Electrical Heat Tracing Cables

With the coming cold season approaching, it is an appropriate time to take a look at what sort of heat tracers are available to the designer. This article will concentrate on the three main forms of electrical heat tracing including self-limiting, zoned constant power density, and mineral insulated heater cables. Each of these heating cables possess unique characteristics that lend each to specific applications. All of the cables that will be discussed are approved for Class 1, Division 1, Groups A, B, C, D. In all cases, it is also recommended that thermostats be used to ensure the design is energy efficient and the performance of the heat tracing system is maximized.

Self-Limiting Heater Cable

Self-limiting heater cables most notable unique feature is its ability to limit its heat output when the cable senses higher temperature. As the carbon matrix core (a semiconductor) expands, responding to warmer temperatures, microscopic electrical paths are broken causing the heat output to decrease. Similarily, the core contracts as it cools, causing the electrical paths to connect and increase heat is produced. Throughout its operation, this cable will continue to thermally fluctuate along its length in response to local temperature. Therefore, this cable may be much cooler or warmer than in other areas along its length. Since this cable will demand more power at start up when it is cool, the designer must be aware of the increase amperage demand. This "inrush", requires appropriate restriction of cable lengths and correct breaker size must be incorporated into the design. Considering overall cost, there is a point at which it is more economical to select a zero inrush cable that will not require expensive oversized electrical wiring and breakers. Because there is a direct relation between heat output, voltage and amperage, it is difficult to monitor this cable and caution must be exercised.

Being a parallel cut-to-length cable, it is easily field fabricated to exact in-situ piping length. As this cable will reduce its watt thermal output when it senses heat, the tracers subjective advantage is that it can be crossed over itself without affecting its performance. It should be noted that self-regulating cables will never "regulate" itself to the point of turning off. Self-regulating heater cable always consume energy and output heat into a system, whether or not heat input is required, and will do so until power is interrupted (i.e. thermostat).

A common question asked regarding self-regulating cable revolves around the continual expanding and contracting of the cable and it relation to life expectency. The cable is engineered to contract and expand, and when properly designed with a temperature controller, its service life potential is excellent. It should be stressed, however, that in the case of steamed cleaned heat traced lines, the life expectency and performance of the cable can be seriously affected, resulting in reduced or zero thermal output capabilities.

There are higher grades of self-limiting heater cables available which are specifically designed for exposure to the high temperatures experienced during pipe steam cleanings. A designer should take precautions to select a higher grade of cable if

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there is a chance the line will be exposed to such elevated temperature excursions. One should look for CONTINUOUS rating (opposed to vague INTERMITTENT) data regarding what the self-limiting cable can withstand. Bear in mind that the CONTINUOUS rating is comfirmed and/or recognized by a certification agency (CSA, FM) whereas an INTERMITTENT rating is assigned by the cable manufacture to a cumulative time/temperature value before the cable ceases to function at its original rated thermal output.

Zoned Constant Power Density Heat Trace
A parallel cut-to-length contruction, zoned constant power density cable consists of a series of parallel connected heater zones within the cable construction. A resistence wire (the actual heater) is wound around double bus wire connecting itself at each end of each zone. Each zone can be viewed as an individual circuit. Exposure to steam cleaning may be a concern to the designer and CONTINUOUS emperhical data (opposed to undefinable INTERMITTENT ratings) should be review to assure that there are no unpleasant surprises down the road.

Zoned constant power desity heater cable is a simple heat trace cable to understand and design. As with all constant power density heat tracers, this cable produces a defined heat output. From this, other definable variables (watts per foot, amps, total watts) can be extrapolated. This allows for a high degree of stability and predictability in your heat trace system. One can establish how the cable will operate on the pipe and, more importantly, how the product will react to the heat tracing. Being a stable non-fluctuating style of cable, a third monitor wire can be very useful in relaying information back to a controller regarding the integrity of the heat tracing. Rated and designed to be powered up to either 120, 240, or 575 VAC, this cut-to-length cable is easily spliced, terminated, etc. in the field. Constant power density cables have zero inrush. Constant power density tracers are ideal for long piping runs (saving money on power points and installation) upwards to 1475 feet, or limited length tracer circuits as short as 12". All may be designed and installed without difficulty. A 200°C rated jacket compliments installations on freeze protection applications, as well as high maintain designs in corrosive or non-corrosive environments.

Generally, self-limiting and constant power density heater cables are now used in temperature services that had previously been exclusively dedicated to steam tracing and copper sheathed M.I. heat tracing cables.

Mineral Insulated Heat Trace
The heat tracers that we have discussed so far are most suitable for application temperatures upwards to +150°C. In the process industry, applications exist were temperatures exceed the limitations of fluorocarbon. This may be seen in the form of a high maintain temperature such as sulphur or a water line that, under normal operations, may be exposed to high temperatures. In both of these applications, a mineral insulated (M.I.) stainless steel sheathed heater cable would be the optimium cable construction, whereas other sheath materials would be subject to accelerated oxidization and failure when subjected to high temperatures.

Mineral insulated heater cable is typically a series connected heat tracer cable. For this reason, field modifications are not recommended. Accurate pipe lengths and in-line heatsink allowances (valves, filters, pumps, pipe supports, etc.) must be considered during the initial design stages. If the originally factory designed circuit length is increased or decreased, the total watts per foot will also change porportionally. This may upset the engineered balance between applied voltage and resistence, potentially defeating the original purposed of the heat tracing.

The industrial standard metal sheath for M.I. cable is a high nickel content Alloy 825. This sheath is best suited for the industrial applications for its ability to withstand a wide variety of hostile plant environments to exposure to simple road salt. Rated to 600 VAC, M.I. cable can be designed to produce a thermal output well above that possible by any cut-to-length cable. At high watts densities, the designer should be aware of the cable sets T-Ratings to ensure the heat tracers sheath does not surpass the areas restrictions. In some cases, a heat transfer cement may be required to conduct the heat produced by the heater cable directly into the system and away from the cables surface.

Mineral insulated series type cables may be designed in a variety of cable set forms, all of which consist of a cold lead and the hot section. The cold lead is constructed of identical materials as the heater section. The only difference lies in the very low resistence characteristics of the cold leads internal wires. The hot lead consist of a specifically rated resistence wires that is engineer to produce a specfic watt desity for a given cable length and applied voltage. It is very important to note that both the cold lead and hot lead sheaths must be constructed of the same material. If this design practice is not aheared to, any perceived benefits will be immediately revoked when the system fails due to dissimilar metals performing independently during normal expansion and contractions, not to mention the accelerated effects of temperature and environmental chemical exposure as previously noted.

In conclusion, it is understood that there is no single "right" heating cable for all heat tracing applications. Some electrical heat tracers are more suitable for shorter lengths or very high temperatures, while others are designed for more diverse heating applications that exist throughout a process plant. This report is offered only to give a quick reference to the reader. Since every application is somewhat unique, a factory representative would be a good place to start to help you with your cable selection and design. Theoretical, and more importantly, practical realities can be reviewed so that the most appropriate complete heat tracing system can be applied to your specific requirements.

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