TECHNICAL UPDATE - TU-4006

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SUBJECT: HEATER SELECTION FOR UNITHERM ELECTRIC TRACED BUNDLES

Unitherm electric heat traced bundles are designed with a variety of heating elements. Heating element selection is a function of the product and application requirements. There are five different types of electrical heating elements used in Unitherm bundles: the self-regulating heating element, the parallel constant wattage heating cable, the self-limiting CPD heating cable, the series resistance heating wire, and the mineral insulated heating cable.

Self-Regulating Heating Element

This heater, called SR heater, has two parallel bus conductors coated with a special semiconductive polymer that creates the heater. This polymer has a positive temperature coefficient of resistance, which means that the resistance of the heater increases in proportion to the temperature of the heater. The end result is a heating element that reduces its output as the temperature increases. This allows the engineer to design a product that maintains a minimum tube temperature at low ambient temperatures, but limits overheating at high ambient temperatures. This heating element is continuous and can be cut to very short lengths.

Two styles of SR heater are presently used, Low Temperature SR (LTSR) and High Temperature SR (HTSR) heater.

LTSR is generally used for freeze protection applications or those applications requiring tube maintenance temperatures below 70°F. It's output is close to zero at heater surface temperatures above 100°F. LTSR can handle tube upset temperatures up to 185°F. This means that this heater can be used to provide shut-down freeze protection to tubes that operate at temperatures up to 185°F. If the tube operates at a higher temperature, or is cleaned with steam, HTSR must be used.

HTSR is used where higher maintenance temperatures are required or where the tube is cleaned with steam. This heater can maintain tube temperatures in the 150°F range for most bundles, and up to 200°F for certain single tube bundles. Since the heater is self-regulating, a bundle designed around it requires more insulation to maintain the higher tube temperatures than a similar bundle designed around a CPD heater.

HTSR can withstand steam cleaning of the tube at steam pressures up to 150 PSIG, or 366°F. Temperatures greater than this will damage the heater. HTSR is generally more expensive than the other heaters due to the materials used in its construction.

One characteristic of SR heaters that is of importance in the design stage is called inrush current. These heaters are what is known as "active resistors". They have a very low resistance when unpowered. When voltage is applied to the heater, the resistance rises rapidly as heat is

generated, becoming fairly stable in about two minutes. During this period of time the current can be many times higher than the stable current. This is the inrush current.

A series of tests have been developed by the heater industry to determine the size of the circuit breakers required to handle SR heaters in response to the need to handle the inrush current. You will notice that the heater manufacturers call out maximum heater circuit lengths in terms of the circuit breaker sizes. The downside to this is that most electric codes require the branch circuit and associated equipment to be sized to handle the maximum load on any component. In the case of SR heater, the branch circuit wiring, ducts, transformers and service may have to be sized to handle 40 or 50 Amps instead of 20 Amps; because a larger circuit breaker is required to handle the inrush current.

Parallel Constant Wattage Heating Cable

This heater, commonly called the Constant Power Density or CPD heater, is comprised of two parallel insulated bus conductors. The insulation is removed from alternate bus wires at fixed lengths along the heater. A fine gauge nickel alloy heater wire is wound around the insulated conductors and joined to the bus wires where the insulation has been removed. This creates fixed zones of constant power output. The output is governed by the heater wire size and alloy, the zone length and the voltage. The wire size and alloy are selected by Furon to provide a range of power outputs at common voltages. Since the heater zones are connected in parallel along the bus wires, this heater can be cut to length without loss of power or the need to vary the voltage. Care must be taken, however, not to cut the heater in the center of a zone. If a zone is not connected at both ends, it will not heat. As the name implies, this heater provides the same output regardless of the process temperature. This heater can maintain tube temperatures in excess of 375°F (190°C), and can withstand short term upsets greater then 400°F (204°C). The maximum allowable heater surface temperature is 446°F (230°C).
A temperature controller or thermostat should always be used with this type heater to prevent overheating due to process upsets or ambient changes. These controllers will also allow the user to control the temperature within a narrow range over a wide span of ambient conditions. Since this heater uses a resistance wire to provide heat, there is no appreciable surge or inrush current on startup.

Self-Limiting CPD Heater

The SLCPD is similar in construction and appearance to the Constant Power Density heating element above, but uses a special alloy resistance wire with a positive temperature coefficient of resistance. This allows the user to maintain higher temperatures than can be achieved with the SR heating elements, but many times without the need for a temperature controller.
This heater goes by many names in the industry. In some cases it is confused with polymeric self-regulating heating tapes. Its main characteristics are that it is a zoned parallel resistance wire heater with a positive temperature coefficient of resistance.
Unlike the polymeric SR heaters, the output of the SLCPD heating element does not drop to zero at high temperatures. The output drops about 25% over the temperature range from 77°F (25°C)

to 302°F (150°C). This drop is usually sufficient to prevent a properly designed traced tubing bundle from overheating at high ambient temperatures.

Like the SR heater, this heater will not maintain a specific set temperature but rather a range of temperatures.
The maximum maintenance temperature for this heater is 302°F (150°C) and maximum exposure temperature (power off) is 482°F (250°C).
A temperature controller can be used with this heater to control the tube temperature at a point below the self-limiting temperature of the bundle. This arrangement is used many times when overtemperature safety is desired.

Series Resistance Heating Wire

The Series Resistance Heating Wire has been used in electric traced tubing bundles for over 30 years. This heater is comprised of an alloy resistance wire with a high temperature insulation and an overall metallic braid. The wire alloy and size are selected to provide the required heat output for the length of the line and the voltage applied.
Power output for this heater is generally 20-26 Watts/Ft, with outputs to 100 Watts/Ft for special applications.
The Series Resistance Heating Wire provides continuous even heat along the length of the bundle.
Maximum maintenance temperature for this heater is 400°F (204°C) with a maximum surface temperature of 482°F (250°C).
This heater is only used in ordinary locations.

Mineral Insulated Heating Cable

The MI cable is a series resistance heating wire encased in a high temperature metal sheath. Like other series resistance wires, it is sized to the length of the bundle and the voltage used. This heater is generally purchased in pre-finished lengths. Special training and tools are required to modify this in the field.
Power output for the MI heater can be as high as 90 Watts/Ft depending on the application, with maintenance temperatures above 482°F (250°C) and exposure temperatures to 1472°F (800°C).
MI heaters cables can be used in hazardous and explosive areas with proper design and termination.

Summary

The following list shows some relative differences between the six heaters listed above. If in doubt concerning the use of a specific heater in your application, contact your Unitherm representative.

Property	Heater Type					
	LTSR	HTSR	CPD	SLCPD	Series Wire	MI Cable
Max Exposure Temperature	185°F	366°F	430°F	482°F	482°F	1472°F
Max Steam Blow Down Pressure	N/A	150 PSIG	335 PSIG	335 PSIG	335 PSIG	>700 PSIG
Zone Length	Cont.	Cont.	2 -3 Ft	2-4 Ft	Cont.†	Cont.†
Max Output @ 50°F	10W/Ft	15W/Ft	18W/Ft	20 W/Ft	100 W/Ft	90 W/Ft
Max Output @ 200°F	Negligible	7W/Ft	18W/Ft	15 W/Ft	100 W/Ft	90 W/Ft
Max Circuit Length @ 120 VAC	180Ft	135Ft	260Ft	to 320 Ft	based on wire	based on wire
Max Circuit Length @ 208 VAC	360Ft	200Ft	450Ft	to 645 Ft	based on wire	based on wire
Circuit Rating @ Max Circuit Lgth	30 Amps	30 Amps	25 Amps	30 Amps	30 Amps	40 Amps
Flexibility	Excellent	Good	Good	Good	Excellent	Fair
Maximum Tube Maintenance Temp 3 tube 3/8" PFA bundle (no temp control)						
@-20F with Standard Insulation	103°F	155°F	229°F	185°F	400°F **	400°F ***
@-20F with Double Insulation	116°F	192°F	317°F	250°F	400°F **	650°F ***
@100F with Standard Insulation	132°F	195°F	284°F	255°F	400°F **	400°F ***
@100F with Double Insulation	134°F	224°F	363°F	310°F	400°F **	650°F ***
Chemical Resistance	Good	Excellent	Excellent	Excellent	Excellent	Excellent
Low Temperature Handling	Good	Very Good	Excellent	Excellent	Excellent	Good
Inrush Current Factor*	2:1	2.6:1	1:1	1:1	1:1	1:1

*Inrush Current Factor is the ratio of the circuit breaker sizing at the maximum circuit length to the current at nominal output. This factor gives an indication of the amount of upsizing required in the branch circuit and equipment to handle heater inrush current.

** Maximum maintenance temperature of heater.

*** Maximum temperature rating of bundle.

† Continuous loop resistance, not a parallel circuit.