TRACE HEATING

CONSTANT WATTAGE OR SELF-LIMITING

WHICH CHOICE TO MAKE?

Electric heat tracing systems have been around for many years. Originally they were in the form of series resistance, constant watt output heaters, like mineral insulated (MI) cables. This style of heater had to be manufactured to suit pipe length, output required and available supply voltage. Changes in any of these criteria would result in re-design. However, technology advanced and parallel resistance, constant watt output heaters, that could be cut to length without affecting the watts per metre output were developed.

In the last few years, self limiting heating tapes, having a semi-conductive heating core matrix, the resistance of which increases with its own developed temperature, have become very popular for heat tracing applications.

This popularity is due to skilful marketing techniques based on the following reasoning.

a) Their propensity to reach a limiting temperature is considered a safety feature.

b) Systems are easy to design and install.

Early sales and marketing information also suggested that thermostatic control was not required. This is still the view of many potential users, although those more experienced have learned that a thermostat control can reduce system operating costs by as much as 90%!

The generally accepted view is that, whilst acknowledging the significance of their self-limiting characteristics, all such tapes, from whatever source, have shortcomings when used for process heating. This is one of the reasons why ESH Trace Heating Ltd recommend that, if self-limiting tapes must be used, they are used only for low temperature freeze protection of pipes and other simple systems where critical temperatures are not involved and where operating efficiency is not important.

SELF-LIMITING HEATERS

The short comings of self-limiting tapes may be listed as follows:

1. The output of self-limiting tape varies along the tape length due to its non-homogenous heating matrix.

2. The output of the heater rarely, if ever, resembles the output curves shown in manufactures literature. For freeze protection duties this is not considered important, but for critical temperatures, this huge output tolerance and, hence, process temperature excursion, is clearly not desirable.

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3. Self-limiting heaters have very high start up currents at low temperatures. This makes it impossible to provide safe over current protection. For example, a 65 metre length of self – limiting heater, with a rated output of 10w/m 240v at 10°c, will need a 16 amp fuse to allow for in-rush current surges. The normally operating current however is only 2.7 amps. Such increased cold start currents result in oversized switchgear, distribution equipment and cables, with an associated increase in costs. This is in addition to compromising safety. This problem is exaggerated with 110v heaters, as the current drawn is greater than an equivalent heater at 240v.

4. Self-limiting heaters, when subjected to temperatures above their maximum withstand temperatures, usually about 65°c, have also been known to go permanently 'open circuit'. The semi-conductive heating matrix can also lose its 'elastic memory' when subjected to higher temperatures and the constant expansion and contraction over a long period of time. Hence, the output of a self-limiting style of heater may degrade over a period of time. Without expensive thermal monitoring equipment placed along each section of the pipe, this will not become evident until heater failure results in unacceptable process temperatures and possible pipeline blockages. The service life and reliability of such heaters should, therefore, be considered by potential users.

5. Self-limiting heaters cannot be tested and monitored for correct operation as the output, and hence the resistance and current consumption, is constantly changing.

Summarising then, it will be appreciated that, when used for maintaining process temperatures, self-limiting tapes :

- Cannot achieve a uniform temperature due to an inherently non-homogenous heating matrix.
- Therefore, may have too high, or too low an output to correctly maintain the process temperature.
- Cannot be safely over-current protected.
- May be endangered by high process temperatures and may go open circuit, or thermally age with time.
- Will be wasteful of energy even when thermostatically controlled.

A further disadvantage of self-limiting tapes for process heating is the very nature of their mode of operation. The higher the desired process temperature, the greater the heat losses and hence, the heating requirements. Conversely, however, the higher the pipe temperature, the lower the heater output, due to its self-limiting nature. It is often necessary therefore, to spiral onto the pipe a large quantity of heating tape in order to achieve a suitable installed lead at the desired pipe operating temperature, whereas, with a constant wattage tape, straight tracing may be possible with a consequent substantial reduction in capital cost.

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CONSTANT WATTAGE TAPES

Constant wattage heaters exist in various forms, of which the more recent zonal parallel circuit devices are the most convenient, since these may be 'cut to length', within practical limits, on site.

Constant Wattage tapes suffer none of the major shortcomings of self-limiting tapes. By comparison :

1. The output of constant wattage tape is virtually constant along the tape length, due to the consistent nature of the wire element.

2. Heater output is always close to the nominal output stated by the manufacturer. The relevant British Standard BS 6351 requires a maximum manufacturing tolerance of plus or minus 10% on the nominal output stated in published literature. Conversely, BS 6351 recognises the imperfect nature of self-limiting tapes which shall have an output tolerance within 'limits defined by the manufacturer'. In fact, no manufacturer of self-limiting tapes willingly states any tolerance in any written material.

3. Constant wattage tapes generally do not exhibit an increases start up load and currents are practically constant at all pipe temperature. Hence, over current protection at the correct levels may be selected, as may switchgear, distribution equipment and electrical supply cables, etc.

4. The nickel alloy heating elements in constant wattage tapes are unaffected by high temperatures. Indeed, their practical limitation is usually that of the surrounding electrical insulation material. Such heaters, therefore, are not affected by thermal cycling. A correctly designed and installed constant output heating tape will cause no concern with questions concerning life and reliability.

5. Because the resistance and current drawn is substantially constant, monitoring constant wattage tapes is simple and effective using resistance monitors or ammeters.

From the foregoing, it can be seen that constant output tapes suffer none of the established disadvantages of self-limiting tapes and indeed show positive advantages all of which in a better overall process heating scheme :

- Uniformity and accuracy of temperatures.
- Reliable and predictable outputs to correctly maintain the process temperature
- Safely fuse protected.
- Unaffected by high temperatures / no thermal aging.
- More efficient (due to uniform temperature / power output.
- System can be comprehensively monitored for correct operation.

This information is by no means detailed, but hopefully will give some information concerning some of the differences between constant wattage heaters and self-regulating heaters.

For further information, please contact ESH Trace Heating Ltd.

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