that weight by 3.1 to obtain the tonnage: an incredible 840 million metric tons of CO_2, without even counting the projected 30,000 new aircraft over the next few years, or the increase in future traffic when emerging countries like China, India, and Mexico (to name only a few) step up their air transportation programmes.
There is a different kind of pollution with wind turbines, which require vast quantities of concrete to attach their bases in the ground. This in turn uses a lot of energy in the form of coal or electricity, etc.
A rapid comparison of the long-term pollution shows that a wind turbine has a minimum 30-year service life of pollution-free power production, while an aircraft will pollute throughout its entire service life!

The Minix device reduces energy

consumption on an aircraft by 6% and leads to a 14% average annual increase in energy production for a wind turbine.
In aviation and the field of wind energy, composite materials are used to make these devices. This includes carbon fibre, glass fibre, or a combination of both, as a function of the structural constraints. ■

fiberforge**More information:**
www.minix.fr
christian.hugues@minix.fr

More information

A twofold problem: not only do wing-tip vortices lead to induced drag and therefore to a waste of fuel, their counter-rotational turbulence can be very violent. There is a potential for serious accidents, especially around airports, if sufficient intervals between each category of aircraft are not observed. Each year, air traffic increases by 5%, and it will soon become difficult to circulate in the airspace due to all this dangerous, invisible turbulence. With MINIX the vortex dissolves faster which increases safety and allows less spacing/time between each aircraft.