SLL-3871-00

Impedance Heating Basics

Principle of Operation:

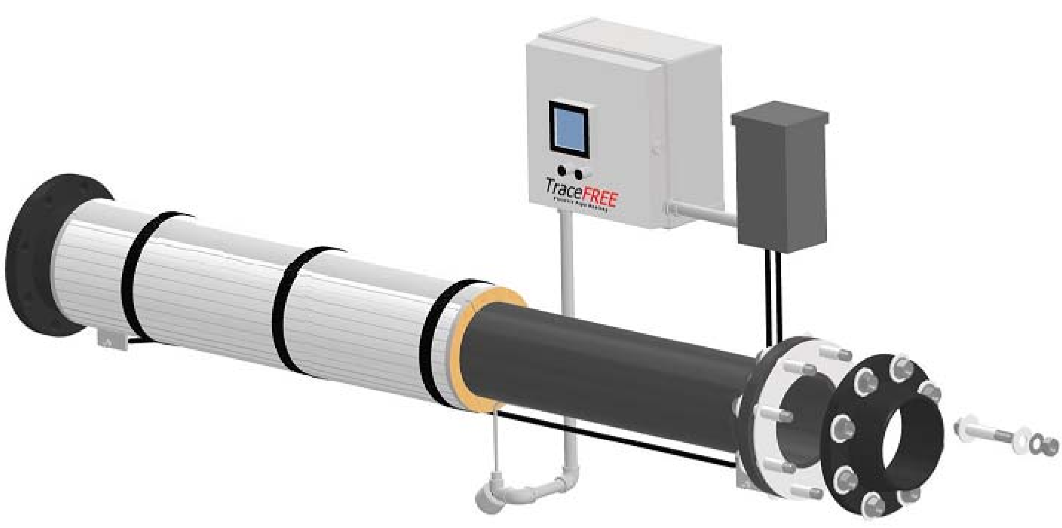
Impedance Heating System technology employs the process pipe as the resistor to generate heat. This is achieved by applying a low voltage AC power across the heated length of the pipe resulting in evenly distributed heat over the entire length. The main mechanism for heat is resistance, or Joule, heating. The pipe becomes energized so that the full surface area of the pipe can deliver heat to the fluid. This provides uniform heat distribution, and helps to avoid localized hot spots.

In addition to the resistance heating there are other electrical effects in action.

- Skin Effect: The tendency for current to concentrate on the outer surface of the conductor.
- Proximity Effect: The current in the pipe is affected by the currents flowing outside of the pipe. The current flow is drawn by the field produced by the secondary wire(s). Secondary wires should be evenly spaced around the pipe in order to distribute the current around the pipe.
- Hysteresis: The magnetic properties of the pipe result in additional heat generation.
- Magnetic field: The relatively high current in the pipe and secondary conductors generate a magnetic field. It is recommended that the secondary conductors are strapped to the exterior of the pipe insulation in order to allow for cancellation of the equal and opposite current flows.

A control panel will switch and monitor the line so that it operates within the design parameters. Temperature control options range from simple on-off switching through sophisticated PID control, full communication capabilities, PLC, and HMI. Contactors, solid state relays, and 0-100% switching SCR switching options are available to suit the specific application. Control panels are available for discreet circuit, or to support multiple Impedance Heating Systems.

An isolation transformer delivers the low voltage power supply to the pipe via secondary conductors connected to the pipe by welded terminal plates.



ImpedancePRO software is used for thermal and electrical system design. The thermal design is performed for the pipe and fluid conditions to determine the heat required for maintain, and/or heat up. Electrical parameters are determined based on the application requirements: pipe size and type, heating requirements, length, etc.

Advantages:

Impedance heating can deliver heating performance and reliability that cannot be matched by any other pipe heating technology for a wide variety of industries and fluids, both liquids and gases.

- Elevated maintain temperatures, in excess of 1,000°F are available as there are no dielectric components within the heating system. The temperature is only limited by the pipe and fluid thresholds.
- The most reliable, and longest lasting, pipe heating technology available. There are systems currently in operation for longer than 40 years.
- System requires minimal site maintenance.
- Long lengths up to 1,000 ft are available as well as very short lengths.
- High watt densities are available for elevated maintenance temperatures, fluid heat up, or thawing. The control system will assure that the high watt density is delivered only as needed. Systems can be designed for freeze protection utilizing low watt density for operation.
- Uniform heating delivered to the fluid from the entire pipe surface area. This provides even heat distribution, and helps to avoid overheating. This is useful for temperature sensitive fluids, and also limits the heater sheath temperature due to maximized heater-to-fluid pipe surface area.

Safety:

Impedance heating has a long history of safe and reliable service. Impedance systems energize the pipe at a low voltage, which is inherently safe for personnel. The magnitude and duration determine the danger for an electrical current path through the human body. The relatively low voltage for impedance heating systems lacks the electrical force to overcome the contact resistance of skin that would be necessary to substantially complete the circuit. For this reason, there is no resulting perceived shock.

In addition to perceived current, heart fibrillation current must be considered. Currents greater than 75 mA flowing through the heart can cause fibrillation current which alters the regular beating pattern that can be dangerous. National Electric Code (NEC) considers voltages above 50 V can cause heart fibrillation if applied across human skin. Impedance systems safely operate below this threshold.

OSHA 29 cfr 1910.303(g)(2)(i) requires that live electrical equipment operating at 50 V or more to be guarded against accidental contact. Despite operating at voltages below 50 V, impedance heating systems include the additional precautionary step for physical protection for the live electrical components to prevent incidental system short or ground.

NEC, CEC and IEEE electrical standards include design and installation guidelines for impedance heating technology. Impedance heating is even recognized for installation in hazardous locations. NEC Article 427 details the requirements for Class I, Division 2 installation with references to ANSI/IEEE 844.

Sheath temperatures are regulated using a control limited approach as outlined by IEEE 844.3 Annex B3.3. An additional temperature sensor is included for over-temperature cut-off. This is used to independently cut-off power in the event of elevated temperature. All system components that will be exposed to elevated temperatures should be insulated or protected from contact for personnel protection, and to minimize heat loss.

Equipment ground fault protection provides an additional safeguard to the fused power supply. A ground fault is an inadvertent short from the energized equipment to ground. The ground fault system constantly monitors the ground fault current, and automatically shuts down power in the event of a ground short.