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Electric Motor Voltage Quality Problems

Excerpts From the U.S. Department of Energy's Energy Matters newsletter (Spring 2005), By Doug Dorr, EPRI Solutions Inc., and Philip Lim, Memphis Light Gas & Water.

Voltage nameplate ratings found on many alternating current (AC) motors and drives can be a source of confusion for utilities and their industrial customers. The confusion stems from the voltage range in which a particular motor may be operated safely. Additionally, voltage unbalance is known to create premature failure of heavily loaded motors if they are not properly de-rated.

Nominal Utilization Voltage - The U.S. standard for motor nameplate information can be found in the NEMA Standards Publication MG 1-2003: Motors and Generators. Motors meeting the criteria contained in the NEMA standard will operate satisfactorily within plus-or- minus 10% of the rated voltage. For example, if the voltage rating on the motor nameplate is 460 volts, that particular motor should operate safely when the utilization voltage is between 414 and 506 volts. However, as the voltage changes-even within the NEMA range-so will the torque, temperature, current, motor speed, and other motor characteristics. Additionally, any increase in operating temperature may accelerate the deterioration of the motor's electrical insulation system. Studies of operating temperature and its effect on insulation life suggest that a rise in steady-state operating temperature of 10 degrees Celsius can reduce insulation life by 50% or more. The plus-or-minus 10% voltage rating for AC induction motors assumes that the motor is operated at the nominal frequency. If the frequency is not the same as the nameplate frequency and in particular when 60-hertz motors are operated on 50-hertz systems, the sum of the percent of voltage difference and the percent of frequency difference from the nameplate ratings must not exceed10%. Values are approximate and voltages at or slightly above nominal are preferred for lower operating temperatures and higher starting torques.

Voltage Unbalance - The second voltage quality related issue that the NEMA standard addresses is voltage unbalance. Unbalanced motor voltages may cause a current unbalance that in turn increases the operating temperature and energy losses of the motor. A voltage unbalance can magnify the percent current unbalance in the stator windings of a motor by as much as 6-10 times the percent voltage unbalance. When the voltage unbalance is more than 1%, de-rating the motor will help to mitigate the effects of the voltage unbalance. If the voltage unbalance exceeds 5%, it is not advisable to operate the motor at all-even when the motor has been de-rated. When a voltage unbalance exceeds 3%, the root cause of the unbalance should be identified and remedied. In cases where motor failures are occurring repetitively and the unbalance is greater than 1%, it may be prudent to investigate and resolve the root cause of the unbalance. Voltage unbalance must be treated separately from unusually low or high voltage conditions for three phase motors. As a matter of fact, both conditions in tandem would be a worst case condition for any motor, however there are a couple of sanity checks

that can be performed to alleviate concerns (even when both voltage related problems are present). Provided that the motor nameplate current is not exceeded on any of the phase conductors and provided the actual motor speed is greater than or equal to the nameplate revolutions per minute (RPM), one can assume that detrimental affects on the motor are minimal. The condition under which the preceding statement would hold true would be that of a lightly (<50%) loaded motor.

Voltage Related Symptoms - Symptoms of motor problems related to either voltage unbalance or to voltages not matching the nameplate rating are not always easy to diagnose because both the utility and facility distribution voltages vary as the system load and other system characteristics vary. Measuring the steady-state voltage at accessible points in the motor circuit is a very good way to determine whether a potential for voltage problems exists. A few symptoms that may trigger such an investigation include:

- Unusually high numbers of motor failures
- Not getting the expected motor life between rewinds
- Unexplained motor trips
- Motors that are more sensitive to voltage sags than other electrical process equipment
- Difficulty getting a specific motor started
- Nuisance tripping of a motor-protective device.

Additional possibilities beyond operating voltage and voltage balance can cause these symptoms. But the list provides a good starting point for deciding whether to conduct a voltage investigation.

If you would like to have the complete article, please send an e-mail request to: rlewis@foxbroselectric.com

Is Your Swimming Pool Pump ready for the "Pool Party Season"?

It never fails. You have planned to have a beginning of the season pool party and your pump has decided to extend its winter vacation without getting approval from you. Doesn't it always happen that way? It never fails until you need it, and green pool water is not very appealing to swim in. Here's a solution for you.

Before you need the pump, remove it and bring it to us. Yes, we work on pool pumps. We can check it out and give you a quote on the repairs that it requires. We have access to motors and repair parts for most pool pumps. The old saying, "If it aint broke, don't fix it", can end up being a lot more expensive. Minor, unresolved problems now can evolve into major problems later.

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