Newsletter 2

Methodologies for evaluating high-strength gear materials

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The demand of wind energy is continuously increasing, given its green potential. In fact, the tendency through the last years has been to build bigger and bigger wind turbines, to achieve greater energy generation power and reduce the levelized cost of energy.

Despite the growing size of wind turbines, the requirements for the gearboxes (responsible for the conversion of the high-torque and low-speed motion of the rotor to the low-torque and high-speed motion the generator) have become more restrictive. That is, the torque density (transmitted torque divided by the mass of the gearbox) has increased, resulting in undesirable fatigue failure modes that compromise the service of the gearbox and the wind turbine. One example of these failures is the Tooth Flank Fracture (TFF), which results from the initiation of cracks at the subsurface and their posterior propagation.

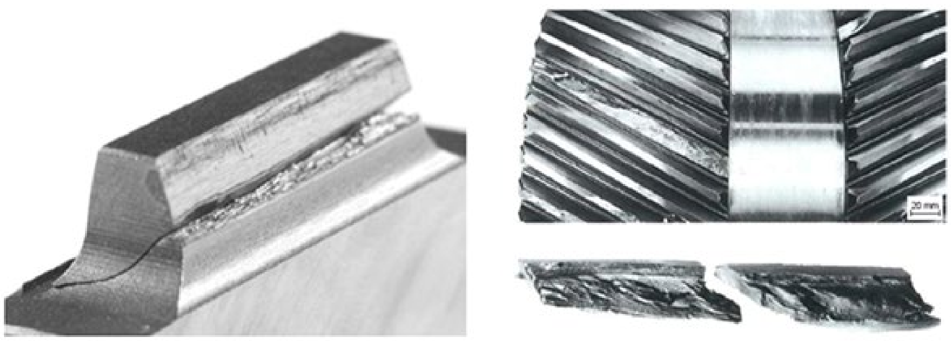

Figure 1 – Examples of Tooth Flank Fracture.

In order to fight TFF, some gearbox manufacturers are replacing the common case carburizing by other heat treatments such as induction hardening that enable the production of deeper hardened cases and, therefore, longer-lasting gears. However, the current standards are valid only for the mechanical reliability calculation of nitrided or carburized gears.

Thus, within R3-Mydas Task 4.3, Ikerlan and Flender aim to develop and validate methodologies and tools for the rating of induction hardened gears. The workflow below shows the proposed approach for the evaluation of critical fatigue failure modes, namely TFF, root bending and wear.

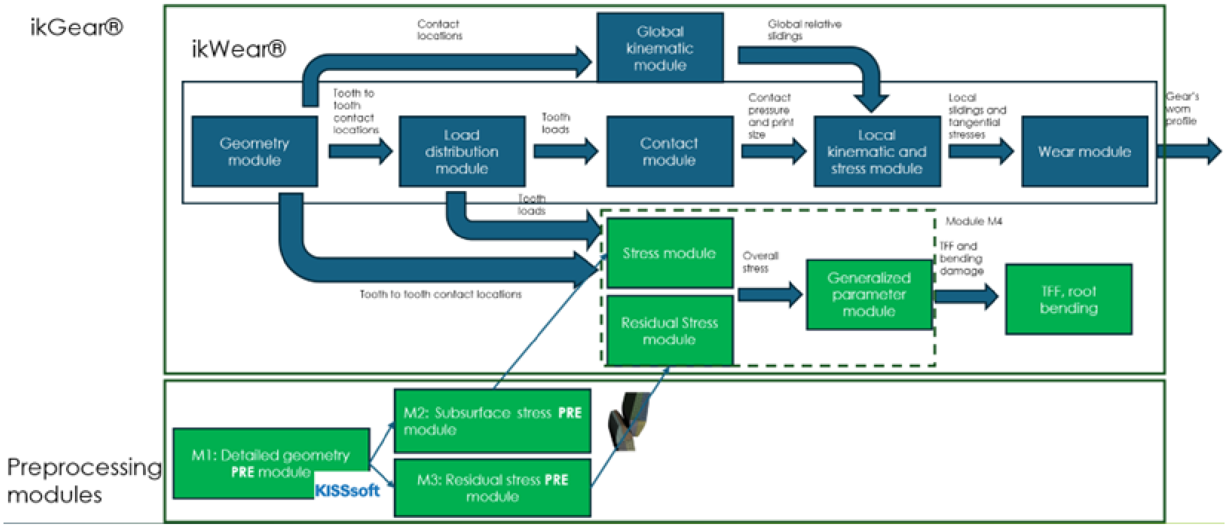

Figure 2 – Workflow of the proposed approach for the evaluation of critical fatigue failure modes.

The proposed approach considers different aspects, such as the calculation of the residual stresses coming from the induction, the stresses originated by the contact loads, the specific geometry of the gear with all its micro-modifications, and the multiaxial subsurface fatigue.

For the time being, the induction hardening simulation is being improved at a cylindrical sample level and a sensitivity analysis of the most relevant numerical parameters has been performed. In addition to that, an Ansys module that computes the contact stress for different meshing points and load levels is also being developed.

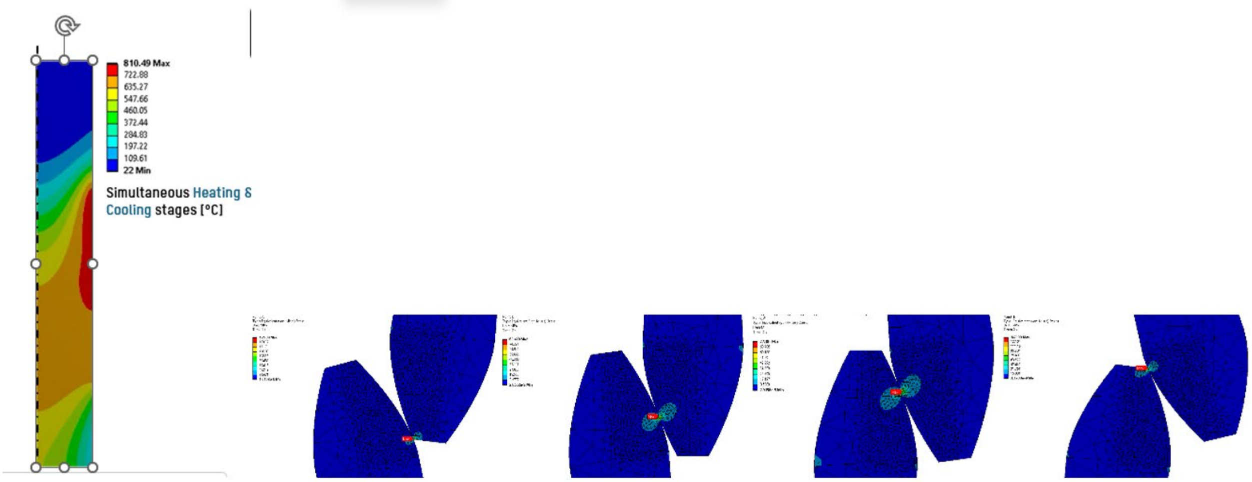

Figure 3 – Induction hardening simulation at a cylindrical sample.

Once these calculation routines are implemented, future work will involve choosing and implementing the right multiaxial governing parameters to calculate the fatigue damage of the gear components, predicting failures and remanufacturing broken teeth.