Impedance Pipe Heating - Controls

By Patrick S. Morris

When it comes to impedance systems, there are some design parameters which are dictated by the application. For example: Where do you put your isolation? How much power do you need to put into the pipe? What size cables do you need, and where do you locate them? All of these are inherent in the design for each specific system. Beyond these elements, for each system, choices need to be made with regard to control. How do you want to control the system? What tolerance do you need? How do you want to handle multiple systems? Each of these questions needs to be addressed, and the appropriate answers will be dependent on your specific application requirements.

If we decide on the most basic form of control, we would have on/off controls. With an on/off control system, we get simply that. The system will either be on, with 100% power being applied to the pipe, or off. When using an on/off system, the designer will need to set a hysterisis. The hysterisis works like a conditional dead zone. Once the temperature reaches a pre-set point the system will turn off. The system will then begin to cool but it won't turn back on at the set point. Instead, it will turn on at a designated temperature below the set point. The system will then begin to oscillate in the hysterisis band, in other words, between the system on and off set points. The on-off range can be set to whatever the operator desires, and is based on material requirements and the duty cycle of the system components.

This system does have its advantages and disadvantages.

Advantage:
The main advantage of an on/off system is its simplicity. The control programming needed is minimal: turn the system on below "x" temperature and off above "y" temperature. Also, the parts needed are relatively inexpensive. At a minimum, on/off control can be achieved with a simple bulb thermostat and a contactor.

Disadvantage:
The disadvantages to the system are of course a result of its simplicity. Alternating a system from full on to full off continually can be hard on the component parts. As a result, the hysterisis usually has to be significant enough that the parts won't fail prematurely from excessive wear. This can result in a large oscillation in the product temperature, which depending on the sensitivity of the material could be undesirable. Also, most impedance systems are designed to not only maintain a pipe's temperature, but to heat it to operating temperature for a startup. This means you end up putting a

much higher load on your power system during “ON” times than is necessary. An alternative to on/off is the SCR system.

An SCR, or silicone controlled rectifier, is another form of control common with impedance systems. Unlike an on/off system, with the use of an SCR the power level applied to a system can be varied from 0% to 100%. This is accomplished by controlling how much current is applied to the power transformer. An AC voltage is a sine wave that oscillates 60 times per second. The SCR restricts the output of the sine wave, acting essentially as a contactor that is off for part of each wave cycle. The temperature controller controls the SCR usually with a 4-20mA or 0-10VDC signal. Using a multimeter, the output you would see is a lowered voltage from the original supply, which would be proportional to the input signal from the temperature controller.

Advantage:
Again, as with on/off control, SCR systems have advantages and disadvantages. The obvious advantage to an SCR system is controllability. With an SCR system, the impedance system will output only what is required at any specific time to heat the pipe. With no switching from full on to full off, the load on the plant power is smoothed, and the wear and tear on component parts is greatly reduced. Also, the temperature tolerance for the pipe can be greatly lowered. An SCR system can be programmed with a PID loop to output the exact amount of power needed to maintain the pipe at the desired temperature. This allows for the use of impedance systems with materials that require exact temperatures, with little or no variation.

Disadvantage:
The down side to an SCR system is cost and complexity. An SCR is more expensive than a simple contactor, and the controller needed to control the SCR is more complex than that of an on/off controller.

In the end, the choice between an on/off and a SCR control system is dependant on your specific application. No matter what the system requirements, there is no one right answer. The temperature requirements of the material, the available tolerances, and the cost all come together to direct a user to one control type or another, but very seldom is there only one solution.