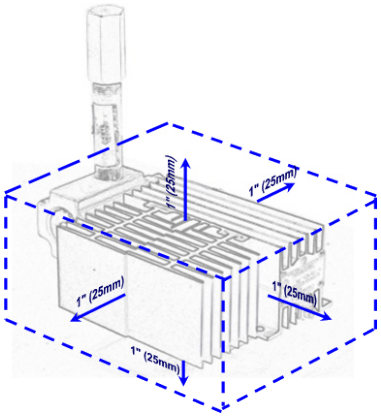
Enclosure Heaters
Best Practices for Selection and Installation

Electric heaters in large enclosures with high maintain temperatures (100°F/40°C and higher) can present some difficult challenges:

- provide enough heat to reach the maintain temperature on the coldest day,
- keep the footprint as small as possible,
- limit the temperature of hot surfaces to prevent ignition of flamable gasse and liquids that may be present.

The most common heater failure is that an internal temperature fuse gets too hot and shuts off the power to the heater cartridge. Heaters that are approved for use in hazardous areas include a non-resettable temperature fuse that keeps the surface of the heater from getting too hot and igniting flammable gasses, liquids or solids in the area. So, the heater has actually done exactly what it was supposed to do to maintain a safe condition. The question now is why did it get too hot?



Allow a minimum of 1" (25mm) on all sides, top and bottom of heater for sufficient airflow.

The entire system of heater, inside air temperature, insulated enclosure and outside air temperature has to reach a balance. In its simplest form it is governed by the following formula:

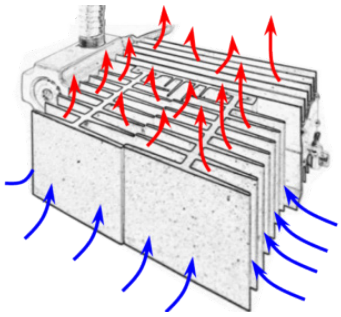
Q = UAΔT

Q = heat in Btu/hr

U = an overall coefficient of heat transfer

ΔT = difference of the enclosure maintain temperature (Te) and the outside ambient temperature (Ta)

The problem of heating analyzer cabinets (or any enclosure) wraps one heat transfer computation around another. First we solve the equation for the heat loss of the enclosure. You know the size of the enclosure "A" you know the temperature you want to maintain inside the enclosure (Te) and you know the minimum ambient temperature outside the enclosure (Ta). The difference is "ΔT".



Fins must be vertical to allow for airflow.

The enclosure material and insulation type and thickness determine the "U" value. For a stainless steel enclosure with 1" of fiberglass insulation 0.3 is a typical U-value.[Note 1] Substitute the numbers in the equation and you get the amount of heat in Btu/hr required to maintain the inside of the enclosure at your desired set point in the ambient you specified.

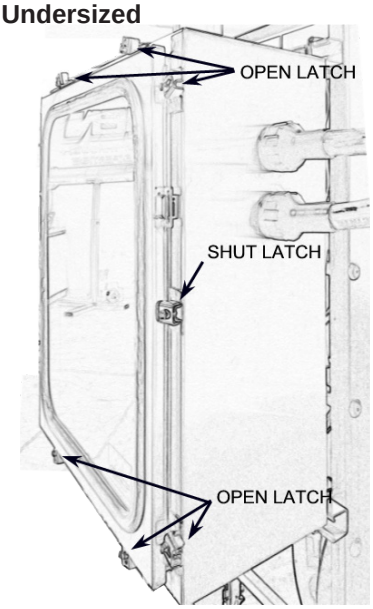
Example: A 36" x 24" x 12" enclosure with 1" of rigid fiberglass insulation maintaining 100°F when it is -40°F outside requires 924 Btu/hr. If we want to start our system at the low ambient and heat it to the desired maintain temperature within a reasonable time we need additional heat. An additional 30% is commonly included for cold start up and as a safety factor or 1201 Btu/hr. There are 3.413 Btu/hr per watt so we need an electric heater with a minimum of 352 watts.

As long as we install a heater with this minimum wattage output we will balance the equation. The energy supplied by the heater must equal or exceed the heat energy lost through the enclosure walls.

Heat Loss Through Enclosure = Heat Supplied by Heater

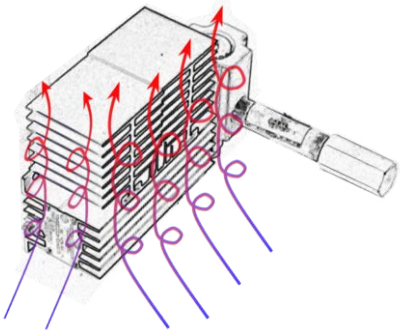
Ue * Ae * (Te – Ta) = Uh * Ah * (Th – Te)

Undersized



Latches that are left open can increase the heat loss by 20 – 30%.

If the heater is undersized it can never supply enough heat to satisfy the enclosure temperature and turn itself off with the temperature switch. Looking at the right side of the equation above representing the heater the only variables are the temperature of the heater body and air in the enclosure. The value of UA for the heater is essentially constant.

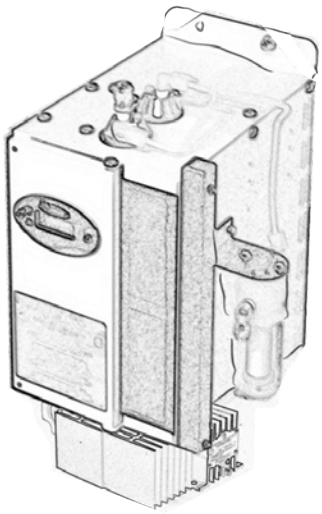


Incorrectly mounted heater does not allow for proper airflow.

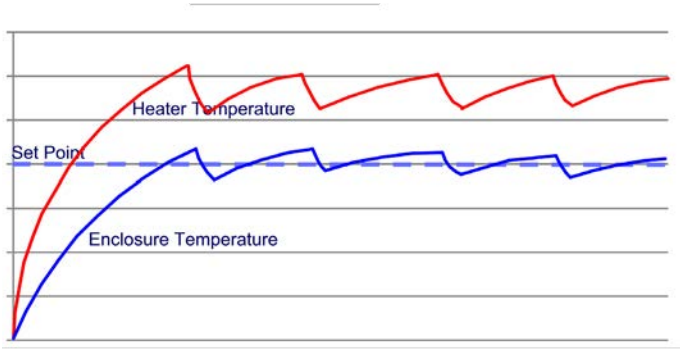
To satisfy the energy demanded by the enclosure losses the heater will continue to get hotter and hotter until the internal temperature safety fuse trips and turns it off. The heater has stopped working.

Blocked Airflow

If the heater does not have adequate air circulation it reduces the effective U-value causing the heater body temperature to increase in an attempt to satisfy the enclosure demand. This usually happens because one or both of two conditions exist: 1. There is insufficient air gap under, over and to the sides of the heater (1” minimum in all directions) 2. The heater is mounted incorrectly so the fins are not vertical. In either instance the heater body gets hotter and hotter until the internal temperature safety fuse trips and turns it off. The heater has just stopped working.



Equipment directly above the heater can block airflow.



Note 1

Do not use the reciprocal of the R value for fiberglass insulation in this calculation. It will yield a false and low number for the heat loss through the enclosure. There are areas where the stainless steel is exposed inside and outside, such as in the door edges. There is higher heat loss around the penetrations and at corners where the insulation may be compressed or gaped. The U-value takes all factors into consideration including the transfer from the heated air to the insulation and the outside surface of the enclosure to the ambient air.

Frequently Asked Questions

1. Why do O'Brien Corporation's heater sizing calculations require more watts than our calculations? We already use a safety factor.

Calculating the heat loss from an enclosure is a relatively simple problem. Differences may be due to the insulating properties used for the enclosure type and insulation as well as heat up and safety factors applied. We use values that have been refined through testing to determine heater performance for each application.

2. What information is needed by O'Brien to properly calculate the size of the heater?

- *Exterior dimensions of enclosure*
- *Insulation type and thickness*
- *Window (if yes, what size)*
- *Maintain temperature*
- *Low ambient temperature*
- *Voltage*
- *Hazardous area classification*

3. Why does the heater fail? I should be able to put the heater on the floor and it should get hot.

Heaters approved for use in hazardous areas require an internal temperature fuse to insure that the heater does not become an ignition source. When a heater is undersized or installed incorrectly, the heater will overheat and the thermal fuse will activate.

4. Why do the heaters only come with a 30 day warranty without a thermostat installed?

Heaters are designed for a specific application. When a thermostat is not supplied we cannot ensure that the heater is operated within its design parameters.

5. What is recommended best practice for installing a T heater in my enclosure? (air gap, orientation, placement of thermostat)

Allow 1" (25mm) on all sides, top and bottom of the heater for air circulation. The heater must be oriented so the gap between the fins is vertical and unobstructed to allow air circulation. The thermostat should be placed at a representative point in the enclosure not directly over the heater.

6. Can I use one thermostat with multiple heaters?

More than one heater can be used with a single thermostat, provided the current ratings of the thermostat are not exceeded.

7. What types of thermostat is offered by O'Brien? How precise is it?

Our standard thermostat is a snap-action switch. The individual switching point will be within ±5°F (3°C) of the marked temperature. Eg. A 50°F (10°C) thermostat may have a set point as low as 45°F (7°C) or as high as 55°F (13°C). Other styles are available as options; please contact the factory for details.

Bulb and Capillary
FM, CSA, ATEX approvals Div 1 / Zone 1
125 – 250V / 22A
Adjustable set point (-4 to 163°C)
Accuracy ±5°C

Electronic Thermostat
FM, CSA, ATEX approvals Div 1 / Zone 1
125 – 250V / 16A
RTD Sensor
Adjustable set point (0°C to 499°C)
Accuracy ±1°C

Single Point Controller
FM / CSA Div 2 / Zone 2
125 – 250V / 30A
RTD Sensor
Adjustable set point (0°C to 200°C)
Accuracy ±1°C
Integral Ground Fault Protection
Programmable Alarms
Local Indication

Dual Point Controller
FM / CSA Div 2 / Zone 2
125 – 250V / 30A
Dual RTD Sensors:
Adjustable set point (0°C to 200°C)
Accuracy ±1°C
Integral Ground Fault Protection
Programmable Alarms
Local Indication

8. Why do I need to fill out a form in order to receive a quotation on a heater?

The information on the form ensures that we have all the information to correctly size a heater for the application. The form is a good communication tool and when the maintain temperature is 125°F/50°C and higher or more than 400 watts is neede we always use this format.

9. What is the temperature range of thermostats offered?

O'Brien Corporation's standard thermostats are 50°F (10°), 75°F (25°C), 100°F (40°C), 125°F (50°C), and 150°F (65°C). We also have available set points of 175°F (80°C), and 190°F (88°C) consult our product specialist team for higher maintain temperatures and alternate temperature controllers.

10. What is the deadband or tolerance that my heater will maintain temperature in the enclosure?

The snap action switch has a 10°F (6°C) deadband. If it turns off at 50°F (10°C) it will not turn back on until the temperature has dropped to 40°F (4°C).

11. What orientation allows for the smallest footprint in my enclosure?

Heaters are configured for horizontal or vertical installation. The difference is the orientation of the fins and the unobstructed airspace between them. Vertical installations cover less area on the floor of the enclosure. Horizontal installations consume less vertical space. Either configuration will require the same volume.

12. Why does a heater fail when put in the wrong orientation?

Heaters utilize fins to transfer heat to the air in an enclosure. The air must be free to flow past the surface of the fins using the natural convection currents. If the airflow is restricted by another fin above it or a web between fins the heater continues to get hotter and hotter until it reaches the maximum safe operating temperature and the internal temperature blows so that further damage by overheating or fire is prevented.

13. Do O'Brien heaters have approvals?

O'Brien T-Series heaters carry the following approvals:
NEC & CSA: Class I Division 1 Group A, B, C, D (T2 or T3)
ATEX: II 2 G Ex d IIC T3

14. What is a "T" Rating?

Heat producing equipment is marked with a Temperature Rating, to indicate the maximum surface temperature.

Temperature Rating	*T1*	*T2*	*T3*	*T4*	*T5*	*T6*
Max Surface Temp (°C)	*450°*	*300°*	*200°*	*135°*	*100°*	*85°*

In the NEC/CSA Division System there are intermediate temperatures indicated by a letter following the T Rating number.

The highest allowable temperature rating is based on the lowest auto-ignition temperature of all the hazardous materials in the area.