Leading edge erosion the state of the art research results

Hasager, Charlotte Bay; Mishnaevsky, Leon; Bak, Christian

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Leading edge erosion at wind turbine blades caused by weather effects dominated by concurrent high-wind, high-rain conditions prevail at several offshore wind farms.

Variations between typical land- and offshore sites explain the degradation speed based on the study of rain and wind climate data [1].

Research to define and characterize the degradation processes investigating materials and the roughness of blades have resulted in new knowledge on droplets in rain erosion tester based on high-speed camera and numerical modelling.

The degradation results in rougher airfoils that causes change in the aerodynamic performance, hence loss of production.

Detailed investigation on the rough surface in wind tunnel testing demonstrate the interplay between surface roughness and aerodynamic performance. These wind tunnel tests showed how surface roughness affected the aerodynamic performance as a function of varying roughness heights.

The roughness of surfaces investigated from detailed observations using X-ray tomography and computational micromechanics simulations.

Interestingly, the micro- and nanoscale structures, including the heterogeneities, particles and voids in the protective coatings, have critical effect on the crack initiation in the coatings under multiple liquid impact.

Based on a systematic finite element simulation on environmental, design, and manufacturing processes, it was revealed what are the desirable coating properties and thicknesses in order to protect leading edges against sharp impacts. This leads to novel coating polymer coating development, relevant for repair of leading edge erosion.

Recently it was proposed to limit leading edge erosion by slowing down turbines during few intense rain events, to prolong lifetime, and reduce cost for repair and even increase the annual energy production [2].

Observations and theory comparison enhance our understanding of leading edge erosion [5].

### Conclusions

Leading edge erosion is multi-faceted research area for which highly inter-disciplinary expertise, experimental and theoretical numerical modelling are the key components for advancing state of the art on the topic.

The solutions for repair of damaged blades and future new types of coating that potentially will provide lasting leading edges what industry is looking for. Also, solutions to reduce the need for repair is relevant in the wind industry.

### References

1. www.rain-erosion.dk