Technical Information

Heating Solids - Platens, Dies & Molds

The calculation of heating requirements for heating solid materials (such as platens, dies and molds) is similar to other applications. The following is a typical application problem:

Example — A plastic forming process uses 20 lbs of plastic (Cp = 0.45 Btu/lb/°F) per hour. The plastic is pliable at 300°F and is formed by two steel platens, each 24 in. long x 12 in. wide x 3 in. thick and weighing 245 lbs. The platens must be preheated to 300°F in the closed position within 30 minutes. The top and bottom of the platens (press side) are insulated with 1/2" of rigid insulation.

Initial Heat Up — To heat the steel platens (Cp = 0.12 Btu/lb/°F)

$$kW = \frac{\text{Lbs} \times Cp \times \Delta T}{3412 \text{ Btu/kW} \times t}$$

$$kW = \frac{245 \text{ lbs} \times 2 \times 0.12 \text{ Btu/lb/°F} \times (300 - 70\text{°F})}{3{,}412 \text{ Btu/kW} \times 0.5 \text{ hrs.}}$$

kW = 7.93

Losses from exposed edges during heat-up: (See Graph G-125S, Curve "A", for oxidized steel.) Edge area = 2 (2 ft) + 2 (1 ft) x 0.5 ft = 3 ft^2

$$kW = \frac{3 \text{ ft}^2 \times 200 \text{ W/ft}^2\text{/hr}}{1000 \text{ W/kW}} = 0.6 \text{ kW/hr}$$

Losses by conduction from top and bottom insulated surfaces of the platen —

$$kW = \frac{\text{Area ft}^2 \times k \times \Delta T}{3412 \text{ Btu/kW} \times d}$$

Where:
k = 0.45 Btu/hr/in/Ft^2/°F thermal conductivity of rigid insulation (Properties of Non-metallic Solids) d = thickness of insulation (0.5 inch)

$$kW = \frac{2(2 \text{ ft}^2) \times 0.45 \times (300 - 70\text{°F})}{3412 \text{ Btu/kW} \times 0.5 \text{ in.}} = 0.24 \text{ kW/hr}$$

Average losses 0.6 kW + 0.24 kW ÷ 2 = 0.42 kW/hr

kW for start up = 7.93 + 0.42 x 1.2 SF = 10.0 kW

Operating Requirements — (Assume losses from opening and closing the platens are negligible.) To heat plastic:

$$kW = \frac{20 \text{ lbs} \times 0.45 \text{ Btu/lb/°F} \times (300 - 70\text{°F})}{3412 \text{ Btu/kW}} = 0.61 \text{ kW}$$

Losses = 0.6 kW + 0.24 kW = 0.84 kW
Total kW = 0.61 kW + 0.84 kW = 1.45 kW
Required kW = 1.45 kW x 1.2 SF = 1.74 kW

Since the heat-up requirement is greater than that for operation, install 10 kW.

Heater Selection — While most platen and die heating applications are accomplished with cartridge heaters, strip or tubular heaters may also be used by inserting them into grooved slots in the metal. (See clamp-on heater applications.) When selecting cartridge heaters, it is essential that the following factors be considered to ensure reasonable heater life and sufficient heat.

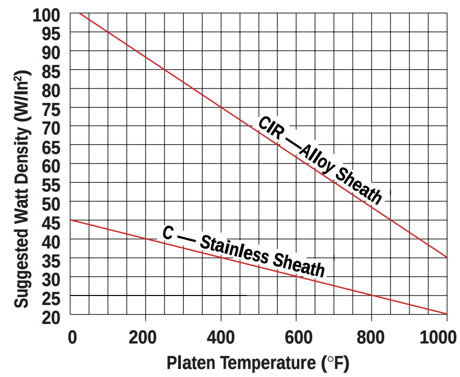
1. **Select Watt Density —** The maximum permissible sheath watt densities for INCOLOY® sheath (CIR) cartridge heaters for a given metal temperature are shown on Graph G-235A. These curves plot the recommended watt densities for various hole clearances. Graph G-201 is useful for determining watt density for optimum life when selecting type CIR heaters.

2. **Determine Proper Fit —** When cartridge heaters are installed in a machined or drilled hole, the hole should be sized to the nominal diameter of the heater. For best fit, holes should be drilled slightly undersized and reamed to the nominal heater diameter. Actual diameters of standard cartridge heaters are 0.003 to 0.005" smaller than nominal. This allows for easy installation when cold. Sheath expansion upon heating provides an interference fit and maximum heat transfer.

3. **Protect Cartridge Heaters from External Contamination —** Contamination can occur when moisture, oil, etc. enters the sheath through the lead wires or terminal end. (The end opposite the lead wires is protected by a seal welded end disc.) Contamination frequently causes short life and dielectric failure. Special moisture resistant terminal constructions are available and hermetic seals can be supplied when severe contamination problems are present.

4. **Provide Mechanical Protection for the Lead Wires —** Most high temperature lead wire electrical insulations have little resistance to mechanical abrasion. Special constructions using sleeving or conduit for mechanical protection are available.

Graph G-201* — *Suggested Watt Density Limits for Optimum Life



Graph G-235A* — *Maximum Watt Density Vs. Platen Temperature for Various Fits Using Type CIR Cartridge Heaters