Written by Allen Patterson, Flanders Electric Motor Service
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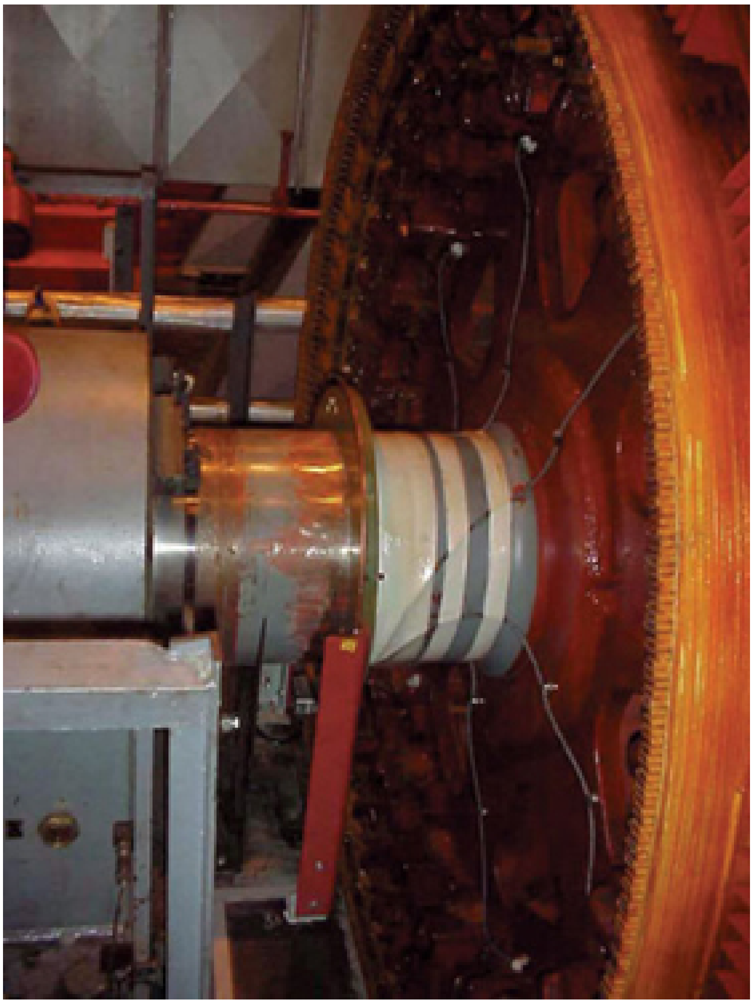

The system consists of three physical elements: the rotor collar—a split ring clamped around the motor output shaft, a copper pickup loop surrounding the rotor collar, and a receiver unit.

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here is a scene in the movie “Hunt for Red October” to which maintenance personnel can relate. In it, the skipper of a Russian attack submarine tells his Executive Officer: “Inquire of engineering whether it is possible to go to 105 percent on the reactor.” A few moments later, the visibly shaken Executive Officer reports, “Engineering says 105 percent is possible but not advisable.”

Sound familiar? It should; throughout industry, those in charge of corporate finances are pushing harder than ever to squeeze every last erg of performance from the money they have invested in equipment. That translates to pushing the equipment harder. In the world of large dc motors, the desire to “do more with what we’ve got” can have disastrous consequences including unplanned outages and expensive repair bills.

Not long ago, a metals-producing company had a 6000 hp dc motor on a rolling mill, and wanted to know if it could “over-load” the motor to get more work out of it. Our answer was guarded: “Maybe, provided you don’t overheat the armature and thermally fail the insulation.”

Monitor armature temperature

In deciding if over-loading is feasible, you need to monitor the temperature of the armature conductor. That is where the greatest current density is, about 4500 A/sq in. The key to monitoring the temperature of the armature conductor is to find a way to transmit the data from the resistance temperature detectors (RTDs) over the air gap from the rotating armature to a stationary receiver.

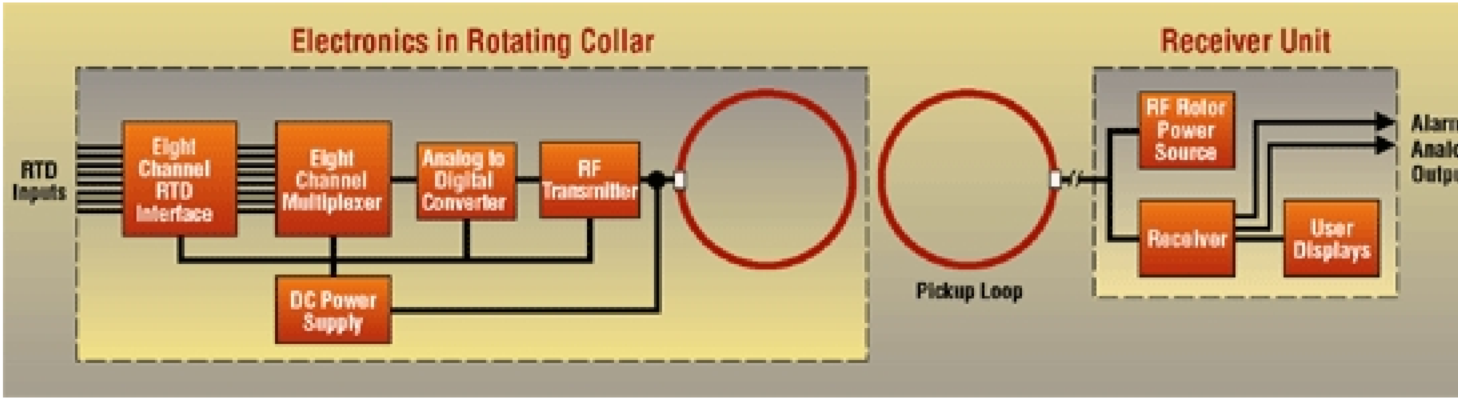
Some people think they can get information about the temperature of the armature indirectly by putting RTDs on the motor frame. This does not work very well because the frame tends to be thermally insulated from the armature, and the current density on the stator is typically much lower than on the armature. We have seen several examples of armatures that have been “cooked” with no warning from the RTDs on the frame. The bottom line: if you want to do health monitoring on an armature, you have to get the data direct.

In addition, it is not good enough to simply do spot checks on a motor. If something goes wrong, it does not take long for the insulation to thermally fail. All it takes is a blockage of air flow to cause an expensive repair. For dc motors of 1000 hp and more, a rebuild can range from $100,000 to $800,000, and a new motor can cost from $250,000 to $2 million. So if the motor is running continuously, there are serious economic reasons for continuous monitoring of the armature temperature, particularly if you are running at or near the recommended limits of the motor.

One system for getting data safely and accurately from the RTDs on the armature to a stationary receiver is the Motor Monitor from Accumetrics Associates, Schenectady, NY. It allows continuous monitoring of up to eight temperature sensors on the armature windings of dc industrial drive motors. The temperature data is transmitted off the rotor by digital wireless means to a stationary receiver that displays the temperature and alerts operators if preset limits are exceeded.

Avoid data contamination

We suggested to the rolling mill that the prudent course would be to instrument the armature and use the Motor Monitor to continuously keep an eye on the temperature. It is a maintenance-free device that can withstand corrosive environments, important in a rolling mill. In addition, because it uses digital telemetry to transmit data, the device is immune to the data contamination that could be caused by the high levels of electrical noise and magnetic fields found in the mill.



BLOCK DIAGRAM OF MOTOR MONITOR: Fig. 1. The monitor employs a digital telemetry technique to insure high data accuracy and noise immunity. Fig. 1 presents a block diagram of the Motor Monitor. Unlike other techniques that have been used in the past to get sensor signals off the rotor, the monitor does not use sliprings and does not rely on older wireless techniques such as analog FM telemetry. The system consists of three physical elements: a rotor collar, a pickup loop, and a receiver unit.

The rotor collar is a split ring customized to clamp around the motor's 18-in. diameter output shaft. The collar is made from a high-strength epoxy glass composite and contains electronics that accept inputs from RTD sensors mounted on the armature windings.

The pickup loop is rigid copper mounted on the motor housing so that it surrounds the rotor collar with about a 3/8 in. gap. A fine wire is embedded in the outside of the collar on the rotor. The pickup loop works in conjunction with this embedded wire to form a rotary transformer, allowing transfer of signals between the rotor and stator. A radio frequency power signal, generated in the receiver unit, is transferred across this transformer to the rotor where it is rectified to provide dc power for the electronics mounted on the rotor.

The telemetry system provides 2 mA constant dc excitation to the eight RTD inputs (the armature actually had only six RTDs so fixed resistors across the two unused inputs provided a means to verify the accuracy of the system). The voltage measured across each of these sensor inputs provides an indication of temperature. The eight input voltages are multiplexed, amplified, and digitized by the rotor electronics. The resulting digital data stream is modulated on an RF carrier and transferred off the rotor through the same transformer windings that transfer the power. The transfer of data through these inductive coils provides a secure data transfer that is not subject to interference from other radio sources that might exist in the environment.

The data is recovered in the receiver and is displayed in degrees C on the front panel of the control cabinet that contains the receiver unit. Alarm and trip temperatures are preset for each RTD and relay outputs are provided to the rolling mill users.

Results were clear

The Motor Monitor was set up on the 6000 hp motor and the temperature was watched carefully as the current was varied. The results of the test were clear: increasing the current by 10 percent was extremely likely to cause the motor to fail very quickly. The rolling mill was left to decide whether the revenue from increased production would offset the cost of an annual motor rebuild.

The system now continuously monitors the temperature of the armature, giving the rolling mill operators a valuable tool for monitoring the health of their motors. Maintenance personnel have bottom-line-oriented information to present to their finance people. That Russian submarine Captain would be envious of hard data like that.

We have reached the inescapable conclusion that all large dc and ac motors should be monitored continuously for rotor temperatures. When warranted, a Motor Monitor also may be configured to provide monitoring of strain, load, pressure, acceleration, and vibration. It seems a good bargain: the cost of a system to provide continuous health monitoring on a large electric motor is a tiny fraction of the capital investment that is at risk. **MT**

Information supplied by Allen Patterson, electrical engineer at Flanders Electric Motor Service, 10334 Hedden Rd., Evansville, IN 47711; (812) 867-4014. For more information about motor monitoring and rotor telemetry, contact John Reschovsky at Accumetrics Associates,

Schenectady, NY; (518) 393-2200.