Is Pump Failure Optional?

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Comparing the effectiveness of different monitoring systems in protecting pumps.

Hundreds of millions of dollars are spent every year repairing and replacing pumps well before they have reached their design life. The meantime between failures (MTBF) for this equipment is abysmal when compared against more complex production machinery!

Along with the cost of repair and replacement parts comes the cost of production downtime. For many users who operate with lean maintenance staffs, the efforts required to reduce downtime, increase productivity and minimize maintenance costs present real challenges. However, simple, inexpensive and proven technology exists that can prevent pump failure.

The majority of pump failures do not occur because the pump was designed or manufactured poorly, but because of abuse during operation. Typical examples would be dry running, dead heading and cavitation. Despite the plant engineer's best efforts to avoid these events, they still occur.

Pump monitoring systems that do not always live up to their respective manufacturer's claims can leave users with either inconsistent performance or nuisance trips if the wrong technology is chosen. Typical technologies utilized for pump protection include:

- Current (amp) monitors
- Temperature sensors (often deployed on progressive cavity pumps)
- Flow monitors
- Power monitors
- Shaft power monitors

Of all these technologies, *current monitors* are by far the least effective solution for pump protection. Given the fact that approximately 80 percent of all abnormal conditions on centrifugal pumps relate to underload conditions, for the current monitor to be effective it is required to detect a drop in amps.

A fact not often discussed by the manufacturers of these devices is that the amperage drawn on an AC induction motor is flat (unchanging) until there is approximately 65 percent or greater load on the pump (see Figure 1). In other words, if the pump motor has 65 percent or less load applied to it under normal pumping conditions, the monitored current will change very little (if at all), when the pump runs dry or is dead headed.

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Temperature monitors are most commonly used on progressive cavity type pumps to sense dry run conditions. As a progressive cavity pump runs dry, friction builds up between the pump's rubber stator and its metallic rotor, causing a rise in temperature. As the pump continues to run dry, the temperature sensor should detect the heat buildup and shut off the pump before it is destroyed.

This is a good concept in theory, but the actual results are unfortunately not always as effective as one might think.

Many users of temperature sensors know that by the time the sensor reacts to the heat buildup, it is often too late and the pump stator is already destroyed. Also, temperature sensors do not protect against deadhead or cavitation conditions. Installation is expensive, and as mentioned above, they are primarily limited to progressive cavity type pumps.

While *flow monitors* provide users with valuable process data, their deployment purely as a pump protection device is an expensive decision. The majority of flow sensors are intrusive devices that will wear out and need to be replaced.

A far more effective solution, in terms of technology as well as cost, is a *power monitor*. Unlike current monitors, it tracks power changes with a linear profile from zero to full motor load. Installation in the motor starter panel is inexpensive and typically takes just 30 minutes. These monitors are reliable in detecting both overload and underload conditions and, unlike the current monitor, are immune to plant voltage variations.

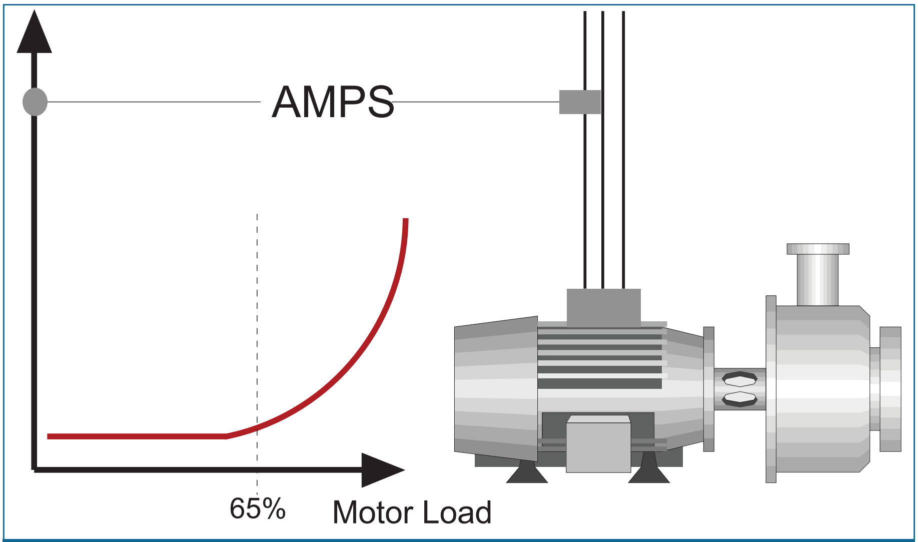

Figure 1. Motor Current vs. Load

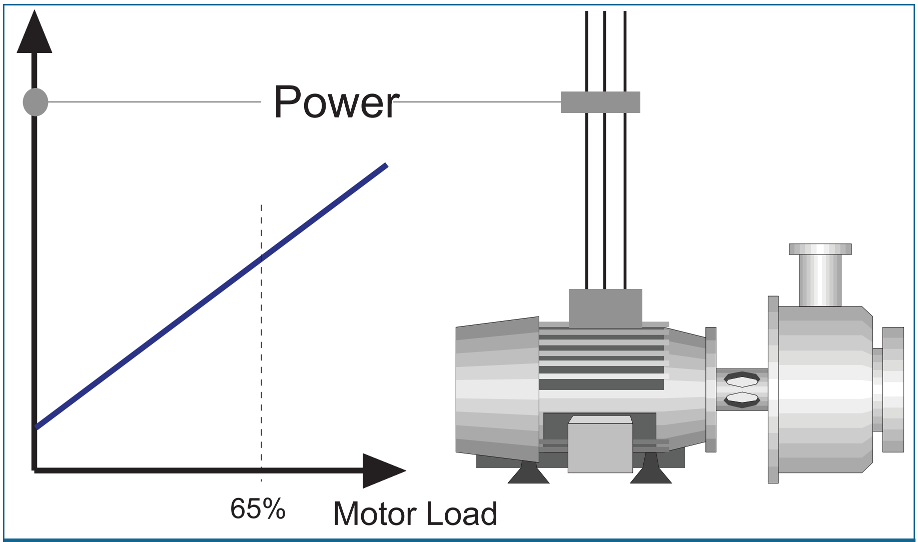

Figure 2. Motor Power vs. Load

The optimum solution in terms of the technology/cost ratio is the *shaft power monitor*. This technology takes power monitoring to the next level, improving accuracy and reliability by subtracting the motor's inefficiencies. These losses – caused by bearing friction, fan windage, eddy current and magnetic losses – can be 10 percent to 15 percent of the input power.

Subtracting these losses out of the equation results in a calculation of the motor's shaft power (or BHP). A byproduct of this calculation is that the engineer can apply this value directly to the pump curve to determine where it is operating.

The newest shaft power monitors have up to four levels of protection (two for overload and two for underload), as well as features that allow the user to establish protection by pushing one key for just three seconds. Some of these units are small enough to be easily installed within most electrical panels and are available to monitor single- and three-phase pumps, from fractional through 800-hp, including medium voltage (2300 / 4160).

Even though pump abuse may inevitably continue, rest assured there are reliable, inexpensive and easy-to-install solutions that will prevent expensive damage and downtime.

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