Protect your machinery by monitoring motor loads

Technologies such as overload devices, and motor management and control systems, can protect motors effectively, but may not safeguard the machinery that they are driving. Amir Sami, business development manager at Charter Controls, looks at how to prevent costly damage and downtime to machinery by monitoring the power consumed by the motor.

There are a variety of issues that can cause inefficiencies and defects in production processes. Equipment failures, set-ups and adjustments, idling, minor stops, running at reduced speeds, and process defects can all affect yield and increase costs. One way to avoid such issues is to protect motor-driven machines effectively.

These machines are often critical components in manufacturing processes and can be expensive to replace if they fail. It is essential to take steps to protect them against damage. There are several ways to do this, including installing overload protection devices, ensuring effective lubrication and maintenance, and monitoring the machines for signs of wear or damage.

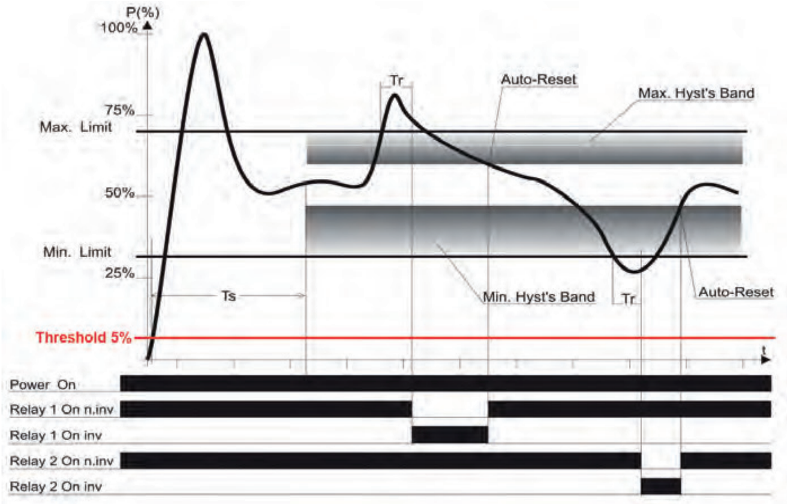
By taking such precautions, manufacturers can help to ensure the reliability and longevity of their equipment and to minimise the risks of process defects and reduced yields.

Continuing to operate motor-driven machines during abnormal conditions caused by jams or blockages can cause irreparable damage, not only to the motor but also to the machinery. In the past, the extent of damage to machines has been understated compared to the damage to the motor. Overload systems, and motor management and control devices, can protect motors, but what is protecting the machine itself?

In pump installations for example, when there's suction loss or a jam long before the thermal overloads trip, serious damage can be done to the machine as well as the motor. Any abnormal operating conditions can have a detrimental effect on the life of the system. Dry pump, dead head, jammed impellers and even premature bearing wear can all lead to motor and pump failures.

To cut upfront costs, motor-driven systems are often installed without any means to monitor their operation. As a result, frequent inspections of the motor and the machine are necessary.

If an unexpected failure occurs, it can mean irreparable damage to a machine and possibly its motor. But such issues can be eliminated by using simple, but effective, monitoring and control techniques. Adding a small cost to the installation will pay for itself several times over the first time a fault is detected and damage to the machine or motor is avoided.



By measuring when power exceeds a 5% threshold, a start-up surge timer can be used to mask when a motor's start in-rush current begins. Unipower's HPL500 digital power monitor is triggered in this way, rather than by power on, and can be connected before or after the motor contactor. The graph shows the protection logic.

Digital load monitors with an analogue load transducer. Such devices can help to protect motor-driven machinery from damage.

Imbalances

To analyse a motor's health, you need to consider all aspects that can affect it under normal operational conditions. Incoming power quality is one area that is often overlooked – correct, safe operation of motors depends on the power conditions. As voltage levels vary during the day there can be imbalances. Raising voltage levels to reduce the current and achieve a motor's nameplate ratings can cause excessive heat, degrading the insulation. Harmonic distortion also affects the power quality, much of which is caused by variable-speed drives (VSDs) and other nearby installations that go undetected most of the time.

Typically, a motor will draw six to ten times its rated current levels during start-up. Hot starts are more detrimental to the windings, because the excessive heat can degrade the insulation. If you examine the voltage, current and torque levels when a motor starts, you can see the levels of stress it is experiencing. As a result, motors often fail during start-ups.

When loads and power conditions are fluctuating – typically at start-up – rotors can experience tremendous stresses. Monitoring these conditions is vital to determining the motor's ability to continue operating. Cracked or broken rotor bars can cause dramatic increases in thermal stress, affecting efficiency.

Parameters that can help to deduce a motor's health include its load, % load, horsepower demand, kilowatt usage, and power factor. If motors are forced to meet load demands above their capacity, their windings can run at unsafe temperatures, even if the current is at nameplate values. A motor running above its nameplate power rating can also suffer from higher torque demands, putting stress on the rotor.

Motors are often oversized and sometimes undersized: both of these have cost implications. Oversized motors can result in higher initial costs, energy consumption and repair costs. Undersized motors perform poorly, suffer from higher losses, and can fail prematurely. Some of these problems can be detected and corrected quickly by using digital motor load monitors (see right). ■

Measure power, not current

Digital load monitors measure the load on the motor electronically. They can replace mechanical forms of protection such as friction clutches, ball detent clutches, shear pins and tacho controllers.

The motor acts as a sensor to detect the state of the equipment being driven. The main aim is to protect the machine from damage, but it can also protect the motor. In abnormal running conditions, load monitors can measure the load being drawn by a motor and compare it to normal values.

The most common use for such monitors is to detect when a pump is running dry. Many pumps cannot be allowed to dry-run, especially if they are pumping hazardous chemicals. In the water industry, dry running and dead heading due to a shut discharge can also result in abnormal motor loads.

Many monitors operate by measuring currents. But this can be a problem if the motor is oversized. In such cases, the motor will never reach its rated load because it is too big for the job and will operate where current is a flat line. Current cannot therefore be measured to assess variations in the work done by the motor.

Phase angle detection used to be one way to get around this, but with advances in technology and the higher efficiency of newer motors, this technique is no longer a reliable way of measuring the work done by the motor.

The only electrical measurement of work that is linear with and proportional to load is power. Power consumption to be used to measure torque indirectly. This measurement needs to be fast and accurate, reaction times must be short, and measurements must be valid for non-sine-shaped currents – for example from frequency inverters generating high, short current peaks (with crest factors of up to 10).

One manufacturer offering digital load monitors capable of calculating power in this way is the Danish company Unipower, whose monitors have been used in motor-driven applications for more than 20 years. They are available in the UK from Unipower UK, trading as Charter Controls.