Rotor blades for low wind speeds

Biomimetic wind turbines modelled on nature

Invention

A geometric rotor blade design is one of the decisive efficiency factors for wind turbines and fans. Scientists at the Rhine-Waal University of Applied Sciences have constructed biomimetic rotor blades based on samara seeds, whose fascinating aerodynamic behavior greatly slows their fall, allowing them to travel long distances thanks to a shape that generates lift. Specifically, the front edge of a samara seed wing generates a vortex that causes a pressure differential between the top and bottom of the wing. Conventional wind turbines also use pressure differentials for rotor blade rotation. Analogously to samara seeds, biomimetic rotor blades are designed so that the front edge generates a vortex that produces the necessary lift. The design not only uses wind energy more efficiently at low wind speeds (less than 5 m/s), but also features lower manufacturing costs than commercially available rotor blades.

Commercial Opportunities

The biomimetic rotor blades described can be used in both small wind turbines and fans for building ventilation. They lower manufacturing costs for these products, increasing profitability. And they achieve good efficiencies, especially at low wind speeds, where their advantages are especially noticeable. They can thus contribute greatly to increased ventilation system efficiency and the successful introduction of small wind turbines. The new rotor blades can be made from commercially available plastics and metals.

Current Status

A small wind turbine prototype (Performance Class 1 kWel) using the new rotor blades is currently being tested in operation. This technology already has a German patent. A European patent is still under review.

Relevant Publications

1. Ruben, J., Analyzing the effect of angle of attack; wind velocity and morphological properties for a biomimetic rotor blade: CFD Simulation, in Department of Science and Engineering. 2020, University of Groningen.
2. Danielle, H., J., Optimization of a samara-inspired flat plate wind turbine blade design using unsteady aerodynamic principles, in Department of Science and Engineering. 2023, University of Groningen.
3. Davids, T., Biomimetic optimization of small scale wind turbines using maple samara seeds, in Department of Science and Engineering. 2024, University of Groningen.
4. El Makdah, A.M., et al., The stability of leading-edge vortices to perturbations on samara-inspired rotors: a novel solution for gust resistance. Bioinspiration & biomimetics, 2019. 15(1): p. 016006.
5. El Makdah, A.M., et al., The influence of axial gusts on the output of low-inertia rotors. Journal of Fluids and Structures, 2019. 88: p. 71-82.
6. Harbig, R.R., J. Sheridan, and M.C. Thompson, Reynolds number and aspect ratio effects on the leading-edge vortex for rotating insect wing planforms. Journal of Fluid Mechanics, 2013. 717: p. 166-192.
7. Phillips, N., K. Knowles, and R.J. Bomphrey, The effect of aspect ratio on the leading-edge vortex over an insect-like flapping wing. Bioinspiration & Biomimetics, 2015. 10(5): p. 056020.
8. Fu, J., W. Shyy, and H. Qiu, Effects of aspect ratio on vortex dynamics of a rotating wing. AIAA Journal, 2017. 55(12): p. 4074-4082.
9. Lee, S.J., E.J. Lee, and M.H. Sohn, Mechanism of autorotation flight of maple samaras (Acer palmatum). Experiments in fluids, 2014. 55: p. 1-9.
10. Lentink, D., et al., Leading-edge vortices elevate lift of autorotating plant seeds. Science, 2009. 324(5933): p. 1438-1440.
11. Birch, J.M., W.B. Dickson, and M.H. Dickinson, Force production and flow structure of the leading edge vortex on flapping wings at high and low Reynolds numbers. Journal of Experimental Biology, 2004. 207(7): p. 1063-1072.

Competitive Advantages

- Simple manufacture
- Low production costs
- Good efficiency
- Wide field of application
- Proven materials such as plastic and metal

Technology Readiness Level

1 2 3 4 5 6 **7** 8 9

System prototype demonstration in operational environment

Industries

- Building technology
- Renewable energies

Ref. No.

4929

Contact

Dr.-Ing. Oliver Kower
E-Mail: ok@provendis.info
Phone: +49(0)208-94105-61

An invention from the Rhine-Waal University of Applied Sciences.

PROvendis GmbH
Schlossstraße 11-15
45468 Muelheim an der Ruhr
Germany
www.provendis.info