Temperature Maintenance vs. Temperature Rise

By Patrick S. Morris

When it comes to impedance systems, not all systems are made equally. Yes, all impedance systems heat by passing current through a pipe. Yes, they all have a set temperature they can maintain. But what about the amount of time it takes the system to heat from startup? What about the ability to heat a product as it flows through a pipe? What can each system do? Or, as usually asked in the initial design phase, what does this system need to do? That simple question opens the door for many possibilities when it comes to the design of an impedance heating system.

An impedance system is a wonderful method to maintain temperature in a pipe, but it can also be used very efficiently as a method to heat a pipe from ambient and to heat product flowing through a pipe. What performance is needed from the system is a very crucial part of the initial design phase. A system that needs to only maintain temperature will require different control and power than one that must heat a product as it flows through the pipe. Even if the system is meant to maintain temperature, does it also need to be able to warm the system from ambient for startups and if so, how fast does it need to do it? Generally, if someone is looking for a heating solution they know what their heating requirements are, and it is just a matter of engineering a system that meets the needs of the user. First, let's look at simple temperature maintenance.

Basically, with a temperature maintenance system we have a product that comes into the pipe at a specific temperature. The product then flows through the pipe and out the other end. When it gets to the other end, we want to make sure it is the same temperature as when it came into the system. For a maintenance system, we need to look at the heat loses as the product moves through the pipe. This value is determined by looking at the difference between the ambient temperature and the product temperature and the amount and type of insulation used. With this, a simple system can be designed to offset the thermal loses, ensuring that the product will maintain an exact temperature throughout the pipe configuration. A system designed for temperature maintenance will be extremely efficient, and exert the lowest possible load on the plant's power system, but will be the most limited. Generally, this system will use a simple on/off control scheme, and require the least amount of control hardware. On the downside, if the system is ever turned off, what happens? Unless the line is drained, the result will be a line full of product that has cooled. If the product will flow at ambient, cooling is not a significant problem, but if it becomes to thick at ambient than another method of heating the pipe to operating temperature will need to be found or the pipe will need to be cleaned before

complete shut-down occurs. An alternative impedance system design is to combine warming/heating in addition to maintaining temperature.

An impedance system can be designed that will maintain the product temperature in normal operation, but also has the capability to warm the pipe from ambient when required. For this type of system, we first consider the maintenance needs, as above, but then we consider how much power is needed to warm the system from ambient to operating temperature with a full pipe of product. Once we know how much power is required, the question becomes how fast does it have to get up to temperature? A system can be designed to heat from ambient to use in anywhere from a few minutes to several days. The design is dependant on the requirements of the customer and the temperature limits of the product. This design configuration results in a transformer generally several times larger than the transformer required for temperature maintenance only, with a higher secondary current, and cabling and connections designed to match. While the overall power used for this temperature rise configuration will be close to a standard maintenance system, the increased current required for raising the temperature will result in slightly higher losses in system components outside of the pipe, and slightly lower efficiency. Additionally, if the system is on/off control, it will have a larger impact on the plant power supply when on than a temperature maintenance system, with components designed to handle the larger load, even though it will have longer off times. A solution to reducing large electric load swings is to utilize silicone rectification controls (SCR). An SCR control smoothes out the power supply load swings but does increase the cost of system control components by approximately 10%. All of this is dependant on just how fast the system needs to raise the temperature and by how many degrees.

As a system is designed, a balance must be achieved between the desire to simply maintain a product temperature and the desire to heat a product from ambient. Does the system need to be able to heat-up, or is maintenance enough? Impedance system designs can be very flexible, with pros and cons to consider for every application. In the end, the designer and the customer need to ask themselves “What are the key performance objectives of the impedance pipe system? What does our process need, and what would be of most benefit to us?” By asking themselves these questions, they can pinpoint their needs, and get a system design that they can be happy with for many long years of operation.