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Prediction of fatigue failure in turbine shafts

When a power plant needs to unexpectedly stop its production because of failure of the turbines, this obviously costs huge amounts of money. One possible reason of turbine failure is fatigue failure of the turbine shaft due to a long-term crack growth that leads at a certain moment to sudden failure. Prediction and monitoring of this crack growth helps avoiding those unexpected failures and allows preventing them by interventions during the planned maintenance periods.

Monitoring crack growth in the turbine shafts can be done using non-destructive methods (like ultrasonic techniques). However this remains a difficult and time-consuming task.

Instead, monitoring the torsional resonances of the shaft is a much more effective method. The torsional resonances are a characteristic of the structure (the shaft) itself, not influenced by external parameters like the operating speed. However, as the number of cracks grows in the shaft, this one becomes less “stiff” and more flexible, changing the characteristic torsional resonances. The more cracks, the lower the torsional resonance frequencies. Once the torsional resonance frequencies are excited by the vibrations generated by the operating turbine itself, accelerated crack growth can quickly lead to sudden failure of the shaft. Regularly monitoring the torsional resonance frequencies and comparing them with the ones of a “healthy” shaft can avoid unexpected and costly shutdown of the plant.

An important element in the whole measurement procedure is the measurement quality itself: next to a high dynamic range, the use of high-accuracy optical sensors and the ability to do butt-joint correction are crucial in this whole process.

Several measurement locations along the length of the shaft allow measurement and detailed analysis of the torsional resonances of the whole turbine shaft and identification of the most critical regions.

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