Extend the Operating Life of Your Motor

Why Do Motors Fail?

Certain components of motors degrade with time and operating stress. Electrical insulation weakens over time with exposure to voltage unbalance, over and undervoltage, voltage disturbances, and temperature. Contact between moving surfaces causes wear. Wear is affected by dirt, moisture, and corrosive fumes and is greatly accelerated when lubricant is misapplied, becomes overheated or contaminated, or is not replaced at regular intervals. When any components are degraded beyond the point of economical repair or replacement, the motor's economic life ends.

For the smallest and least expensive standard efficiency motors, the motor should be put out of service and replaced when a key component, such as a bearing, fails. Depending on type and replacement cost, larger standard motors—up to 20 or 50 horsepower (hp) —may be refurbished and get new bearings but are often scrapped after a winding failure. Still larger and more expensive motors may be refurbished and rewound to extend life indefinitely. An economic analysis should always be completed before motor failure to ensure that the appropriate repair/replacement decision is made.

How Long Do Motors Last?

The answer to how long motors last will vary and is dependent upon many factors. Some manufacturers estimate 30,000 hours, while others state 40,000 hours. Some will say "it depends." One thing is clear—a motor should last much longer with a conscientious motor systems maintenance plan than without one.

Motor life can range from less than two years to several decades under particular circumstances. In the best circumstances, degradation still proceeds and a failure eventually will occur. Much of this progressive deterioration can be detected by modern predictive maintenance techniques to enable life-extending intervention.

Even with excellent selection and care, motors may suffer short lifetimes in unavoidably severe environments. In some industries, motors are exposed to contaminants that are severely corrosive, abrasive, and/or electrically conductive. In such cases, motor life can be extended by purchasing special motors, such as those conforming to the Institute of Electrical and Electronics Engineers (IEEE) 841 specifications, or other severe-duty or corrosion-resistant models. Alternatively, stock motors can be modified by a competent service center.

The operating environment, conditions of use (or misuse), and quality of preventive maintenance will determine how quickly motor parts degrade. Higher temperatures shorten motor life. For every 10°C rise in operating temperature, the insulation life is reduced by half. This can mislead one to think that purchasing new motors with higher insulation temperature ratings will significantly increase motor life. This is not always true, because new motors designed with higher insulation thermal ratings may actually operate at higher internal temperatures (as permitted by the higher thermal rating). Increasing the thermal rating during rewinding, for example, from Class B (130°C) to Class H (180°C), does increase the winding life.

The best safeguard against thermal damage is to mitigate conditions that contribute to overheating. These include dirt, under and overvoltage, voltage unbalance, harmonics, high ambient temperature, poor ventilation, and overload operation (even within the service factor).

Suggested Actions

- Evaluate and select a motor repair service center. Ask the service center to conduct a root cause failure analysis and confirm proper repair. A competent motor service center can often pinpoint failure modes and indicate optional features or rebuild methods to strengthen new and rewound motors against critical stresses.
- Follow motor manufacturers' recommendations and user guides to protect out-of-service motors from humidity, vibration, and corrosion exposure.
- Establish and follow a good predictive and preventive maintenance program.

Bearing failures account for nearly two-thirds of all motor failures.[1] If not detected in time, the failing bearing can cause overheating and damage insulation, or can fail drastically and do irreparable mechanical damage to the motor. Vibration trending and thermal scanning can be used to detect bearing problems and allow intervention before such damage occurs.

A bearing L_{10} is defined by International Organization for Standardization (ISO) and American Bearing Manufacturers Association (ABMA) standards as the life that 90% of a sufficiently large group of apparently identical bearings can be expected to reach or exceed. The median or average life, sometimes called mean time between failure, is about five times the calculated basic rating life.[2] With bearings often implicated in motor failures, the L_{10h} rating of a bearing may be cause for concern. For fixed operating conditions, a longer L_{10h} rating implies a longer bearing life. The bearing service life under actual operating conditions is affected by excessive lubricant use, incorrect lubrication interval, contaminated lubricant, use of an incorrect lubricant, excessive vibration, misaligned couplings, or excessive belt tension. Power quality problems and electronic adjustable speed drive–induced bearing currents also may result in premature bearing failure (see Motor Systems Tip Sheet #15, *Minimize Adverse Motor and Adjustable Speed Drive Interactions*).

Ensure that motors are not exposed to loading or operating conditions in excess of limitations defined in manufacturer specifications and National Electrical Manufacturers Association (NEMA) standard MG1. This NEMA standard defines limits for ambient temperature, voltage variation, voltage unbalance, and frequency of starts.

References

[1]Bonnett, Austin H. and Chuck Yung. “A Construction, Performance and Reliability Comparison for Pre-EPAct, EPAct and Premium-Efficient Motors.” Institute of Electrical and Electronics Engineers Paper No. PCIC-2006-7.

[2]Snyder, Daniel R. Snyder. “The Meaning of Bearing Life” *Machine Design,* April 12, 2012.

Resources

National Electrical Manufacturers Association (NEMA)—For information on NEMA Premium™ standards, visit *www.nema.org*.

Electrical Apparatus Service Association (EASA)—Provides guidelines on motor repair/rewind practices at *www.easa.com*.

Motor Decisions Matter—Download a motor management planning kit at *www.motorsmatter.org* that contains advice on building your in-plant motor inventory, decision rules, critical planning tips, and motor replacement.

U.S. Department of Energy (DOE)—For more information on motor and motor-driven system efficiency and to download the MotorMaster+ software tool, visit the Advanced Manufacturing Office (AMO) website at *manufacturing.energy.gov.*

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