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Exploring the benefits of new, ultra-high temperature sensors on aeroderivative turbines

By Mike Spalding

When two Baker Hughes companies recently teamed up, they produced groundbreaking results in the flame detection industry. Nexus Controls is an automation control expert and one area of its expertise includes upgrading control systems on gas turbines. Reuter-Stokes manufactures the ultraviolet flame sensors used with these control systems. It's a winning partnership, as it is much easier to communicate and work with a partner company rather than another third-party vendor outside the Baker Hughes family.

In the case of most gas turbines, control systems are built by the original equipment manufacturer, such as General Electric Power and Siemens. Nexus Controls comes into the picture when an end-user wants to upgrade an aging control system. Nexus works with each customer to determine if a complete system upgrade is appropriate for their needs or if their situation would require only control-board migration. Each project is determined by a customer's unique needs.

Chances are, these older control systems will also have aging flame sensors. This can impact overall turbine reliability. When a turbine requires new sensors, Nexus Controls engineers know they can immediately turn to Reuter-Stokes for a quick solution. Both companies work together to upgrade these vital sensing devices as part of a control system update.

Landmark sensor installation

That's exactly what happened with an industrial customer on the West Coast when it upgraded its aeroderivative gas turbine's control system at one of its plants. The customer generated 100 percent of its industrial plant's power and also supplied power to the regional utility's commercial and residential customer base.

As part of the control system upgrade, company officials wanted to add new flame sensor technology to this turbine. During the upgrade process, Nexus Controls installed two Reuter-Stokes Flame Tracker Dry 325 (FTD 325) sensors.

The FTD325 is typically installed on frame or heavy-duty gas turbines. This installation on the customer's aeroderivative gas turbine was a first, not just for Reuter-Stokes, but also for the flame detection industry. Because the FTD 325 sensors are new to this kind of gas turbine, Nexus Controls worked

with Reuter-Stokes on installation details, such as cool end location, optical pathway, and system checkout.

Gas turbines and flame sensors

Gas turbines burn hydrocarbon fuels, most often natural gas. The expanding gases are channeled across the engine blades, causing the blades to turn. The turning blades spin a rotor that drives a generator to produce power on a grid. Aeroderivative gas turbines are similar in build and operation to an aircraft engine, unlike frame gas turbines, which are heavier, bigger and bulkier. An aeroderivative gas turbine is optimized for weight to make it easier to transport and install.

Flame sensors are key safety devices for gas turbines. The flame from the burning gas can sometimes become unstable and go out. If it does, the uncombusted fuel will continue to pump into the turbine, running the risk of spontaneous reignition. This could injure people and definitely will damage the gas turbine. The FTD 325 sensors tell the control system when the turbine's flame goes out. The control system then shuts down the turbine's fuel valves to avoid reignition.

The FTD 325 senses the ultraviolet (UV) light produced by a flame and outputs a signal that is proportional to the UV lights intensity. The silicon carbide (SiC) optical photodiode is designed for use with multiple fuels, low NOx combustors and steam injection. The sensor output is a 4-20 mA current loop signal, a common industry standard for sensors in industrial settings.

Gas turbines provide a harsh environment for instrumentation, delivering extremely high temperatures, vibration, pressure, and the potential for corrosion. The FTD 325's innovative design allows it to operate at temperatures up to 325°C, while still meeting all of the other harsh environment requirements. The remote electronics design reduces maintenance by moving sensitive electronics away from the heat, thereby eliminating the need for air or water cooling.

For installation on the LM2500, the team connected the FTD 325 hot ends to sight tubes on right-angle brackets positioned above sight glasses located at approximately 11 o'clock and 3 o'clock. The sight glasses provide a view into the combustion chamber.

The mineral-insulated (MI) cables ran down the sides of the turbine, and the MI cable from the 3 o'clock sensor was run under the turbine to the left side. Both FTD 325 cool ends were clamped to strut channels located near the floor of the turbine compartment. Four 20 mA cables connected the cool ends to a nearby junction box.

Successful troubleshooting

Nexus Controls and Reuter-Stokes worked hand-in-hand to ensure the design developed for this customer was the right fit for the application.

The sensors worked perfectly when we tested them with a UV flashlight. However, we discovered the sight glasses were attenuating the light from the combustion flame. The flame sensors were moved closer to the sight glasses to increase the sensor outputs. This would ensure the sensors would detect the proper output threshold generated by a healthy, burning flame.

To do this, Nexus Controls engineers that were on-site worked with Reuter-Stokes engineers to determine the best spacing for the sensors. They also inspected the sight glasses and made sure they were in optimum working order.

Safe power generation

Ultimately, the first installation of Reuter-Stokes FTD 325 sensors in an aeroderivative gas turbine was a success; the new sensors and the Nexus Controls control system operated perfectly together.

As we discovered through this installation, using Reuter-Stokes FTD 325 sensors increases the safety and reliability of the LM2500 gas turbine. This means the customer can now easily and reliably produce power at its plant and for customers on the regional utility's grid.

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