METALS INDUSTRY SPEED FEEDBACK DEVICES

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Speed Sensors

The Dictionary.com definition for Tachometer:

[ta-kom-i-ter, tuh-]
any of various instruments for measuring or indicating velocity or speed

So tachometers are speed measurement devices. Their use in the metals industry goes back decades to the development of analog drive control systems.

1. Tach-Generators-State-of-the-art…..in 1950!!

For many years, the standard type of tachometer used was a Tach-Generator.

Tach-Generators are small DC rotating machines. They are coupled to the motor driving the process and used as voltage generators to measure the speed of the driving device. In legacy metals applications, the driving device would have been a DC motor.

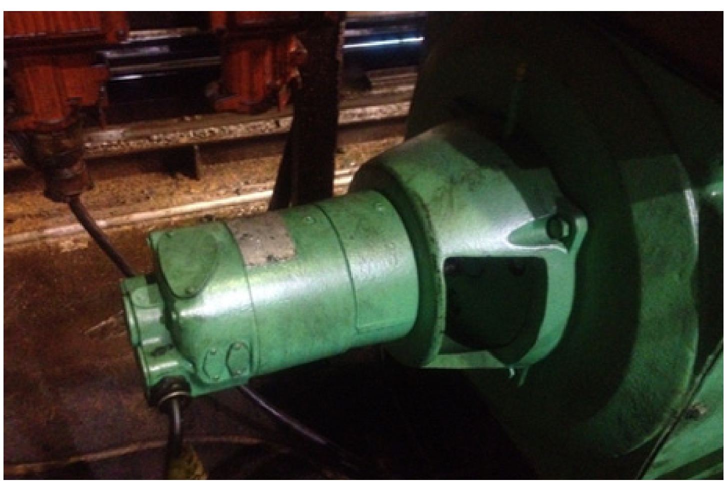

Figure 1-A General Electric BC46 Tach-Generator coupled to a DC motor

The output signal is a voltage proportional to the rotational speed (i.e. 100 volts per 1,000 RPM) which was used to provide speed feedback to the closed-loop controller driving the metals process. The controller could then very accurately control the speed of the driving motor which in turn allowed very accurate control of the metals process.

In metals applications historically, the closed-loop controller was originally a motor-generator set. Most of these systems have been replaced with the second-generation controller, the variable speed DC drive. For either system, the use of the BC46 tach-generator as speed feedback to the controller was identical.

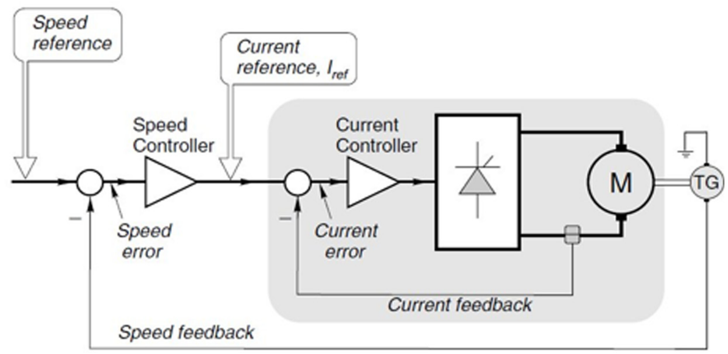

Figure 2-A BC46 Tach-Generator (TG) used for speed feedback to a DC drive controller

There were inherent problems with using an analog device as feedback to the controller. Any inaccuracy or drift inherent in the device directly translated to inaccuracy and drift in the driving motor control and a degradation of performance to the metals process. The tach-generator used brushes with a rotating commutator to generate the output voltage. This caused the output to be non-linear and to drift with changing temperature, humidity and mechanical shock/vibration. It also meant that costly periodic maintenance was required to change the brushes and clean the commutator.

2. "The Fox Shouldn't Watch the Hen-House"

By the 1970s, metals closed-loop control systems had grown in complexity and troubleshooting was becoming problematic. Because the tach-generator was integral to the control system, it was very difficult to determine if control system upsets were being caused by the tach or the drive. So any troubleshooting techniques based using the tach to measure the speed were suspect. In the words of an industry control system leader in 1970, "the fox shouldn't watch the hen-house!"

The industry saw the value in having another means of measuring speed that was OUTSIDE the closed-loop controller. It was especially desired that the measurement system not be subject to inaccuracies with environment or mechanical disturbances. At the same time, industrial electronics had progressed to the point where a DIGITAL measurement system was possible. This led to the introduction of the independent speed measurement systems based on a pulse generator input.

The pulse generator was a digital device that generated a specific number of pulses per revolution. It was used as an input to a separate, digital speed measurement system that could provide maintenance personnel with an independent method of measuring process speeds.

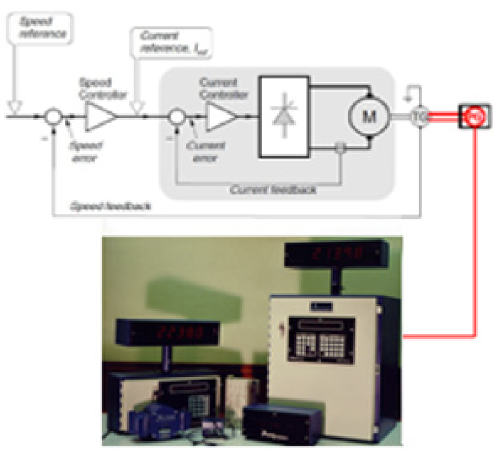

Figure 3-A Separate Speed Measurement System using a Pulse Generator

Because the pulse generator did not drift and the speed measurement system was digital, the system quickly identified performance issues with the analog tach and drive system. These issues were eventually directly correlated to changes in temperature, humidity and mechanical shock/vibration. This led to realization that the weakest performing device in the system was the analog tach-generator because it was on the mill floor and directly exposed to environment/mechanical fluctuations.

3. Brushless Tachs-State-of-the-art…..in 1980!!

A desire quickly grew to combine the digital, non-drifting performance of the measurement system into the control system to improve the system performance. This was especially true for the weakest component of the system, the feedback device. Everyone could see the pulse generator-based digital measurement was an improvement but the control system still required an analog voltage for feedback. This led to the development of the hybrid Brushless Tachometer in the late 1970s.

The Brushless Tachometer was a frequency-to-voltage converter module that accepted the frequency output of the pulse generator and converted it onto an analog voltage for the drive system feedback. It was analagous to the digital watch with analog face that was common by this time. Like the watch, the Brushless Tachometer was more accurate and did not drift with environment or mechanical fluctuations.

An added benefit was the combining of the tach-generator and pulse generator into one device, a dual-output pulse generator, which simplified the mechanical mounting, thereby improving the reliability of the installation.

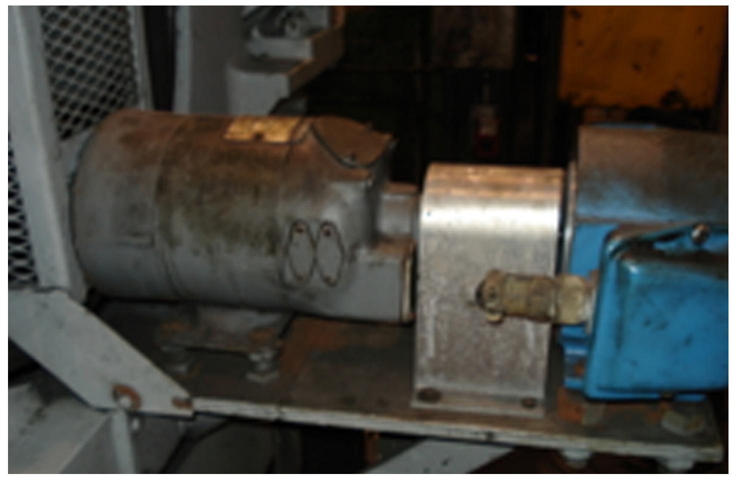

Figure 4A-Tach-Generator/Pulse Generator installation

Figure 4B-Dual Output Pulse Generator installation

Both the separate digital speed measurement system and the brushless tach were huge performance improvements and a huge industry success stories. They became the industry standard monitoring and drive feedback solutions in 1973 and lasted until the introduction of hybrid digital-analog drives in the early 1980s.

4. Drives Grow Up-Direct Encoder Feedback-Today's State-of-the-Art

When drive technology matured to the point where outer speed regulator loops were digital, the Frequency-to-Voltage Converter Module was no longer needed. These newer drives, and the next-generation fully-digital designs that followed, could accept the frequency directly from the pulse generator without the need for voltage conversion. This also began making the separate digital speed measurement system an unneeded redundancy. The elimination of both, and the associated cost-reduction, was complete by the early 1990s.

Figure 5-A State-of-the-Art Encoder Installation

The use of encoders for speed feedback for metals control systems has been the industry standard since this time. This standardization has increased the usage of pulse generators, now commonly called Incremental Encoders or just Encoders. This has allowed manufacturers to concentrate development efforts on maximizing reliability through improved mounting styles, tighter signal tolerances through sensor self-adjustment and reducing miss-diagnosis of control system upsets as encoder problems through on-board diagnostics.

For more information about this article or encoders & tachometers in general, contact:

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