Selecting the Right Heater for the Job

By: Watlow - March 17, 2020

Choosing a heater (/en/products/heaters) is a complex process that incorporates many elements. After calculating the required wattage (/en/resources-and-support/engineering-tools/wattage-calculator) you should consider the application of your heater. This includes everything from how hot it will operate, to the safety factors and life cycle of the unit. And finally, the replacement costs need to be taken into consideration. Here we highlight some of the main areas that should affect your heater selection.

Watt densities

A heater's Watt density rating gives us an indication of how hot a heater will operate. This information is used to establish limits on the heater application. Including the various temperatures and variety of operating conditions. The maximum operating Watt density is based on applying a heater such that heater life will exceed one year. In conjunction with the desired life, Watt density is used to calculate both the required number of heaters and their size.

Mechanical considerations

Full access must be provided (in the design process) for ease of heater replacement. This is usually done with shrouds or guards over the heaters. These guards can also minimize convective heat losses from the back of heaters and increase the efficiency of the system.

Where the heater must be attached to a surface (/en/app-guide/sys-ex-solid), it is extremely important to maintain an intimate contact, to aid heat transfer. Heaters mounted on the exterior of a part should have clamping bands or bolts to facilitate this contact. Heaters inserted in holes should have hole fits as tight as possible to improve the heat transfer from the heater to the material. Whenever possible, the holes should exit through the opposite side of the material to facilitate the removal of the heater.

Operating environment factors

Contaminants are the primary cause of shortened heater life. Decomposed oils and plastics (hydrocarbons in general), conductive pastes used as anti-seize materials, molten metals and metal vapors can all create situations that affect heater life. Some heater constructions are better sealed against contaminants than others. In analyzing applications, all possible contaminants must be listed in order to be able to fully evaluate the proposed
heater.

The corrosiveness of the materials heated, or the materials that will contact the heater must also be taken into consideration. Even if a heater is completely sealed, the choice of the external sheath material is very important to heater life.

Explosive environments generally require that the heater be completely isolated from potentially dangerous areas. The heater can be put in protective wells and the wiring routed through sealed passageways, out of the hazardous area. Very close fusing is recommended in these cases to minimize the magnitude of the failure, should it occur.

Safety factor calculation

Heaters should always be sized for a higher value than the calculated figure, often referred to as adding in a safety factor. Generally speaking, the fewer variables and outside influences in the system, the smaller the safety factor.

Here are some general guidelines:

- 10 percent safety factor for large heating systems or when there are very few unknown variables.
- 20 percent safety factor for small to medium heating systems where you are not 100 percent sure you have accurate information.
- 20 to 35 percent for heating systems where you are making many assumptions.

How long will the heater last?

The higher the temperature, the shorter a heater's service life. Mineral insulated heaters using traditional alloys for resistance elements are subject to the life-limiting factor of wire oxidation. The winding wire oxidizes at a rate proportional to the element temperature. If the element temperature is known it is possible to project a heater life.

Heaters utilizing lower temperature-rated insulating materials (silicone rubber and mica) have life-limiting factors. These are associated with exceeding the temperature limits of the insulation and with thermal cycling. Flexible heaters, mica strip and band heaters must be properly sized and controlled (/en/products/controllers), to minimize temperature swings during thermal cycling of the elements.

Excessive thermal cycling will accelerate heater failure. The worst cycle rate is one that allows full expansion and full contraction of the heater at a high frequency (approximately 30 to 60 seconds on and off).

Replacement cost

The cost of replacing a failed heater must be considered when choosing a heater. Generally, these costs are actually much greater than expected. Heater life must be such that replacement can be scheduled and planned during off-peak production times to avoid lost production. The following factors should be considered when determining the cost of a heater replacement:

Removal of existing heater
Equipment downtime cost
Material cost — heater, brackets, wiring
Labor to remove and install heating elements
Additional purchasing costs
Scrap products after heater failure and during the restart of the process
Frequency of burnouts

Cost case study

A plastic extrusion barrel is operating 40 hours per week. The barrels are using five-band heaters are utilized at 1000 watts each. The energy cost of these barrels is $0.07/kWH. Assume one-shift operation or 2080 hours per year to calculate the replacement cost of these heaters.

Case 1: Shrouded and Uninsulated = 4.06 kW/H

Annual Energy Cost:

2080 Hours x 4.06 kW/H x $0.07/kWH = $591.00

Replacement Cost:

5 Heaters x $12.00 Each = $60

4 Hours Labor to Install x $20.00/hr = $80

4 Hours Lost Production Time x $50.00/hr = $200

Total/Year = $931

Case 2: Shrouded and Insulated = 2.38 kW/H

Annual Energy Cost:

2080 Hours x 2.38 kW/H x $0.07/kWH = $346

Replacement Cost:

Same as Case 1 = $340

Total/Year = $686