

SUBJECT: Constant Power Density Heating Elements for Dekoron Unitherm Heat Traced Bundles

Constant Power Density (CPD) heating elements (also known as constant watt cables) are the backbone of most Unitherm Electric Traced Tubing Bundle applications where tube maintenance temperatures are above 250°F, or where exposure temperatures exceed 366°F. Self Regulating Heating Elements are generally not used for these applications as the power loading and temperatures required are above the range of this type heater. For a detailed explanation of the construction and operation of CPD and SR heaters, please see Technical Update TU-4006.

Dekoron Unitherm found that stock CPD heaters are not always the best product for our application. Most CPD users and designers are concerned primarily with field installation of heat tracing on large diameter pipes, while Dekoron Unitherm focuses on heaters for prefabricated, preinsulated electric traced tubing bundles.

The stresses seen in the construction, installation and operation of a preinsulated electric traced tubing bundle are much greater than those seen in a typical field installation. Attention to each detail of the construction of this heater is essential if the life expectancy required by today's industry is to be attained.

Dekoron Unitherm uses three different CPD heater constructions for our bundles. The selection is based upon the process temperature required and the application.

We have two fluoropolymer insulated heating elements for general freeze protection or temperature/viscosity maintenance applications.

Both designs include:

- 12 AWG stranded, nickel plated bus wires
- bonded connections between the bus wires and the nichrome heater
- tinned-copper overall braid with 85% minimum coverage
- heater zone lengths between 2 and 3 feet

Our FEP insulated CPD heater is used for applications requiring a process maintenance temperature 300°F or less. This heater provides a cost effective means of heating bundles used for general freeze protection and temperature/viscosity maintenance applications.

This heater has a maximum exposure temperature of 400°.

Our PFA insulated heater is used for applications with maintenance temperatures up to 385°F, and has a maximum exposure temperature of 450°F. This heater also features a one piece, extruded core. The extruded core provides the heater with added strength which improves heater life.

Dekoron Unitherm gas analyzer bundles employ a CPD heater constructed of Kapton® Polyimide film. This heater has a maximum exposure temperature of 575°F and can maintain process temperatures up to 550°F. Kapton provides the higher temperature rating and reduces thermal expansion. Thermal expansion has proven to be the major cause of early heater failure in gas analyzer applications.

All Dekoron Unitherm CPD heaters undergo the testing proscribed in IEEE Standard 515, "Standard for the Testing, Design, Installation, and Maintenance of Electrical Resistance Heat Tracing for Industrial Applications". In addition, Dekoron Unitherm has developed a series of tests to determine the heater's ability to withstand real-world situations. Three tests that are key are the twist test, flex test, and thermal cycle test.

The twist test gauges the ability of the heater to withstand torque introduced in the production of a cabled tubing bundle. For this test, a three zone length of heater is clamped at one end then twisted about its axis a total of two full revolutions. The heater must not lose contact with any zone connections, nor must it lose continuity in the heater or bus wires.

The flex test indicates the heater's ability to take the coiling, de-reeling, and bending seen in a typical bundle installation. Here a section of heater is bent through a 120° arc until failure. The target value is 100,000 cycles. At the end of the test there should be no damage to the heater wire or insulation. Some heater designs tested failed in as little as 50,000 cycles. A typical test value for Dekoron Unitherm heaters is 350,000 cycles before failure.

The thermal cycle test was developed to gauge the effect of daily calibration cycles on the life of a CPD heater. The test fixture powers the heater on for 8 minutes then off for 12 minutes. During this cycle, the ambient temperature is raised from ambient to 300°F then dropped back to ambient. This is similar to the effect of cold calibration gas flowing through an analyzer bundle during the calibration cycle, but greatly accelerated. The test is terminated if the heater loses one or more heating zones. Some heaters have failed in less than 360 cycles (5 days) while others have lasted up to 2000 cycles (4 weeks). The heater design used by Dekoron Unitherm for analyzer bundles was removed from the test after 14,000 cycles (over 6 months) and was still operating.

In addition to the tests outlined above, Dekoron Unitherm has been testing the effect of temperature control methods on heater life. Five identical bundles were powered to 275°F using the following control methods:

- On-Off control using a bulb-and-capillary thermostat
- On-Off control using an electronic controller with a 20°F deadband
- Time proportional control without reset or derivative functions
- PID control
- Voltage proportioning control.

At the time of this update, these bundles have been operating for five years with no loss of heater function or increase in current draw. This test shows that the Dekoron Unitherm CPD heater can be controlled successfully with any common type of controller.

Dekoron Unitherm feels that the CPD heater used in our electric traced tubing bundles is a rugged design and is well suited to the application. Testing is continuing on these and other heaters present and future bundle applications.