Unity Lab Services
A Thermo Fisher Scientific Brand

Instruction

1700C Furnace Operations Expectations and Diagnostics

Lindberg Blue M brand furnaces

1700C furnaces
Revision Date: December 24 2020

1700C Furnace Operations Expectations and Diagnostics

This document includes:

Introduction
Model numbers
Unique Molybdenum disilicide heating elements
Control system used with 1700C furnace
Thermocouples used to measure temperature
Installation of 1700C furnace
Operation of 1700C furnace
Temperature control and heating limitations
Diagnostics

Introduction

The following is an overview of the 1700°C furnaces, to better understand this equipment and some of the differences when compared to lower temperature furnaces with traditional control components.
The normal Operations and Expectations along with Diagnostics is covered.

Model numbers

BF51634C and BF51664C are Box furnaces that have the Controller, relays, fuses, transformer Integrated in the same cabinet at the Chamber with heating elements and thermocouple.

BF51314C and BF51524C, are Box furnaces while STF54434C and STF54454C are Tube furnaces that include an Independent Cabinet with the Chamber, heating elements and thermocouple.
These models require an Independent Control Console that includes the Controller, relays, fuses, and transformer.
This design allows for some flexibility in the positioning of the Furnace, with the Controls nearby.

BF51314C is matched to CC59246PCOMC-1
BF51524C and STF54434C are matched to CC59256PCOMC-1
STF54454C is matched to CC59256PCM2CTC-1

Unique Molybdenum disilicide heating elements

The 1700C furnace uses unique Molybdenum disilicide heating elements, that are ceramic-like and fragile at room temperature, but become softer when energized and heated.
The Resistance in these elements increases from 3-Ohms for a group of 12 at room temperature, to 6-Ohms while they are at 1700C.

Control system used with 1700C furnace

This heater circuit requires a current-limiting device, known as the Power Module, to regulate the voltage pulse applied to these heaters while cold, along with a step-down transformer to limit the current draw on the building 240 VAC supply.

If the current-limiting device is replaced, a Current calibration is required.
Braided wire connections are used at the terminals of these elements.

Thermocouples used to measure temperature

The B-Type thermocouple is used in all the 1700C furnaces.
This temperature sensor provides accurate measurements in the operating range from 500 to 1700C, but is inaccurate between 20 and 500C.
This inaccuracy is small, and not a problem for most applications and processes.

Installation of 1700C furnace

The Integrated furnaces only need building voltage delivered to the cabinet, and the furnace is ready to operate.

Professional electrician is recommended to select and install wiring that follows local practices and codes, and delivers the recommended voltage and amperes.

The Independent furnaces require the building voltage delivered to the Control Console, with additional wiring between the Furnace and Control Console to carry voltage for the Cooling fans and Heaters.
The Thermocouples are delivered installed in the Furnace and need to be plugged into the Console.

Standard work surfaces are sufficient under these furnaces. But devices to protect the adjacent surfaces may be useful if a hot Load is removed and needs to be cooled.

Operation of 1700C furnace

With building voltage is supplied to the Furnace/Console, and the power switch 'off', cooling fans are operating in the Furnace and Control cabinets. These fans cool the heater wiring and control components while the power switch on the furnace is in the 'off' position.

After the furnace power switch is 'on', the digital controller boots up.
If the controller process was interrupted with the last power-off, the controller will work to achieve the last command.
If the controller process was stopped prior to last power-off, the controller awaits a button press to select a setpoint or run a Program.

The digital controllers will display the measured temperature in the chamber, along with the target setpoint, or progress of the running Program.

Most control panels have an Ammeter that shows the measured electrical current from the building supply toward the heater circuit. This meter pointing to a high level of amps indicates that the Heaters and control circuit are operational. The actual current measurement will vary throughout the heating, holding and cooling temperature process.

The Integrate furnace models BF51634C and BF51664C have a Door switch that will interrupt voltage to the heaters while the Door remains open.
A red "Ready" indicator lamp on the control panel illuminates while the Door is closed and indicates the potential of voltage going to the Heaters. The Ready lamp extinguishes while the door is open, or while there are Controller alarm events or other circuits interrupting the voltage going to the Heaters.

The Independent furnaces do Not have the Door switch and Ready lamp features.

The Box furnace Chamber door can be opened and loaded or unloaded while cold or hot.
The Tube furnace Chamber should be loaded with a Process Tube only while cold.

Temperature control and heating limitations

Both Single-setpoint and multiple setpoint (Programming) operations are available.

These furnaces heat quickly to the selected setpoint, generally achieving approximately 1400C in 30-minutes or less, with maximum temperature of 1700C achieved in less than 2-hours.

Slowing the heating rate is achieved through Programming a ramp rate, or programming a length of time to achieve the desired setpoint. Programs typically include a hold or Dwell time, to sustain the temperature for a desired length of time needed for the Process or Load. Programs can also include a cool-down phase that would be slower than the natural heat-loss from the chamber.

Diagnostics

Problems can occur while operating these furnaces.
Below are many of these problems and diagnostics to solve or better understand the issue.

Controller is blank

- Check if the cooling fans are operational. If operational, the Building electrical supply is good.
- If the cooling fans are stopped, Check the building electrical supply.
- Check the power switch on the Control Panel is in the 'on' position. This switch also operates as a Circuit Breaker and will trip to the Middle-position. If tripped, move to 'off, then 'on' position.
- Check the fuses for the Controller circuit, located on the rear or inside the Cabinet.

Controller shows Sensor failed, burned out or broken

- Thermocouple has failed.
- Thermocouple Wires are loose or disconnected at thermocouple terminal or controller.
- Check if the Controller configuration was changed to Different sensor type.

Cooling fan is not moving

- Check the building voltage to the Furnace or Control Console.
- Check wiring between Control Console and Independent furnace.
- Possible defective fan.

No Heat

- Furnace was just powered-on; allow 1-hour for temperature to stabilize.
- Wires between Control Console and Furnace have not been installed.
- Transformer wire changes, to operate on 208 VAC supply, are on wrong terminal.
- Thermocouple receptacle on rear of Control Console is empty because insufficient thermocouples were installed in the furnace by Production, to match the Control design.
- Check the door switch operations on the Integrated Box furnaces.
- Check the Controller is operating to an elevated setpoint, to increase the temperature.
- Check the Heating elements for a break in the chamber, or a break in the portion that passes through the insulation.
- Check the braided wires connecting the heater terminals, and the ceramic terminals at corners.
- Check wire connections for the heater circuit in the control compartment.
- Check the Heater fuses in the control compartment.
- Check the signal from the Controller to the Power Module which controls voltage to Heaters.
- Check the Over-Temp controller installed in some models.
- Check the Controller configuration.

Ammeter stays at Zero

- Check items listed above for “No Heat”

Heating is slow

- Check the door switch operations on the Integrated Box furnaces.
- Check the Program ramp rate is set as expected.
- Power module may be faulty and not passing the voltage to match the incoming signal.
- Heat losses from the Door with a poor seal to the chamber opening.
- Noisy, chattering or non-functioning mechanical relay. May be from low voltage to relay coil. If less than 200 VAC delivered from building, these relays will not close properly.
- Process tube is not installed in Tube furnace and heat leaks out openings.

Temperature is too high

- Check the controller program or single-setpoint setting.
- Check thermocouple wires between controller and thermocouple terminals. A short of these wires will create an additional temperature measurement which is interpreted by the Controller as a temperature lower than the actual temperature in the chamber.

Temperature is fluctuating at setpoint

- Check the PID control parameters
- Run Auto tune function built-in to the Controller

Element has spots or flakes

- The 1700C elements will normally produce spots or flakes of Silica on the surface, to flush away contaminates from the element surface.
- During temperature changes, this Silica will break and fall off, landing in the chamber, and possibly on the Load.
- Heat chamber above 995 °C to restore element coating.

Element is Curling sideways toward other heaters

- The Grain direction of an element may cause the element to curl to the side (parallel to chamber insulation). This grain direction is set by the manufacturer to normally cause the elements to move toward or away from the insulation. No Corrective Action can be made to this part.
- The twisting or torque of the braided wires on the heater terminals can cause the element to curl to the side, because the element becomes soft at higher temperatures.

- It is recommended that the terminal braids be pre-formed to allow the loops to slide onto both element terminals (one each of adjoining elements), without twisting or shaping the braid. After the loops are installed, the terminal clamps are carefully applied to each loop.

Element curling in toward insulation

- This curling toward the insulation can be caused by the location of the product load. Loads too close to the element will overheat the element surface nearest the load, causing the element to expand on the load-side and curl toward the insulation.

Element curling out toward center of chamber

- If the elements are installed too close to the insulation, the element will expand on the surfaces nearest the insulation and curl outward toward the center of chamber and product load.

Cracks in the chamber insulation

- Small cracks, less than 1/8-inch wide, are common and not detrimental to the operation and performance of the furnace. These cracks represent the normal shrinkage of the insulation.
- Carefully monitor cracks at the chamber ceiling, that they do not get wider, as there is no support in the center of the ceiling insulation.
- Cracks that continue to get wider, or connect into polygon shapes, indicate the insulation is experiencing temperatures higher than the insulation tolerance.
  Check the thermocouple accuracy, because thermocouples typically drift to Colder temperatures, causing the actual temperature to be hotter than shown on the Controller.

Paint is burned on the door or above the door

- Check the Door insulation and contact to the chamber opening.
- The Independent Box furnaces do not have any soft insulation materials at the door or chamber to act as a seal to reduce heat and smoke losses.
  Adjust the closure of the Door to the Chamber opening to minimize the heat losses at this junction of insulation. Replace door insulation as needed.
- Check the door catch-latch on the Integrated Box furnaces.
- The Integrated Box furnaces has a soft insulation at the front of the chamber, which may be worn. This insulation can be replaced.

End of Document