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TECHNOLOGY TIPSHEET

9 Critical Points

for Specifying a Heavy-Duty Encoder

BY MARK LANGILLE

An emerging class of rugged optical encoders made for harsh-duty environments creates a new option for engineers specifying devices for applications once dominated by magneto-resistive encoders.

In a rolling mill or process line, where the demand for productivity is continually increasing, plant engineers are turning their attention to the quality of motion control. If they can achieve a finer degree of control over motors and machine movement, then automated equipment can run faster and with less wear. One critical component of a motion control system is a feedback loop that tells the controller what actually is happening. How fast is a motor turning? How many revolutions has a shaft turned? Usually the feedback is supplied by an encoder: a sensor that converts rotary movement into a stream of electronic pulses.

Danaher's harsh-duty optical encoder has dual outputs to maximize uptime. If one connection is broken, the operation can continue without interruption.

Beyond shaft size and pulses per revolution (PPR), there are a lot of considerations to specifying an encoder for a steel mill or metal processing operation. Grease, dust, metal shavings, vibration, and mechanical shock are the norm, and here there is no room for sissies — choosing the right encoder has a direct impact on the uptime of your operation and plant profitability.

In the past, engineers would simply choose the biggest, 'baddest' encoder they could find. But advances in encoder design mean that there is more to think about. There is an emerging class of rugged optical encoders made for harsh-duty environments, offering a new option for engineers specifying encoders in places where magneto-resistive encoders used to reign supreme.

Whether you're looking at one of the new, optical encoders, or a standard, magneto-resistive encoder, there are nine critical points to address when specifying a heavy-duty encoder. Address all nine and you will be assured of a reliable application.

1. Washdown. Dirt and grease have consequences for equipment and worker safety, which is why equipment may receive an occasional scrubbing using water or even a pressure washer. Rugged optical encoders are now available that are washdown safe (rated IP67). Magneto-resistive encoders aren't rated for washdown, but don't need to be: because they use magnets rather than an optical disk, their operation is unaffected by water.

While seals are not terribly important on magneto-resistive encoders (some models don't even use bearings), good seals are crucial on harsh-duty optical encoders. The most secure is a double labyrinth seal because it provides two chambers of protection.

This compartmentalizes any difference in pressure, so that the inner seal is protected from extreme pressure outside the encoder, such as high-pressure washdown.

2. Housing. The traditional material for heavy-duty encoders is cast iron, with optional brass or stainless steel housings for washdown applications. Here, "heavy" is used advisedly, as some magneto-resistive models tip the scales at up to 30 pounds. Yet bigger is not always better. Smaller encoders that are reasonably rugged have emerged only recently and offer aluminum, electroless nickel-plated, and stainless housing options.

3. Resolution. Of course, the resolution needed for an encoder depends on the application. For example, an encoder used in a gantry hoist will require greater resolution than one used to generate tachometer signals in a roller table. For PPR higher than 2,048, an optical encoder may be your only choice. Magneto-resistive encoders use magnetized teeth that have a physical limit to how closely they can be spaced, and therefore they are best used in applications requiring moderate resolution and a limited range of shaft speed.

4. Pulses per revolution. When specifying the PPR of an encoder, keep a few simple rules in mind.

Try to choose a PPR that is close to the value you wish to display, because this eliminates or reduces the need for a calibration constant. For example, if you wish to display 12 inches for every revolution, then choose a PPR of 12. If you wish to display 12.00 inches, choose 1,200 PPR.

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However, don't forget the multiplication of the controller's input. Most controllers have X2 or X4 logic. If it is X2 logic, this will change your PPR to 600 for a 12.00 display; and the PPR would be 300 for X4 logic.

Don't choose a PPR that will cause you to exceed the maximum frequency of your controller or encoder, and don't choose one so low that your controller cannot recognize the signal.

5. Mounting. There are many ways to mount encoders in heavy-duty applications. If your application is measuring the speed or rotation of a large horsepower motor, then there are magneto-resistive encoders made to mount on the motor face. Although large enough to accommodate large shaft diameters, some of these encoders are less than two inches in profile and so well integrated to the motor after installation that they permit users to mount a second device, such as a sensor or brake, outboard of the encoder. They also fit easily into cranes, hoists, and gantries. On the other hand, harsh-duty optical encoders are more compact and fit more easily into complex machinery.

Bigger is not always better. Smaller, reasonably rugged encoders are available in aluminum, electroless nickel-plated, and stainless housings.

When specifying an encoder to mount directly on a large motor, the style of encoder is determined by the mounting requirements. For the right fit, provide your supplier with the following information: the motor manufacturer, the motor frame size, whether the motor is AC or DC, whether the motor is cooling, the motor shaft size, and the required mounting (i.e., drive-end or opposite drive end.)

6. Temperature. Metal processing usually involves heat, and heat can be detrimental to the reliability of electro-mechanical components. Check the encoder spec sheet to see what is the highest temperature recommended for continual operation. A typical rating for a magneto-resistive encoder is 70° or 80° C, while the latest generation optical encoders can operate reliably in ambient temperatures up to 100° C.

7. Intrinsically Safe/Explosion Proof. If your encoder is going into an environment where explosive gas or dust may be present, then look for an encoder that carries an "intrinsically safe" or "ATEX" certification. An explosion-proof device is built such that if an explosive atmosphere gets inside the device and is somehow ignited, the resulting internal explosion will not escape the housing and ignite the surrounding atmosphere. An intrinsically safe device approaches safety from the other direction: It has so little electrical energy within it that it is incapable of creating a spark. Both optical and magneto-resistive encoders are available that meet these requirements.

8. Dual Sensors/Dual Outputs. Some encoders offer dual signal outputs — if one connection is broken, the operation can continue without interruption. Also, some encoders offer dual sensors. If one sensor fails, the other sensor is available as a backup. This allows operation to resume immediately — the failed sensor can be replaced while the motor continues operation with the backup sensor. How crucial is the application? If a failure will shut down an assembly line whose output is valued at $50,000 per hour, then the cost of a heavy-duty encoder with dual sensors and dual outputs is money well spent.

9. Absolute Feedback. There is a special type of encoder called an absolute encoder. Long popular in Europe, it is now being rapidly adopted in North America. Unlike conventional encoders, which calculate rotation from a home starting position, absolute encoders always know their position. An absolute encoder has each position of the revolution uniquely numbered. Instead of an output of pulses, the controller receives an output that is a specific value in a binary format. This is useful when exact positioning is a must. Because each location in an absolute encoder's revolution is a unique binary value, if the power should be lost, the position will be known when power is restored. This saves valuable production time because the machinery does not need to be driven to a home position upon restart. Hoists and overhead gantries in particular may benefit from the increased precision and uptime of an absolute encoder. Also, absolute encoders provide higher resolution than incremental encoders, which is beneficial for measuring speed at low rpm.

Mark Langille is a product manager at Danaher Industrial Controls in Gurnee, IL. For information, call 1-800-878-8731, or visit www.feedbackdevices.com.