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Reducing Total Harmonic Distortion Effects in VFD/Motor Systems

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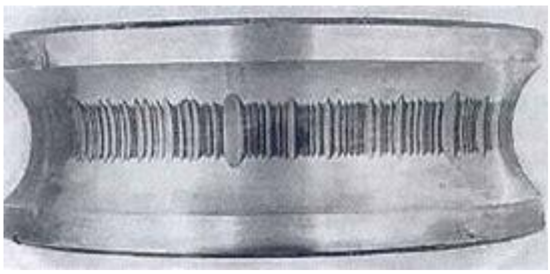
The topic of harmonic distortion and the effects on motors, electrical systems and sensors has become more headlined as people in the industry are searching for a working solution to the problem.

IEEE defines harmonics as voltage or current waveforms at integer multiples of the fundamental frequency at which the power system operates. These harmonic waveforms combine with the fundamental frequency producing a distorted waveform. Waveform distortions are non-sinusoidal currents or voltages that are present in a normally sinusoidal network. Common harmonic distortion sources are components that take AC power in and convert it to DC power, referred to a non-linear load, such as VFD's.

These unwanted harmonic waveforms are an additional source of high frequency AC voltages or currents, supplying energy to motor windings, decreasing the motor efficiency and increasing operating temperatures. Harmonic currents reach the stator windings, producing harmonic currents in the rotor. These rotor harmonics, with a high rate of change in voltage, will create dV/dt voltage spikes, which are transferred to the motor shaft as voltage induced along the axial length of the machine. The shaft voltage results in a circulating motor bearing current with the magnitude limited only by the motor bearing impedance.

The motor bearing acts like a capacitor as the impedance attains values in the meg-ohm range. With the increase in speed, the balls (rollers) ride on the lubricating film which forms a boundary between the rolling elements and the raceway, with the exception of instantaneous asperity points of contact. The lubrication acts as a capacitor as it gets charged by the rotor shaft voltage. When the shaft voltage that is applied to the lubrication reaches the dielectric breakdown range of the lubrication, or when a rolling element asperity point contacts the raceway, a destructive instantaneous high electrical discharge (EDM) takes place, pitting the bearing race and destroying the lubrication. These instantaneous discharges also can interfere with sensors and other electronics in proximity of the motor, as the discharges look for a path to ground to complete their circuit.



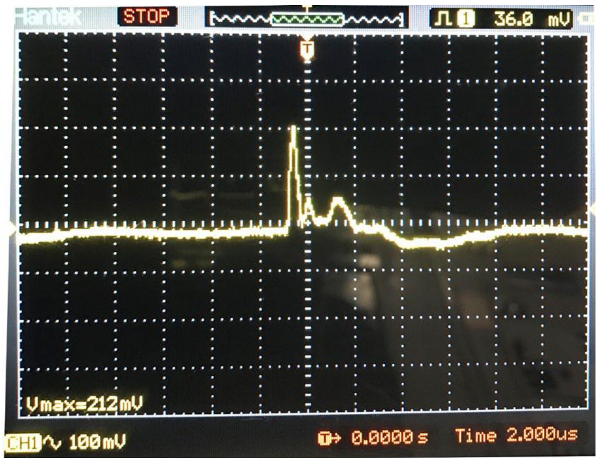
Bearing fluting from High Frequency Currents

Without intervention, this action of discharges will repeat until the premature damage to the bearing is discovered by bearing monitoring, inspection or a catastrophic failure occurs. This results in costly downtime, unnecessary repair costs and revenue loss.

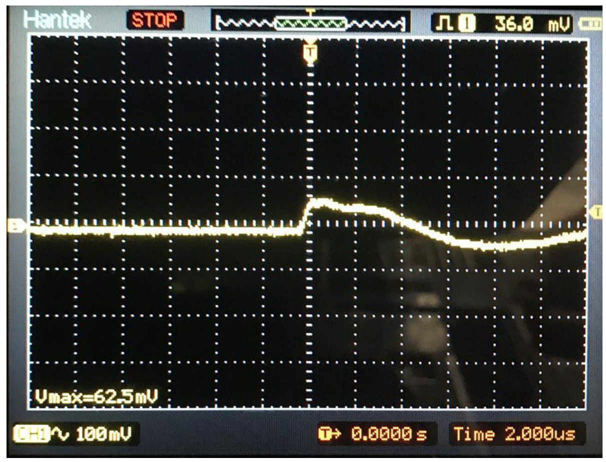
These harmonic distortions created from the VFD become high frequency currents in the 100kHz range to 5mHz. Motor/Drive systems do not account for the generation of these high frequency currents in their system design, which leaves no path to ground for these damaging currents. Without a proper path, these damaging currents travel through a path of least resistance. Common practice is to protect motor bearings by utilizing a combination of shaft grounding and insulated bearings, but this only aims to protect the bearings, leaving sensitive monitoring equipment, sensors, metal detectors, gauges and the like, open targets for these high frequency currents as they search for a source for ground.

Prevention of eminent motor bearing failure is possible by reducing the high frequency current spikes and slowing the dV/dt rise to levels that a motor bearing can tolerate without being damaged. Installing a choke to absorb these high frequency currents at the source of the distortion has been a proven solution in the industry. CoolBLUE common mode chokes and NaLA differential line chokes offer the highest reliability and longevity in the market. CoolBLUE and NaLA provide additional impedance between the VFD and motor to reduce the high current spikes and slow the dV/dt, by absorbing the high frequency currents and dissipating them as heat, protecting the entire system.

Harmonic distortion can be seen when measuring high frequency currents with a Rogowski Coil and 200MHz Oscilloscope. The high spikes in the wave form and then the ringing from the dV/dt can be seen clearly with the proper tools. Installation of CoolBLUE and NaLA greatly reduce these damaging currents to a non-damaging level, protecting not just the motor bearings, but will also prevent damage to the windings of the motor, interference with sensitive electrical sensors and other delicate electronic equipment and monitors.



With no high frequency current protection



With CoolBLUE and NaLA installed on cables near the VFD

Increase system efficiency, decrease maintenance costs and improve the power quality, upstream and across distribution by utilizing CoolBLUE and NaLA chokes in your VFD/motor system. Protect your bearings, motor windings, sensors, metal detectors, gauges, and sensitive electronics, by reducing the harmonic distortion at the source. Use in existing systems to prevent re-occurring problems or consider designing in CoolBLUE and NaLA when installing a new system. The solution is simple, easy to install and does not require maintenance. An ounce of prevention is worth a pound of cure ~ Benjamin Franklin

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