Heat Tracing Systems

An Online Continuing Education Course for Engineers

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HEAT TRACING SYSTEMS

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Abstract

The term heat-tracing refers to the continuous or intermittent application of heat on the piping, equipment, and instrumentation where fluid (water or other product) may be exposed to low temperature/freezing conditions. Whenever the contents of a pipe or vessel are maintained at temperatures exceeding the ambient temperature, there will be a flow of heat from the product to the external air. Insulation will slow the heat loss, but will not prevent it. Heat tracing is a method to provide the supplemental heat just enough to compensate for the heat loss due to lower ambient temperature.

The general intent of heat tracing is either tracing for winterization and/or tracing for process maintenance. Winterization tracing is designed to protect the product from freezing and is typically designed to operate when the ambient temperature falls below a certain level — commonly 40°F to 50°F. Heat tracing for process maintenance is commonly used where higher temperatures must be maintained for the purpose of reducing product viscosity and/or preventing wax or hydrates from forming in the product. The design is more complex compared to freeze protection in a way that additional heater circuits and more specialized controls may be needed.

Sometimes, heat tracing is used for raising the temperature of product following short shutdown periods, but this is not a primary objective.

Types of Heat Tracing Systems

Heat tracing can be accomplished through several methods, including electricity, steam, glycol, and even hot oil. However for the majority of applications, the choice falls between electric and steam tracing.

Electrical heat tracing is a system incorporating electrical heating cables attached to the product pipe or the equipment surface. The majority of commercial electric heat-tracing systems use the resistive type heater, wherein the heat is produced in proportion to the square of the current (I) and the resistance (R) of the elements (I^2R). Other specialized electric tracing systems make use of impedance, induction, and skin conduction effects to generate and transfer heat.

Steam tracing is described by attaching a carbon steel, copper or stainless steel tubing containing low pressure saturated steam to the product pipe. The two pipes are then insulated together and jacketed, if necessary. The tracer tube size varies from ¼ - ½" diameter for winterization or instrumentation tracing, and 3/8" to 1" diameter for process pipe tracing. The other available options are 1) the use of cemented steam tracing, which uses conductive cement cased over steam tracer tubes and 2) the use of jacketed pipe when extremely high heat flow is required. In all these approaches, the condensate produced is removed at strategic locations using energy efficient steam traps and is returned back to the boiler (steam generator).

Electric or Steam Heat Tracing

The most significant factor in deciding steam or electric tracing is the initial investment on equipment, installation and the operating costs. These costs depend on factors such availability and reliability of energy supplies, cost of labor and local tracing practice. In general:

Steam tracing is frequently chosen in plants where steam is easily available as a by-product of condensation ("flash" steam) or where generated from waste heat or where surplus capacity exist that must be either used or lost. The incentive to use steam in such scenarios will be compelling. It is doubtful that anyone would invest in a steam boiler and associated infrastructure for heat tracing only. The other pros and cons are discussed later in Section-4 of the course.

Electric tracing offers convenience of installation and provides better temperature control and much more efficient utilization of energy. Auxiliary equipment is not required, so the total operating costs include only the electrical usage for the electric heat tracing and the control system. However, the reliability of the power for uninterrupted delivery, available voltages, and the consequences of outages must be evaluated when considering its use.

This course presents an overview of heat tracing systems and describes the criteria for selection. The course is divided into 4 sections:

SECTION – 1: OVERVIEW OF ELECTRIC HEAT-TRACING

Electric trace heating (also known as electric heat tape) takes the form of an electrical heating element run in physical contact along the length of a pipe. Heat generated by the element will maintain the temperature of the pipe and the wrapped thermal insulation retains the heat losses from the pipe.

TYPES OF ELECTRIC HEAT TRACING SYSTEMS

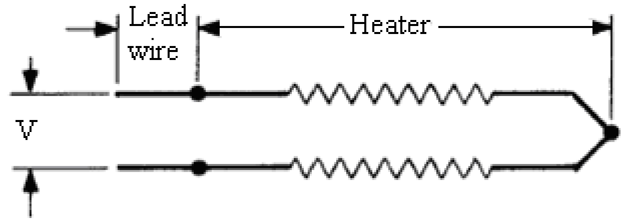
Electric trace heating cable can be divided into four distinct product classifications:

1. Series circuit, Mineral insulated (MI) cables (constant watt output)
2. Parallel circuit heating cables (constant watt output)
3. Self-regulating heating cables (variable watt output)
4. Skin effect heating

SERIES CIRCUIT MINERAL INSULATED (MI) CABLES

Series resistance-type heater cables use single or multiple resistive conductors to create a heating circuit. Power output of these cables is relatively constant and as voltage is applied, the power output is determined by a combination of the length of the cable and the overall resistance of the conductor. The drawback is that since the power output is dependent on the length of the cable, these cables are always supplied in predetermined factory-terminated lengths. If the cable is cut too short or too long, the overall resistance will change, resulting in a cable that provides either too little or too much heat output. Another serious drawback is that a break anywhere along the line will result in complete failure of the tracing.

Series resistance cables are available with flexible, polymer outer-jackets as well as with a metal jacket commonly known as mineral insulated (MI) cable. A mineral Insulated (MI) cable essentially consists of one or two conductors of copper or alloy embedded in dielectric magnesium oxide insulation and surrounded by an Incoloy 825 sheath. These cables are recognized for their high temperature service and excellent protection against corrosion. Circuit below indicates MI cable with two conductors in series arrangement.



Features:

- Power output of these cables is relatively constant, and they do not exhibit self-regulating characteristics;
- Suitable for high
- Voltage up
- Wattage ou
- Long circuit
- Uniform pow
- Copper constr ... F;
- Alloy construc ... F;
- Series circuit h ... uration for heating of long pipelines;
- No start-up curr

Advantages

- Extremely long circuit lengths are possible;
- Can have very high watt output which can be used in some process heating applications (as high as 1500°F for MI cable);
- Relatively low cost per feet length.