R&D areas/s: 07. Forecasting, cloud physics and aerodynamics

A CFD benchmark study of ice accretion on a wind turbine blade and a comparison to the ice accretion of a rotating blade cylinder model

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This presentation will show results from a Computational Fluid Dynamic (CFD) benchmark study that has been done as part of the research project IceLoss 2.0, partly funded by the Swedish Energy Agency. IceLoss 2.0 is an upgraded version of Kjeller Vindteknikk's (KVT) IceLoss algorithm, which is used to analytically predict long-term and short-term production loss estimates due to ice on wind turbines using modeled weather data.
Five different CFD model setups has been used to simulate ice accretion on the 3.4 MW onshore research turbine developed within IEA Task 37. The simulations were done for three pre-defined meteorological cases and performed in co-operation with the Arctic University of Norway (UiT), Lund University (LTH) and Norwegian University of Science and Technology (NTNU). A total of 30 different simulation runs was performed.
The Makkonen standard cylinder ice accretion model, originally developed for estimating ice loads on power lines, has proved to be useful within the wind industry on estimating icing losses. Although widely used, the model is limited to the fact that it models ice on a cylinder with the mean wind speed fed in as droplet collision velocity. In a study by Davis et al. (2014), the inputs to the Makkonen model was modified to better represent a rotating turbine blade and it was shown to have a better skill score than the standard cylinder model. KVT has developed a Blade Cylinder model based on this as part of the IceLoss 2.0 project and has performed calculations equivalent to the benchmark CFD simulations to make it comparable in this study.
It is seen that all CFD models give approximately the same amount of ice mass, although the ice shapes have some differences, especially for the more extreme meteorological cases. The chosen droplet distribution also has a significant impact on the estimated ice loads. Although the simulated ice loads of the KVT Blade Cylinder model is of the same magnitude as the CFD models, it shows buildup of larger ice loads in general. Due to a reduction in accretion coefficient (alpha3) in the blade cylinder model, the icing intensity remains the same although the collision speed increases for the different blade sections. This is not the case for the CFD calculations where an increase is seen for the outer blade sections also under the extreme icing case.

Web site: http://www.vindteknikk.com

Short biography: Johannes holds a PhD in atmosperic sciences from Stockholm University and continued with research on boundary layer clouds at NASA Jet Propulsion Laboratory and Stockholm University before joining Kjeller Vindteknikk in 2013. At Kjeller Vindteknikk, Johannes works with commercial and R&D-projects. At the moment, the majority of his hours are put into the IceLoss 2 research project, which aims to develop Kjeller Vindteknikk next model for predicting production losses due to icing. Johannes is also a United States champion in floorball, which means nothing.