

Use of Wireless Sensors in Heat Trace Installations

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Adoption of industrial wireless sensor networks (IWSNs) reduces installation costs, solves complications with hard-to-reach sensing locations and expedites implementation of advanced diagnostics. It is a growing market that was valued at \$2.64 billion in 2016 by Grand View Research, and in a recent IWSN market analysis [report the company forecasts](#) the IWSN market to reach \$8.67 billion by 2025 for a compound annual growth rate of 14.5 percent.

The aggressive growth rate is fueled by the maturity of open wireless communications protocols, including WirelessHART and ISA-100.11a, and their presence in industrial facilities has become increasingly more common. With a growing user base, there is an ever-increasing demand for enhanced connectivity, and while IWSNs are predominantly used for process monitoring, they are now beginning to penetrate process control applications.

Why Do Wireless Sensors Work Well with Heat Trace?

A heat tracing system is an ideal use case for wireless sensors due to the relative stability of the system thermal dynamics. Several factors influence the thermal stability of the system. First, many installations use self-regulating heat trace cable that automatically regulates output power as process temperatures fluctuate. This helps stabilize the system and prevents the system from overheating. The large mass of pipe and fluid versus the relatively low output of the heat trace system (typically less than 60 watts per meter), results in increased thermal stability and is further enhanced by piping insulation.

The resulting change of temperatures is slow enough that wireless updates of the pipe temperature to the control system can take place over a longer time period than other process control applications. Depending on the process and the size of the pipe, the proportional-integral-derivative (PID) temperature control algorithm may only need to run once every one to five minutes without process upset, at which time the power output to the cable may be adjusted.

The reduced measurement frequency greatly extends battery life, which can be further improved by programming burst modes through the WirelessHART protocol. This further saves critical battery power and increases heat trace reliability, as devices report when there is a significant temperature deviation, allowing heat trace systems to readily respond to process upset conditions.

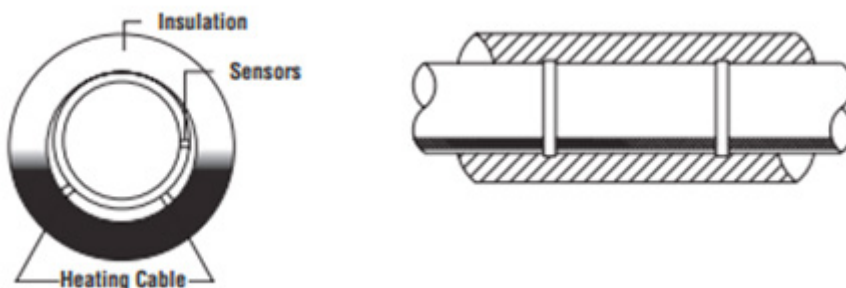


Figure 1: Insulated self-regulating heat tracing system. Source: Chromalox

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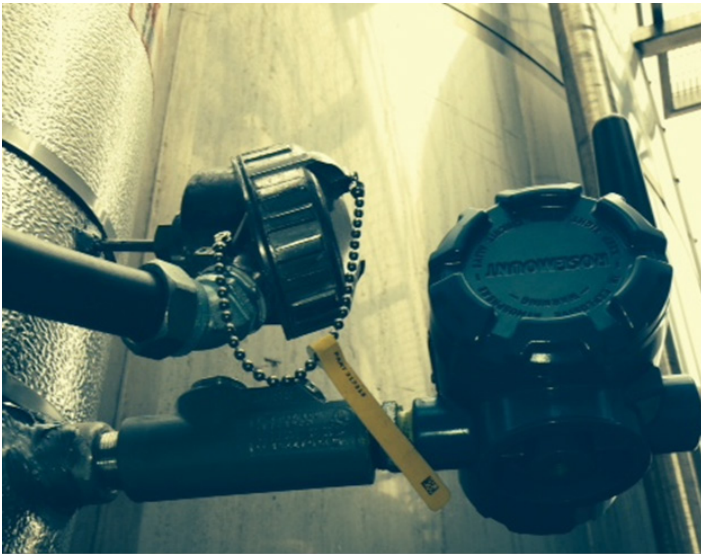


Figure 2: A wired and wireless sensor. One for control and one for remote diagnostics of a heat trace system. Source: Chromalox

In addition to the preferential use of IWSNs for control of non-critical heat trace systems, they provide added value to wired systems when utilized for process monitoring and diagnostics. In 2010, Emerson Process Management published a white paper on the success of using wireless temperature transmitters to monitor critical process lines that transport bitumen. In this application, wired sensors were utilized for process control alongside wireless sensors for predictive maintenance systems. Critical process lines were held to tight tolerances, while the wireless sensors increased the system’s ability to identify potential problem spots early.

Existing Installations with Off-the-Shelf Battery-Powered Transmitters

Chromalox’s IntelliTrace line of heat trace control and monitoring systems incorporate industrial wireless gateways, allowing for wireless communication through a mesh network of temperature sensors on pipes and tanks. The design allows the IntelliTrace system to work in conjunction with existing field sensors that operate on the existing plant-wide wireless network. It also allows for a hybrid approach in

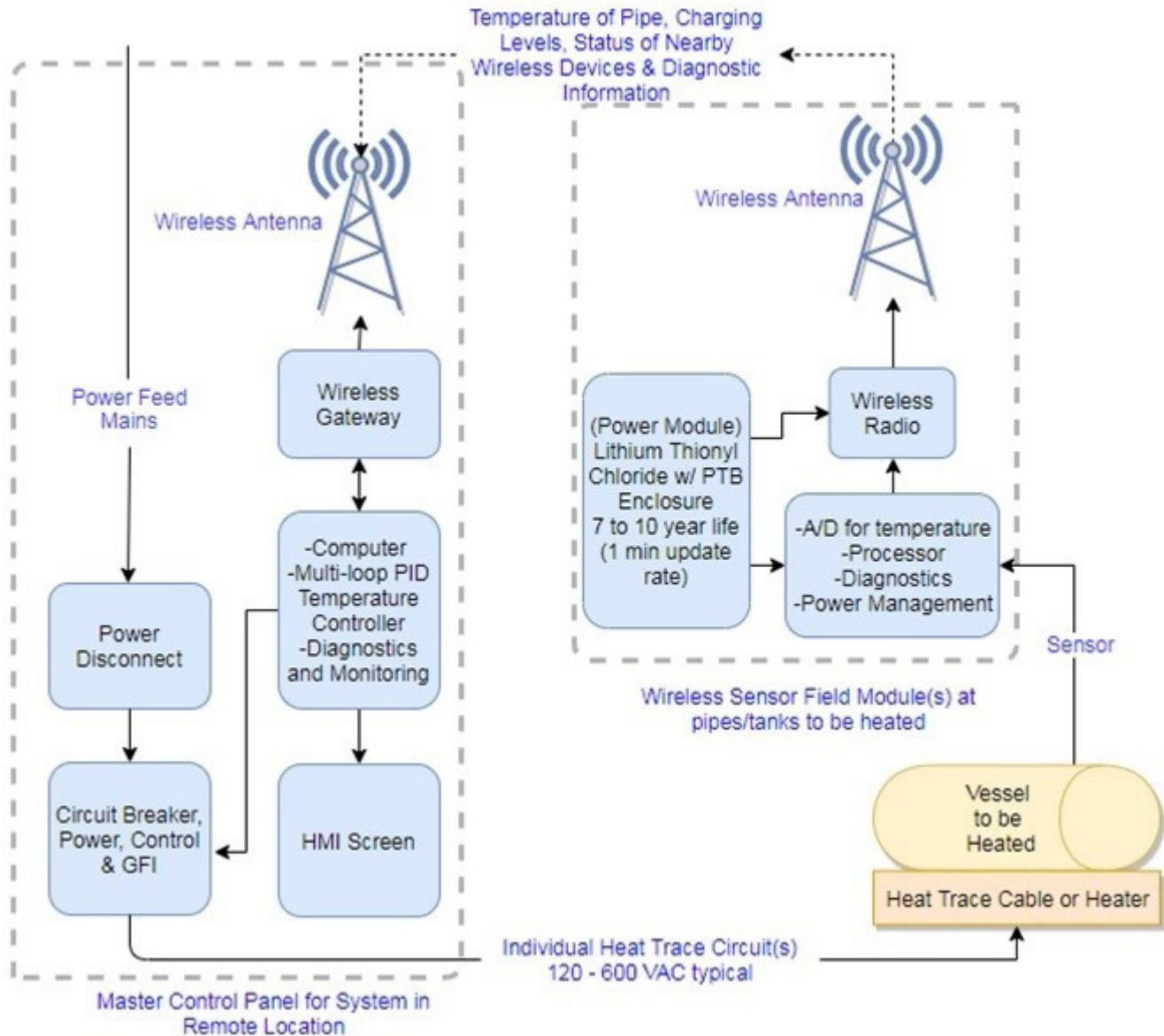


Figure 3: Heat trace system schematic. Source: Chromalox

which wired and wireless sensors are mapped to independent output loops of the heat trace control system.

Hybrid sensor mapping schemes provide for design flexibility. Sensors can be altered to support process changes and improperly tagged circuits can be remapped without lifting any control wiring through the control panel's HMI.

In addition, mapping multiple sensors to a single heat trace power output can also be accomplished. This provides the highest degree of flexibility without ever needing to lift sensor wiring from the control panel, as well as facilitates mapping of wireless field devices.

What About Security?

While there are several advantages to using IWSNs, including the elimination of costly and time-consuming cabling, sensor location flexibility and self-organizing capabilities, the primary concerns with IWSNs are data security, reliability and device interoperability.

WirelessHART addresses these concerns and is specifically designed for process measurement and control applications. It operates over a mesh network topology and each device in the network has the capability of rerouting signals through neighboring devices, greatly increasing reliability.

WirelessHART is an interoperable and open IWSN standard that operates over the 2.4 GHz unrestricted industrial, scientific and medical (ISM) radio frequency band and adopts the physical layer from the IEEE 802.15.4 standard. Channel hopping occurs over 15 different channels to help evade signal interference while a time-synchronized MAC layer supports the co-existence of other networks, such as ISA-100.11a.

Enhanced security is addressed through adoption of a multi-layered technique for data authentication as well as use of established encryption algorithms, including industry standard AES-128 bit encryption, ever-changing encryption keys, authentication, secure join procedures, message integrity schemes and encrypted messaging.

Utilization of industrial wireless standards and certifying devices to WirelessHART helps prevent rogue service attacks, denial of service attacks, spoofing and replay attacks. End users can select a level of security that best suits the intended application with the capability of managing and allocating security encryption keys for each device in the network, and even though the wireless mesh network may extend beyond plant boundaries, use of tested and approved industrial protocols safeguards the network and prevents unauthorized devices from interfering with the system.

Installation Cost Reductions

By utilizing wireless technology, installation costs of the sensors on a heat trace system are greatly reduced. A typical heat trace circuit will require about 80 ft. (25 m) of resistance temperature device (RTD) sensor wiring. Many systems

include hundreds of circuits of control in large industrial facilities. By utilizing wireless, the installed cost savings are significant and summarized below.

WIRED vs. WIRELESS SENSING COST COMPARISON		
PER LOOP INSTALLATION COSTS		
<i>*Based on 80 ft. conduit per circuit</i>		
Installation Consideration	Wired	Wireless
Engineering Design	\$ 200	\$ 50
Instrumentation Documentation	\$ 100	\$ 100
RTD and Wiring Material	\$ 900	\$ 180
Wireless Transmitter	\$ -	\$ 2,150
Installation Labor	\$ 2,600	\$ 100
Misc. Materials & Tools	& 50	\$ 50
Per Loop Installation Cost	\$ 3,850	\$ 2,630
Savings Per Loop		\$ 1,220
100 Loop System Savings		\$ 122,000
1000 Loop System Savings		\$ 1,220,000

Figure 4: Per loop cost comparison chart. Source: Chromalox

This savings reflects the heat trace system alone; further savings are possible, eliminating the wiring or batteries of other field devices.

Operating and Maintenance Cost Reductions

Chromalox's IntelliTrace line of heat trace control and monitoring systems provide for additional operating and maintenance cost reductions. The adoption of wireless sensors allows users to capture diagnostic data, whereas a wired RTD sensor only transmits process temperature. Users can monitor the ambient temperature of the device, status of nearby sensors and potential issues with the sensor itself and take corrective actions that can prevent unnecessary downtime.

These advanced capabilities also reduce maintenance costs when there is a system failure. It effectively eliminates the need for a technician to physically troubleshoot the sensor and identify the cause for device failure as all data is readily available via the control panel or other wireless device used for device configuration, diagnostics and calibration.

Additional cost savings are realized if the process requirements change and the sensor needs to be moved. Wireless sensors facilitate these process changes and may be easily lifted off the pipe and relocated. There is no need to re-engineer sensor wiring and conduit. Engineering drawings for the location of the sensor simply need to be updated, greatly reducing reinstallation labor costs and time.

Utilizing the sensor mapping functionality of the IntelliTrace system, inputs and outputs can be soft programmed through the interface. In addition, if spare heat trace circuits have been specified in the control system, new process lines can

be added easily without disturbing critical sensor wiring by simply adding another wireless device.

Conclusion

The relative thermal dynamic stability of heat tracing systems is best served by a wireless sensor system. Chromalox IntelliTrace line of heat trace control and monitoring systems are an ideal replacement for wired systems. They also provide for several additional benefits, including the facilitation of process changes, increased safety and enhanced reliability of the user's process.

Utilizing recommended process configurations allows users to experience a battery life of seven to ten years. They also benefit from exact sensor placements, experience significantly lower installation costs and are able to increase the value realized from existing wireless networks. To learn more about [Chromalox IntelliTrace line of heat trace control and monitoring systems](#), contact a representative today.

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ABOUT CHROMALOX

Chromalox is a thermal technology company. We engineer thermal solutions for the world's toughest industrial heating applications. Our Heat Trace segment delivers temperature management solutions for piping systems, valves, and tanks. Our Industrial Heaters and Systems segment delivers process heating solutions for revenue-generating industrial processes, and our Component Technologies segment delivers component heating solutions for industrial equipment manufacturers. Chromalox was founded in 1917 and is headquartered in Pittsburgh, PA, USA.