KEMA

Bump testing services

Experience you can trust.

Vibration diagnostics of stator end-windings

Electromagnetic forces cause vibration of stator end-windings. This vibration can cause the following problems:

- erosion of coil insulation (precipitating a ground fault)
- breakage of coil strands (leading to overheating)
- weakened end-windings (decreasing rigidity of structure)

Over time, stator vibration can loosen the end-windings.

Background

Bump testing analyzes the natural response of stator end-windings upon excitation from a mechanical impulse. The response is fully determined by the stator end-winding's properties, including mechanical rigidity.

This principle is comparable to the excitation of a piano string by its hammer. The string will start to vibrate in distinct frequencies, which produces a tone. In both cases it is conditional that the excitation is produced by a suitable hammer.

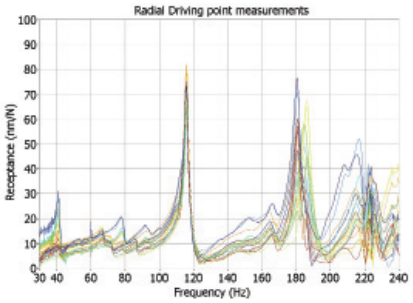
Generally, this is a self-accelerating process which, once started, can cause severe deterioration within a surprisingly short time and may require a complete stator rewind. Bump testing can reveal whether generator stator end-windings have resonance frequencies that are close to twice the frequency of the power grid. Corrective actions can be taken to avoid an entire rewind of the stator, thereby saving considerable amounts of time and money.

The string model is relatively simple compared with the end-winding; however, the natural vibration frequencies of a complex part can be measured accurately.

Both the individual bar-ends and the integral structure within the end-windings need to be investigated. KEMA analyzes the bar-ends with Driving Point Measurements and the end-winding structure with Modal Analysis.

Driving point measurements

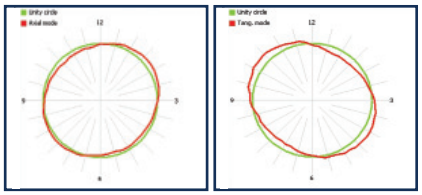
Acceleration transducers are mounted temporarily on each tested bar-end to measure the radial, tangential, and axial directions. An impact hammer with an integrated force transducer excites the bar-ends. Data acquisition starts when the trigger criteria have been met. KEMA's specially developed software processes the data and calculates the Frequency Response Function (FRF). The FRF spectra show the normalized natural vibration response of the end-winding induced by the impact. We can display the response in either receptance (displacement/force; see figure) or accelerance (acceleration/force), based on client's preference.



Averaging over at least three excitations is applied to monitor coherence and enhance the signal to noise ratio.

Modal Analysis

KEMA performs a Modal Analysis to obtain the end-winding's modal shapes. Through the process, the acceleration transducer moves across the bar-ends, while excitation of the end-winding occurs at a suitable location. Two "rings" are tested: an inner ring close to the core and an outer ring close to the bar-ends.



Inner Ring Outer Ring

Criteria

Electromagnetic forces at the end-windings work on the structure with a frequency twice that of the power grid. When natural frequencies are close to this frequency, resonance will lead to high movement and rapid wear of the end windings, culminating in collapse. End-windings that have four-node modal shapes close to twice the power grid's frequency are even more susceptible to damage from electromagnetic forces. Quantitative analysis is based on either simple comparative rules, or the manufacturer's specifications. Through data trending, such as follow-up tests and a comparison of spectrum changes, you will gain much information about the condition of the machine. KEMA can provide additional insight and recommendations on appropriate actions.

Special applications

KEMA developed the Bumptest software in-house and can customize the package to meet your specific needs. Therefore, the system is capable of diagnosing critical vibrations in all kinds of generators.

Specifications

Analog signal sampling takes place with 5kHz (up to 25kHz possible). The frequency response spectra are typically monitored in the range of 30 to 240Hz.

About KEMA

Established in 1927, KEMA is an independent knowledge leader and a global provider of high-quality services to the energy value chain, including business & technical consultancy, operational support, measurements & inspection, and testing & certification. KEMA provides impartial advice and support to producers, suppliers and end users of energy, as well as to governmental bodies. In addition, KEMA certifies products, systems and individuals for a wide range of clients.

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