

ENERGY OUTPUT OPTIMISATION OF WIND POWER STATIONS BY INFLUENCING SPECIFICALLY THE AERODYNAMIC BEHAVIOR OF THE ROTOR BLADES

cand.-Ing. M. Seidel, Dr.-Ing. T. Rische
cp.max Rotortechnik GmbH & Co. KG
Großenhainer Strasse 92, 01127 Dresden

Summary

At different locations wind turbines haven't an effect of computed energy yields of interpretation. A cause for the energy yield fluctuations can be the aerodynamics of the rotor blades. This work is pointed out possibilities especially for affect and chance the aerodynamics of rotor blades.

1. Introduction

For a maximum energy yield it is really important to use the best possible aerodynamic potential of the rotor blades. An individual location-referred output optimization of wind turbines is a goal of the modification.

2. Investigation of the current

As a first step, we examine the aerodynamic behaviour of rotor blades. Through this investigation we decide, if an installation of additional flow elements is useful.

The Investigation gets accomplished with help of installed thread of wool. The flow pictures are photographically taken while the turbine is operating and at different wind velocities. The evaluation of flow pictures detects flow separation zones.

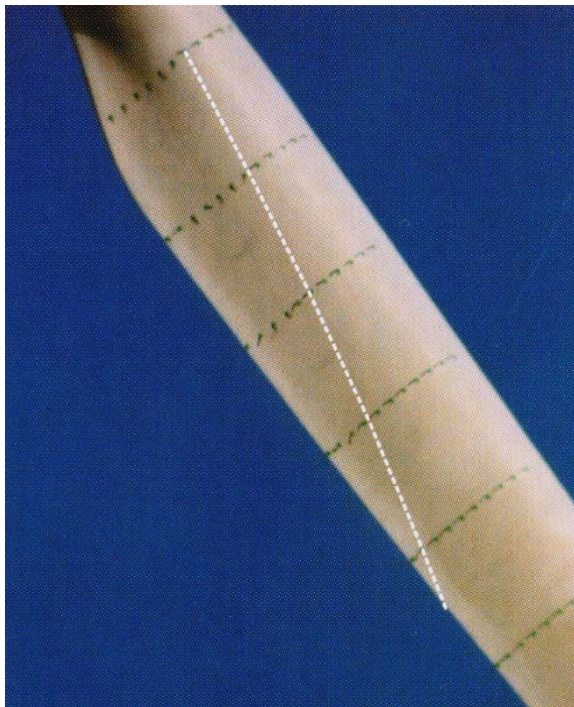


Fig. 1: Flow separation line in the suction side of the rotor blade LM 31.2 P

Based on the results of these investigations a special configuration of flow elements is developed.

3. Influence of the aerodynamics

If the Investigation of the flow shows separations, then there are possibilities to reduce or eliminate these separations with special flow elements. For this purpose special Vortex generators and Boundary layer barriers can be designed.

Vortex generators are diagonally into one another posed fins, which because of the rotated position either slow down or on the other hand speed up the boundary layer flow. If the boundary layer flows meet with different speeds behind the fins, they create micro vortex. This little vortex takes air away from the outer flow. The air is supplied to the boundary layer flow. The boundary layer experiences an energy increase. For this reason the separation-endangered boundary layer can better bear against the profile. The flow separation shifts from one point to another one near the trailing edge or gets completely eliminated.

Boundary layer barriers divide the wing in several parts. A cross-flow at the rotor blade will be weakened towards the blade tip by these boundary layer barriers and the flow separation of the boundary layer flow will be reduced.

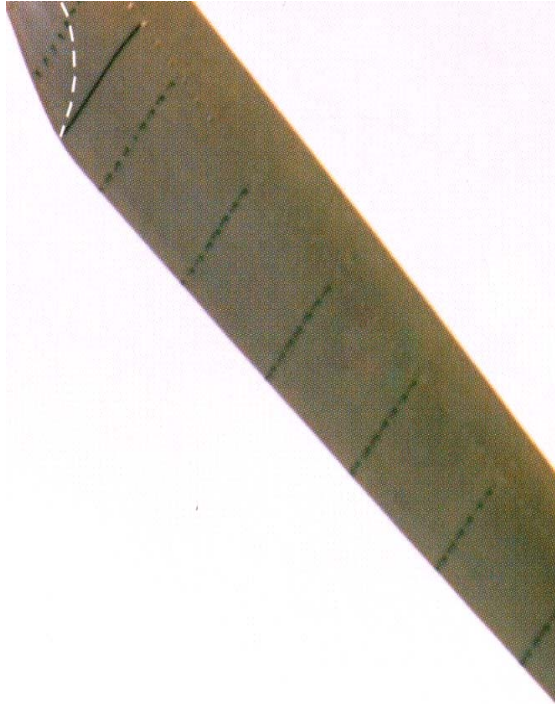


Fig. 2: Flow separation line at the same rotor blade LM 31.2 P after the installation of Vortex generators and Boundary layer barriers

The aerodynamic modifications give rise to a better flow attitude. Through this better flow attitude a positive effect of the performance of the wind turbine can be expected.

4. Profile influence

Another possibility to improve the effectiveness of the rotor blades is change of the profile characteristics. In this matter the profiles of rotor blades can be affected by attachment of flaps, at the leading and/or trailing edge. Such attachment flaps change the curvature of the profile. It changes the aerodynamic characteristics and factors of the respective profiles. Through mounting flaps especially the lift of the profile will be increased.

Special designed Gurney flaps have a high potential to increase the lift of the rotor blades.

A gurney flap is a small stripe that is mounted in a right angle, or another smaller mounting angle, at the trailing edge of a wing element. The circulations of the wing element are increased. Due to this increase the lift coefficient is increased too. The drag coefficient will also be increased.

With several simulation calculations with such a flap, energy yield paste run genes were computed up to over 5 per cent.

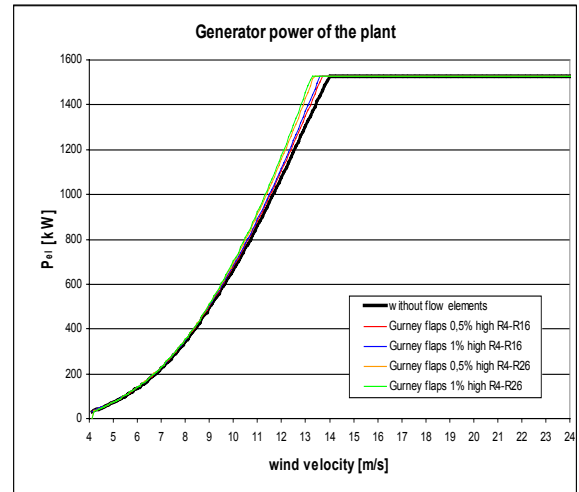


Fig. 3: Results of a simulation calculation for different arrangements of Gurney flaps (calculations were carried out in cooperation with EUROS Entwicklungsgesellschaft für Windkraftanlagen mbH)

5. Results

As example at the rotor blades LM 31.2 P of a wind turbine in a wind park were installed special Vortex generators and Boundary layer barriers. For comparison of the energy yields a second turbine from the wind park was used. The evaluation time area amounted to about two years.

The evaluation showed that because of the carried out modification an increase of approximately 3 per cent of the energy yield can be realised (Fig. 4).

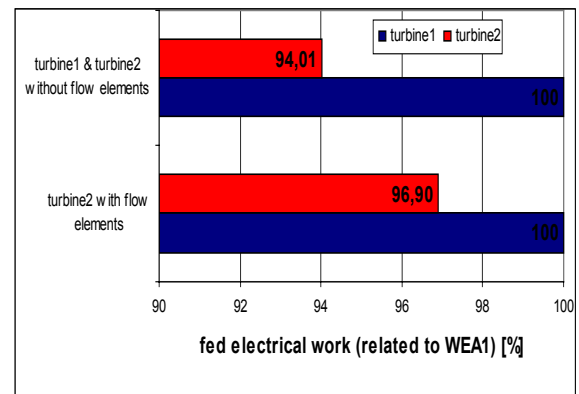


Fig. 4: Evaluated energy yield data by wind turbine with and without modified rotor blades

This results show that an individual optimisation of rotor blades has a high potential to optimise the energy output of the wind turbine.