



Impedance Pipe Heating – Basic System Components

By Patrick S. Morris

In a previous article, how an impedance system heats was discussed. Now, let's look at the components utilized to produce an impedance system. The parts of an impedance system can be broken down into three categories:

- **Isolation** – Component that keeps all of the power in the correct location.
- **Power** – Component of the system that produces and applies a low voltage to the pipe.
- **Control** – Component of the system that determines how the power will be applied.

Isolation:

In many ways, the proper isolation of an impedance system is the most important component. Without proper isolation, the currents that should be going through the pipe will find alternate paths, resulting in poor and uneven heating of the pipe. The entire length of the impedance heated pipe must be isolated from ground, and the first step to isolation focuses on the support method of the pipe. The best method to achieve isolation at the support points is to support the pipe from outside the insulation. This ensures that no contact can occur between the pipe and a metallic ground point. Short of this method, it is possible to isolate a pipe by using a non-conductive material, such as a wear resistance polymer or equivalent, between the supports and pipe, or if the pipe is being hung to use non-conductive threaded rod. Once the supports are isolated, the various connection points on the pipe must be examined.

Every support or connection point of the pipe to be heated requires some form of isolation. Typically, the connection point of a heated pipe and a non-heated pipe is made with a flange, assembled with a non-conductive full face gasket, and Nylon or Teflon bolt isolators, depending on temperatures. This simple method isolates the impedance system, and ensures proper operation. Now that the supports and pipe connection points are isolated, it is time to look at the schematic flow diagram of the piping system noting if it has "T" connections, drops, or other intersections.

In essence, the electric current flow of an impedance system is much like the water flow of a river. At any point, a river has a specific volume of water. When the river takes a single path, that flow is constant at any point of the river. But if the river breaks into several paths, the water will be divided, and each path will have a different volume. The same is true with an electrical current, and each path with a different volume will have a different amount of heat produced. Not a desirable trait for a pipe heating system. This

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problem is solved by using specially placed isolation points and cable connections to change a multi-path river to a single path. At any break in the path, an isolation flange is inserted, forcing the current down one side of the break. Once the current reaches the end of the forced path, a cable is installed to connect the end point to the other side of the original break, on the opposite side of the isolation flange. This ensures a single path for current flow and even heating for the pipe. With all support and connection points addressed, completing the isolation process, lets now focus on the power system.

Power:

The power for most impedance systems will start with your standard 480V, single phase, AC source. While any primary voltage can be utilized, 480V is the standard experienced in most plants. The 480VAC is connected to a specially designed transformer. This transformer, which can range from 1kVA up to 100kVA and larger, is designed specifically for the given impedance pipe heating application. The transformer will take the 480V and produce a low voltage secondary, usually under 30V, but always under 80V. By keeping the voltage below 80V, we stay within the limits dictated by NEC Code article 427.27. The low voltage secondary of the transformer is then attached to the pipe by means of cables. The cables vary from size 2/0 all the way to 750MCM, with single or multiple cables per connection, depending on the current required and pipe size. It is important to note, that the secondary cable is not sized based solely on its ability to handle the current, but on its electrical resistance as well. Incorrect sizing of the secondary cables can result in higher cable power losses, which means less heating power to the pipe. Finally, the cables are connected to the pipe by the use of cable lugs and weld plates. The use of weld plates ensures a good connection to the pipe, and further reduces any unwanted power losses. With the isolation and power complete, we will now focus on control.

Control:

The control component of an impedance system allows for significant variation. The basic parts of the control system are a temperature sensor (usually an RTD), a temperature controller, and method to control the application of 480V to the power transformer. The temperature controller can vary from a simple thermostatic switch for on/off control, to a full PLC system controlling multiple impedance systems at the same time. Most commonly used is a digital temperature controller designed with a single temperature sensor input and an output to match the selected power control method. The power control method will usually be a simple power contactor, allowing for on/off control. When precise temperature control (+/- 1 °F) is required, an SCR system is typically used. Whether on/off, or SCR control, the style of controller, the temperature tolerances, and the duty cycles will be unique to each system application.

From the outside, an impedance system may seem complex, but once it is broken down into its individual parts, the simplicity of this heating method can be recognized. In

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essence, it is an isolated system, with a power source attached, and a control system to turn that power source on and off. The individual details of each component will change from system to system, with each tailored to fit the specific requirements of the materials being heated. In the end, the basic purpose of each component from system to system is the same. This basic simplicity makes impedance pipe heat the great method that it is.

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