Conditioning monitoring with intelligent drives in Industry 4.0

By Sydney Govender, Danfoss Drives South Africa Senior Country Sales Manager

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The fourth industrial revolution, which is also known as Industry 4.0, refers to the combination of physical assets and advanced digital technologies that communicate, analyse, and act upon information, which in turn enables organizations and consumers to be flexible and make more intelligent, responsive, data-driven decisions.

Industry 4.0 has emerged as a result of the intelligent networking of computers, people, and devices, fueled by data and machine learning, using all possibilities of digitalization across the entire value chain.

This significant change in technology has led to a whole new way of working in a digital world. It embraces the internet of things (IoT), artificial intelligence (AI), robots, drones, autonomous vehicles, 3D printing, cloud computing, and nanotechnology, to name a few.

Trends in industry 4.0 automation systems

In automation systems, the impact of Industry 4.0 on motor systems is a migration from the 'automation pyramid' to 'networked systems'. This means that the various elements of the system, such as motors, drives, sensors, and controls, are interconnected and connected to a cloud data centre, where data is stored, processed, and analysed, and decisions are made.

In an automation network, the amount of data is prominent. As data is mainly produced by sensors, the number of sensors in modern automation systems is increasing. Sensors are required to collect data from motors and motor-driven machines such as fans, pumps and conveyors, and are connected to the data network by various means to use the data.

Modern variable-speed drives open new opportunities in the Industry 4.0 automation network. Traditionally, drives have been considered power processors for controlling the motor speed. Today, drives are also part of the information chain, using the advantage of built-in processing power, storage capacity, and communication interface within the drive itself.

What is an intelligent drive?

In the Industry 4.0 network, the drive plays an important role and is characterized by some enabling features:

- **Secure connectivity:** The drive can connect to other elements in a secure manner. Other elements in the network may include drives, PLCs, sensors, and a cloud data centre.
- **The drive acts as a sensor:** The drive uses motor current and voltage signature analysis to sense the motor and application performance.
- **The drive acts as a sensor hub:** The drive acquires data from external sensors related to the process, which is controlled by the drive.
- **The drive acts as a controller:** The drive can replace the PLC wherever application constraints allow.
- **Bring your own device concept:** This uses wireless connectivity to smart devices such as smartphones or tablets.

Information from the drive can be identified as follows:

- **Instantaneous signals:** Signals which are directly measured by the drive using built-in sensors. Data such as motor current, voltage, drive temperature, and their derivative, which is power as a multiplication of current and voltage, or motor torque. Moreover, the drive can be used as a hub for connecting external sensors that provide instantaneous signals.
- **Processed signals:** Signals which are derived from the instantaneous signal, which can include statistical distribution (maximum, minimum, mean, and standard deviation values), frequency domain analysis, or mission profile indicators.
- **Analytics signals:** Signals which provide indications of the condition of the drive, motor, and application. The signals are used to trigger maintenance or lead to system design improvements.

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Motor current signature analysis techniques enable the drive to monitor the condition of the motor and application. The technique allows the system to potentially eliminate physical sensors, or extract early fault signatures that might not otherwise have been possible to detect. For example, this technique makes it possible to detect winding faults in advance, or mechanical load eccentricity.

The concept of the drive as a sensor hub involves connecting external sensors to the drive, thus eliminating the need for a gateway to connect the physical sensor to the data network. Vibration sensors, pressure sensors, and temperature sensors are examples of sensors which can be connected to the drive.

The advantages of the concept include the ability to correlate sensor data with different types of data present in the drive.

Why is condition-based maintenance needed?

The condition of a piece of equipment typically degrades over time. The introduction of Industry 4.0 and the availability of sensor data means that condition-based and predictive maintenance is now possible. The idea of condition-based maintenance is to detect a potential failure before an actual failure occurs.

Such maintenance strategies use actual sensor data to determine the condition of the equipment in service (condition-based maintenance) or to predict future failures (predictive maintenance).

Condition-based maintenance uses data from the equipment itself to monitor the health of the equipment in service. For this purpose, key parameters are selected as indicators to identify developing faults.

In this case, planning maintenance actions provides many advantages such as:

- Downtime reduction
- Elimination of unexpected production stops
- Maintenance optimization
- Reduction in spare part stock inventory.

Condition monitoring follows a three-step procedure:

- Establish a baseline
- Define thresholds
- Perform monitoring.

Conclusion

Today, drives are more than simple power processors – they are vital elements in modern automation systems, with the ability to act as sensors and sensor hubs, and to process, store, and analyse data, along with connectivity capabilities.

Drives are often already present in automation installations and therefore present a great opportunity to upgrade to Industry 4.0. This enables new ways of performing maintenance, such as condition-based maintenance. The functions are already available in some drives, and early adopters have already started using the drive as a sensor.

For more information:

Lynne McCarthy, Senior Marketing Communications Specialist, Danfoss Turkey, Middle East & Africa,
Email: mccarthyl@danfoss.com, www.danfoss.co.za, Phone: +27 11 785 7628

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