

MINING & MINERAL TECH NOTES

Application Guidelines to Keep You Better Informed

MOTORS & DRIVES

Common Causes of Motor Failures

HOW DO MOTORS FAIL?

The proper application and selection of low voltage motors can be a demanding task.

A good starting point would be to consider why motors fail in the first place. Toshiba investigates some of the reasons why motors fail. If you talk to your local rewind shop, you would most likely find that they also experience very similar, if not identical, reasons described in this application guideline.

Studies show that bearings fail more often than insulation systems, and the number one cause of bearing failure is due to over/under lubrication. Improper lubrication causes a heat buildup in the bearing cavity, and the added heat causes the grease to break down prematurely, eventually resulting in failure. Ultimately, many of these bearing failures are a result of the bearing exceeding its temperature limits in one form or another.

BEARING FAILURES (60 to 70%)

- Over/Under Lubrication
- Misalignment/
Belt Tension
- Contaminants
Compatibility
- Vibration
- Thrust
- High Ambient
- Bearing Currents
- L10 Fatigue



When evaluating motor bearing systems, the following important considerations should be made:

- 1) Bearing Temperature Rise: Temperature is the root cause of many of the failures listed above. A larger thermal margin in the bearing design is ideal. For every 15°C temperature decrease, the life of your bearing doubles.
- 2) Grease Nipples & Relief Valves: This is done to allow greasing and prevent over greasing.
- 3) Sealed or Open-Style Bearings: Sealed bearings do not require as much greasing maintenance and are commonly used on smaller frames that are often installed in hard-to-reach places. As frames sizes increase, a transition to open-style bearings is important to allow for reduced temperature rises, which in turn extends grease life and greasing intervals.
- 4) Bearing Clearance Rating: C3 'loose' fitting bearings allow for thermal growth.
- 5) Shaft Seals: To protect against contaminants, a V-ring seal (forsheda seal) is better than a flat seal. Librium-type seals provide IP55 protection and industry-leading bearing protection.
- 6) Bearings Sizes on DE & ODE: Larger bearings run on lower temperatures. They can handle larger radial loads, have longer L10 lives to extend the effects of fatigue, and are not as sensitive to small misalignments. 300 series bearings are wider and have much larger outside diameters.
- 7) Inner Bearing Caps: Caps can prevent bearings from failing by damage caused to the stator and rotor.
- 8) Drain & Breather Plugs: These allow for water to escape and prevents water from entering the motor.
- 9) Grease Type: Premium-grade polyurea or lithium based greases extend grease life, have wider operating temperature ranges, contain rust and oxidation inhibitors, run quieter, and have higher operating speed capabilities.

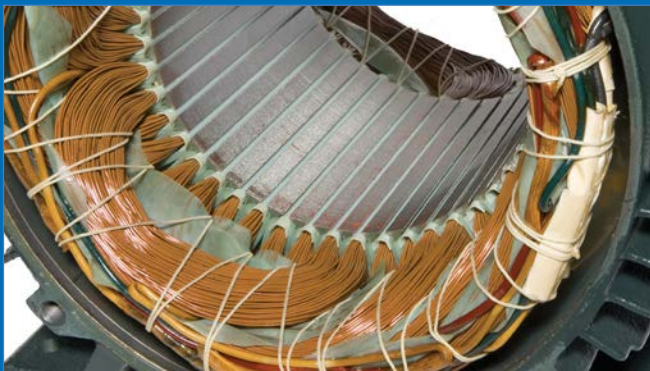


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The number one cause of an insulation failure is due to overload conditions, not just from a lack of proper protection, but also due to abuse. Furthermore, as is the case in bearing failures, many of the insulation failures are a result of the insulation exceeding its temperature limits in one form or another, indicating that a motor design with a large thermal margin is very valuable. Thermal margin is the difference between actual design temperature rise of the motor at 1.0 SF under load, and the rated maximum allowable temperature (in most cases, which would be 155°C, the limit for a Class F rated insulation system). Insulation failures that are affected by temperature in one way or another include: Overload, Excessive Number of Starts, Contaminants/Ventilation Failure, Thermal Aging, System Disturbances, Excessive Load Inertia, Insufficient Torque, Locked Rotor, Single Phasing, and High Ambient Temperature.

INSULATION FAILURES (30 to 40%)

- Overload
- Excessive Number of Starts
- Contaminants
- Ventilation Failure
- Thermal Aging
- Voltage Spikes from VFDs
- System Disturbances
- Excessive Load Inertia
- Insufficient Torque
- Locked Rotor
- Single Phasing
- High Ambient
- Vibration



When evaluating motor insulation systems, the following important considerations should be made:

- 1) Temperature Rise: The cooler the motor's operating temperature, the longer the expected life of the motor will be. For every 10°C cooler, the life of your insulation doubles.
- 2) Torque: The more torque a motor has, the faster the acceleration time, which results in less heating of the motor.
- 3) Class of Insulation: Most motors sold meet Class F insulation ratings; however a motor that is constructed with Class H materials will typically have a longer thermal life.
- 4) Solid Bracing of End Turns / Cuffed Slot Liners / # of Dip & Bakes / Proper Phase Separation: Heat shrink lacing material helps to ensure the solid bracing of end turns. Lack of proper support of the insulation system can cause vibrations between turns, phases, and ground at startup and when exposed to PWM waveforms. The more dip and bakes, the more secure and solid the insulation system becomes. Proper phase paper placement is very important to help ensure complete separation of phases, minimizing opportunities for failures.
- 5) Length of Stator & Rotor Cores: Overall weight of the motor might be a good indication of core length in a properly designed motor. Long cores not only indicate a motor with good efficiencies and torque capability, but also give the motor mass to absorb heat.
- 6) Slot Fill: A tight slot fill maximizes copper volume for reducing resistance losses in the stator, but also allows for proper heat conduction to the motor frame and prevents potentially damaging vibrations between turns and ground.
- 7) Efficiency Design Features: Tooth density, thickness of laminations, size of end rings, width of the air gap, and fan size are all factors which can increase and/ or decrease efficiency. More efficient motors run cooler. A well-designed motor is one with very high efficiencies, very high torques, and very large thermal margin.
- 8) Inverter Duty Wire: Dielectric strength of insulation system rated to handle voltage spikes as per NEMA MG1, Part 31, $V_{peak} = 3.11 \times VRMS$, with a $\geq 0.1 \mu s$ rise time.