Extending the lifespan of motor-driven systems

Key considerations in the maintenance and repair of electric motors

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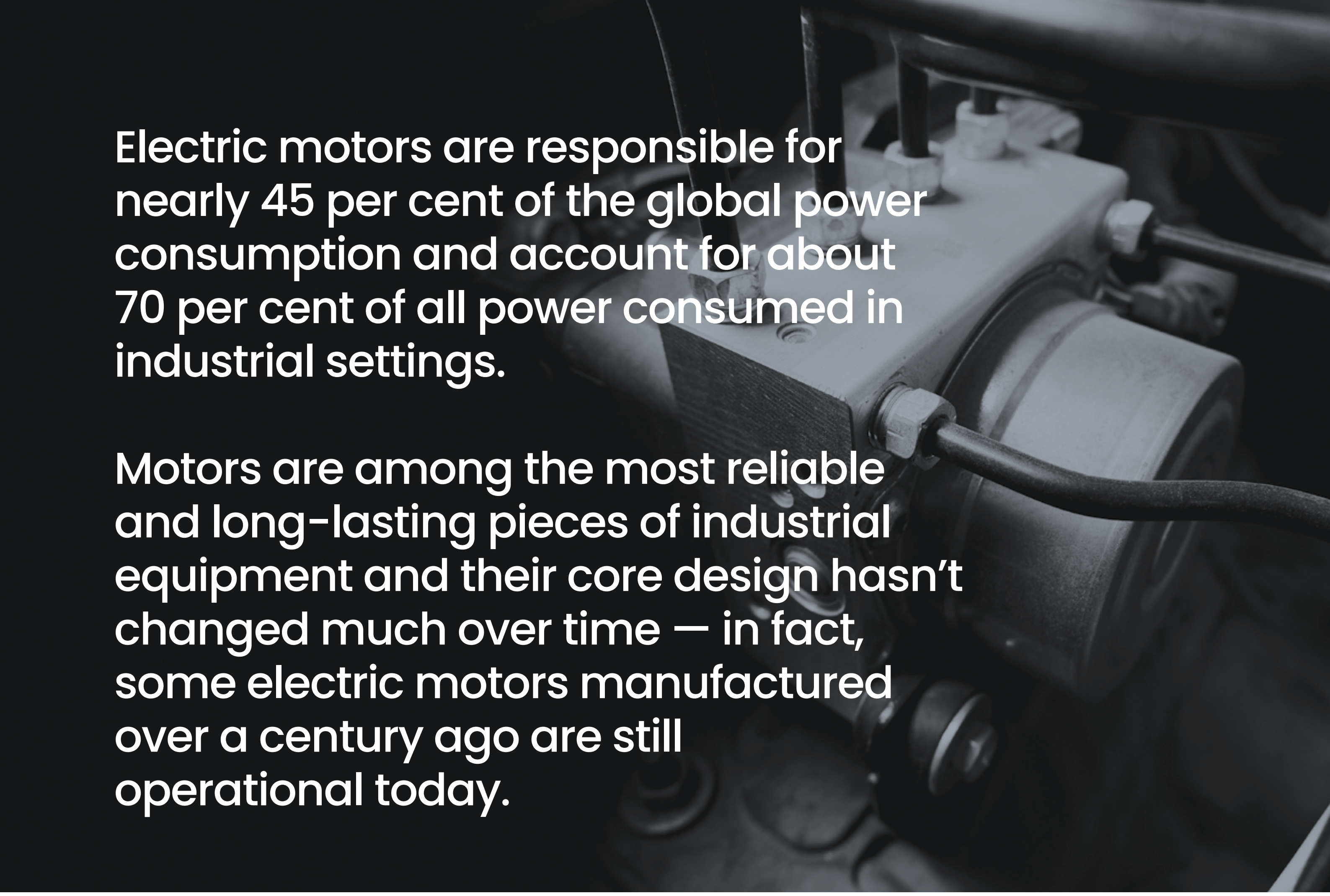


Electric motors are responsible for nearly 45 per cent of the global power consumption and account for about 70 per cent of all power consumed in industrial settings.

Motors are among the most reliable and long-lasting pieces of industrial equipment and their core design hasn’t changed much over time — in fact, some electric motors manufactured over a century ago are still operational today.

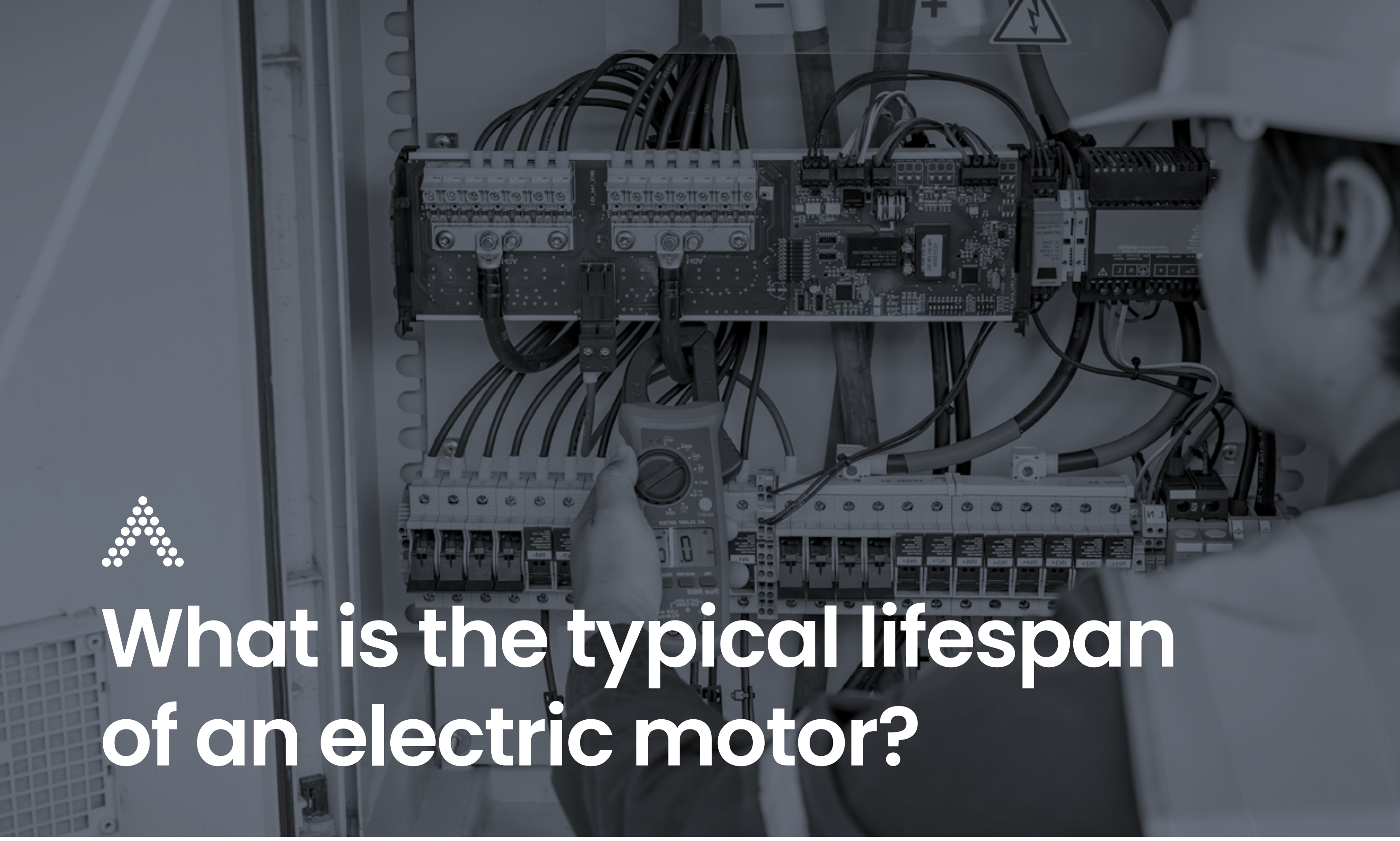
However, electric motors need careful maintenance to reliably operate for the whole duration of their intended lifespan. The factors that impact their functionality don’t normally lead to immediate catastrophic failure, but work by progressively damaging the motor’s insulation to the point of no return.

Since damage is usually gradual, there might be hard-to-spot issues that lead to a motor’s slow demise. But, with an appropriate testing and maintenance regime, these factors can be detected and counteracted.

In these cases, if the motor can't be repaired or replaced quickly, downtime is inevitable. Motor-driven systems are usually at the core of critical factory applications, so when motors fail, stoppages can lead to a dangerous domino effect that impacts the profitability of the whole plant.

Motor-driven systems encompass a wide variety of electro mechanical assets, such as fans, pumps, gearboxes and more. However, electric motors sit at the heart of it all, which is why this guide focuses on how to extend their active lifespan.

We will cover how long electric motors typically last, what can be done to extend their healthy lifespan, and what to consider when faced with the decision of undertaking extensive repairs or purchasing a new model.

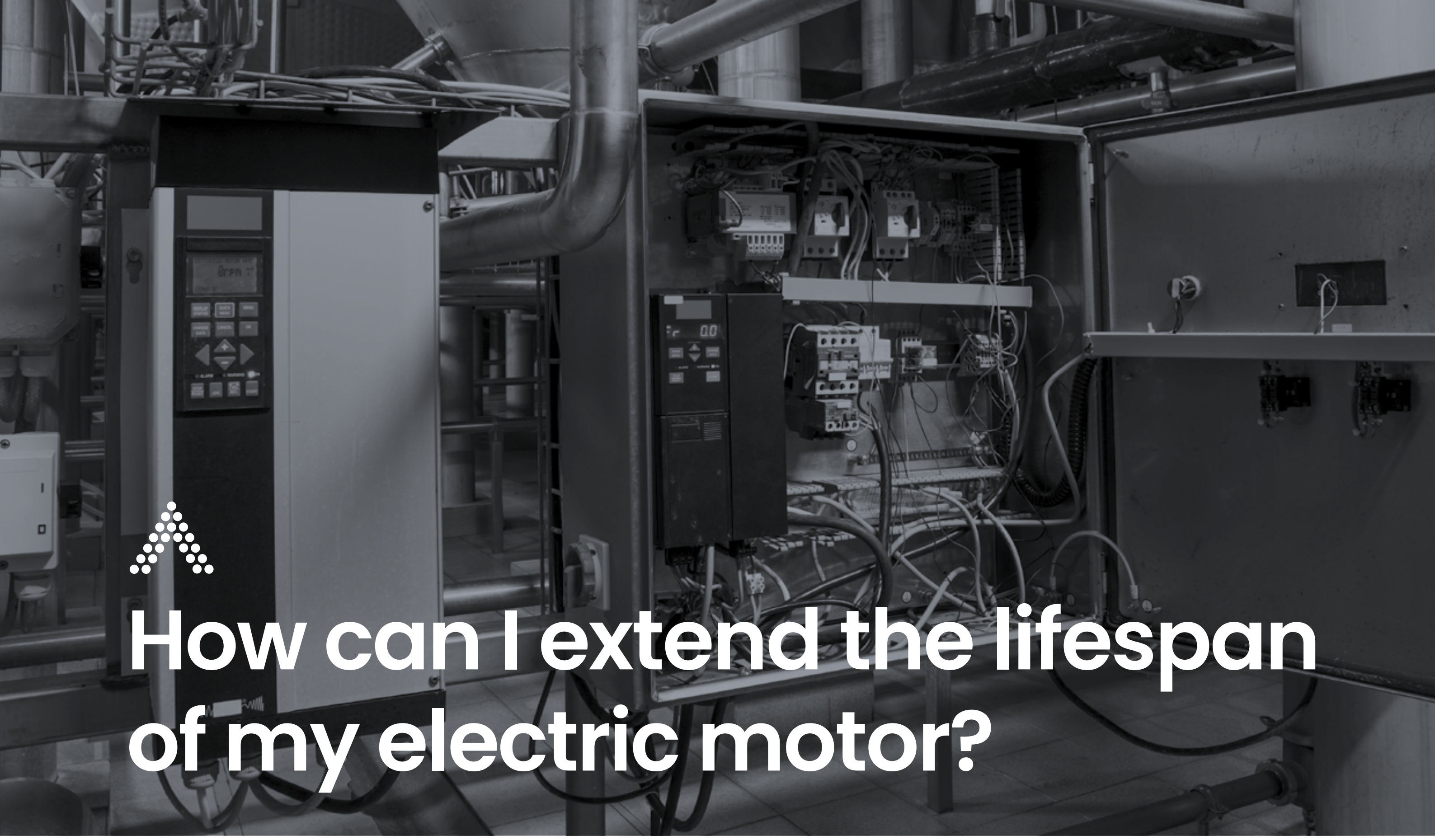


What is the typical lifespan of an electric motor?

The active lifespan of electric motors widely varies depending on several parameters, such as the motor's size and application, the environment in which it operates, and the quality and frequency of maintenance.

That said, 30,000 to 40,000 hours of active lifespan is generally considered the average, meaning that if properly maintained, electric motors can reliably operate for several decades.

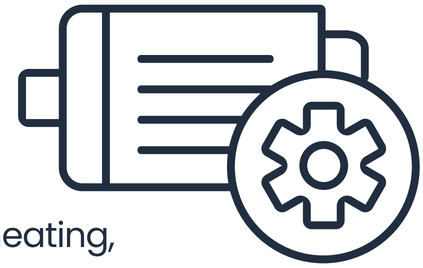
This timeframe can drastically decrease in harsh environments with extreme temperatures or corrosive, abrasive or electrically conductive contaminants, such as in foundries or offshore applications. In these cases, the Institute of Electric and Electronics Engineers (IEEE) recommends purchasing heavy duty motors that conform to the IEEE-841 standard to ensure a longer active life.



How can I extend the lifespan of my electric motor?

The progressive degradation of electric motors is inevitable, but its consequences can be mitigated with a proactive testing and maintenance regime.

There are several factors that typically impact a motor's lifespan and contribute to premature failure. Let's see the most common ones and how they can be effectively managed.



Bearings

According to the US Department of Energy, bearing failures account for nearly two-thirds of all motor failures. This is because failed bearings will lead to overheating, as well as contributing to insulation and mechanical damage.

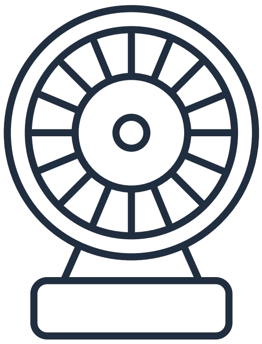
Vibration analysis and thermal scanning are two preventive maintenance strategies that can help detect bearing problems, allowing assets managers to replace failed bearings before they cause irreparable damage.

To have a more precise idea of how long bearings will last, it is possible to calculate their L10, which is a unit of measure for bearings' active life. You will need to know the bearing dynamic capacity, imposed radial load and speed in RPM. If this is too complex or you don't have all the necessary information, many bearing manufacturers provide handy online calculators to help users predict when bearings will reach the end of their fatigue life.

Temperature

Exposure to temperatures higher than the motor can withstand, even for a short period of time, can irreparably compromise a motor's functionality. The US Department of Energy confirms that for every 10° rise in operating temperature, the lifespan of the motor's insulation is reduced by half. The Department also warns that buying motors with higher insulation temperature ratings is not always a fix, because these motors will often operate at higher internal temperatures.

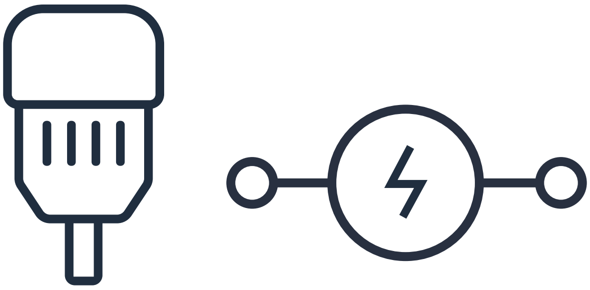
Instead, manufacturers should try and mitigate factors that contribute to overheating, such as incorrect or intermittent power supply, excessive workload, poor ventilation, broken enclosures, high ambient temperatures and overload. It's also important to choose motors that are compatible with the intended use — for example, motors designed for intermittent use will fail prematurely if not allowed to cool down between uses.



Alignment

Incorrect shaft alignment causes excessive radial and axial vibration, which leads to premature components wear if not addressed in a timely manner. Consider that motors that have been recently installed are especially prone to misalignment due to foundation settling.

Flexible couplings can compensate for some level of misalignment, but the Advanced Manufacturing Office of the US Department of Energy warns that it's a mistake to over-rely on them, because flexing of the coupling and shaft will exert forces on the motor that might lead to cracking.



Load

Voltage should be kept as close to the nameplate value as possible — the US Department of Energy recommends a maximum deviation of five per cent. Motors can generally withstand a 10 per cent difference, but this will have an impact on their efficiency and longevity.

For example, when operating at less than 95 per cent of their designated voltage, motors typically lose two to four efficiency points and their operating temperature increases by more than 10°, threatening insulation integrity.

Purchasing motors that are the right size for the application they power is critical to maintain efficiency and extend assets' lifespan. A motor that is too small will soon wear itself down as it tries to keep up with the application's requirements. A slightly oversized motor can help in case more capacity is needed in the future, but assets managers should avoid going too large, since efficiency returns won't compensate for the initial price of a large motor.

Power issues

Excessive or inconsistent power supply can also negatively impact a motor's lifespan. For example, harmonic currents caused by pulse width modulation can deteriorate the windings' insulation. The same can happen with transient voltages, which are harder to spot because they occur infrequently and for very short intervals.

Imbalances in voltage distribution can also damage insulation, since the excess of current flow in one or more phases can cause overheating. This will damage the phase circuits and ultimately cause winding failure.

Are complex repairs worth it?

Small routine repairs like seals and bearing replacements can go a long way in ensuring a motor's reliability and are therefore a no brainer for assets managers. However, when larger repairs are needed, making a decision on whether to repair or replace the motor can be more difficult. This is the case, for example, for rewinding work that requires the custom-manufacturing of coils, or when obsolete components need to be reverse engineered.

Assets managers often rely on the so-called 50 per cent rule — if the cost of repairs exceeds 50 per cent of the total cost of replacing a motor, it's best to replace. However, things aren't always so easy and the initial cost of repair versus replacement is not the only factor to consider.

For example, the lead times for rewinding high voltage motors are often shorter than he procurement time for a new unit. This means that by choosing to repair their existing machine, plant managers might avoid many hours of costly downtime.

Repairing existing assets also ensures that there will be no need to adapt the facility and processes to accommodate the new motor, meaning that integration costs are avoided. This is especially important with legacy and obsolete motors. In these cases, the exact same model may no longer be available on the market and an upgraded version might require changes to the production environment that further extend downtime.

With the rising cost of energy, plant managers might also be concerned about efficiency. There is a misconception that motors that have had extensive repairs will lose their original efficiency, which might lead assets managers to invest in a new model to reduce the total cost of ownership (TCO). However, this idea has been disproved by a four-year study by the Electrical Apparatus Service Association (EASA) in collaboration with the Association of Electric and Mechanical Trades (AEMT). The study found that, if motors are rewound using good practice procedures, their efficiency is not only maintained but can actually be enhanced.

For example, the study revealed that the I2R loss, the largest efficiency loss for most motors, can be reduced by hand-inserting winding during repairs. This could improve heat transfer, reduce winding temperature and enhance efficiency. However, when motors are rewound to a high standard, their performance is often slightly improved even without specific modifications.

Repairs can also offer the chance to update a motor's conformity to the latest environmental guidelines. For example, the technician in charge of rewinding could optimise the motor for a specific voltage, increasing efficiency while ensuring regulatory compliance.

These modifications improve a motor's performance and extend its lifespan, but they also help minimise its mean time between failures (MTBF) and therefore its TCO.

When we consider all these variables — lead times, integration costs, efficiency and the possibility for upgrades during repairs — it's easy to see the shortcomings of the 50 per cent rule. The decision of upgrading to a new electric motor should be a conscious one, based on a precise business strategy and not on the panic that follows an unexpected failure.

That said, motors sometimes experience irreparable damage, either as a consequence of natural aging or because of improper use or insufficient maintenance. When replacements are inevitable, the best solution is to partner with a trustworthy supplier, like EU Automation, who can source a huge range of quality motors from all major manufacturers, including Siemens, Schneider, Omron, Fanuc and more.

Conclusion

Electric motors are the workhorse of manufacturing and their resilience means they can easily last for decades. However, their condition should be proactively monitored with a thorough predictive maintenance strategy. If a factory runs its motors to failure, its primary concern will be how to replace them quickly. This means that assets managers might be rushed into making a decision and might not be in a position to assess their best options.

Evaluating the condition of all motors in a facility and developing a replacement plan for legacy, inefficient or incorrectly-sized ones is the best way to make an informed decision, in line with the plant's real needs and growth objectives.

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