



# **Checklist — Selecting a High Temperature Tubular Duct Heater**



### Sizing the Duct Heater

To properly match a duct heater to an application, the wattage, air velocity and element watt density must be determined.

Formulas and graphs on the following pages that will aid you in your design include:

- Wattage calculation formulas and table
- Element Watt Density vs. Sheath Temperature and Air Velocity Graph
- Pressure Drop vs. Air Velocity Graph

# In most applications the following design limitations should be adhered to:

- Maximum watt density of 40 watts/in<sup>2</sup> (6.2 watts/cm<sup>2</sup>)
- Maximum element sheath temperature of 1400°F (760°C)
- Minimum air velocity of 200 feet per minute (61 meters per minute)
- Maximum voltage for UL certified heaters is 480V.
- Maximum voltage for CSA certified heaters is 600V.

### ✓ Calculating Minimum Wattage Requirement

#### **Calculating Minimum Wattage Requirement**

Table is for quick-estimation purposes and is based on air under standard conditions (70°F inlet air temperature at 14.7 PSIA).



*Note:* If air flow is given in CFM at operating temperature and pressure it can be converted to SCFM (Standard Cubic Feet per Minute) with the following formula (use the equations to the right for compressed air):

$$SCFM = CFM \times \frac{P}{14.7} \times \frac{530}{T + 460}$$

- P = operating pressure (gauge pressure + 14.7)
- T = operating temperature

Remember when calculating wattage to use the maximum anticipated air flow and to compensate for any heat losses.

#### For free air use equations:

$$KW = \frac{SCFM \times \text{Temperature rise (°F)}}{3000}$$

 $KW = \frac{SCMM \times \text{Temperature rise (°C)}}{47}$ 

#### For compressed air use equations:

$$\begin{split} \mathrm{KW} &= \frac{\mathrm{CFM^{*}} \times \mathrm{Density^{*}} \left( \mathrm{lbs/cu. ft.} \right) \times \mathrm{Temperature \ rise} \ (^{\circ}\mathrm{F})}{228} \\ & \mathbf{or} \\ \mathrm{KW} &= \frac{\mathrm{CMM^{*}} \times \mathrm{Density^{*}} \left( \mathrm{kgs/cu. m} \right) \times \mathrm{Temperature \ rise} \ (^{\circ}\mathrm{C})}{57.5} \end{split}$$

\*At heater inlet temperature and pressure

Note: The free air equations include a 6% safety factor.

#### KWH to Heat Air at Selected Flow Rates

	Temperature Rise (°F)										
mt. of Air	50	100	150	200	250	300	350	400	450	500	600
CFM	Kilowatt Hours to Heat Air										
100	1.7	3.3	5	6.7	8.3	10	11.7	13.3	15	16.7	20
200	3.3	6.7	10	13.3	16.7	20	23.3	26.7	30	33.3	40
300	5.0	10.0	15	20.0	25.0	30	35.0	40.0	45	50.0	60
400	6.7	13.3	20	26.7	33.3	40	46.7	53.3	60	66.7	80
500	8.3	16.7	25	33.3	41.7	50	58.3	66.7	75	83.3	100
600	10.0	20.0	30	40.0	50.0	60	70.0	80.0	90	100.0	120
700	11.7	23.3	35	46.7	58.3	70	81.7	93.3	105	116.7	140
800	13.3	26.7	40	53.3	66.7	80	93.3	106.7	120	133.3	160
900	15.0	30.0	45	60.0	75.0	90	105.0	120.0	135	150.0	180
1000	16.7	33.3	50	66.7	83.3	100	116.7	133.3	150	166.7	200
1100	18.3	36.7	55	73.3	91.7	110	128.3	146.7	165	183.3	220
1200	20.0	40.0	60	80.0	100.0	120	140.0	160.0	180	200.0	240 /
	<b>mt. of Air</b> <b>CFM</b> 100 200 300 400 500 600 700 800 900 1000 1100 1200	mt. of Air 50   CFM 50   100 1.7   200 3.3   300 5.0   400 6.7   500 8.3   600 10.0   700 11.7   800 13.3   900 15.0   1000 16.7   1100 18.3   1200 20.0	mt. of Air CFM 50 100   100 1.7 3.3   200 3.3 6.7   300 5.0 10.0   400 6.7 13.3   500 8.3 16.7   600 10.0 20.0   700 11.7 23.3   800 13.3 26.7   900 15.0 30.0   1000 16.7 33.3   1100 18.3 36.7   1200 20.0 40.0	store 50 100 150   CFM 50 100 150   100 1.7 3.3 5   200 3.3 6.7 10   300 5.0 10.0 15   400 6.7 13.3 20   500 8.3 16.7 25   600 10.0 20.0 30   700 11.7 23.3 35   800 13.3 26.7 40   900 15.0 30.0 45   1000 16.7 33.3 50   1100 18.3 36.7 55   1200 20.0 40.0 60	50 100 150 200   CFM 50 100 150 200   100 1.7 3.3 5 6.7   200 3.3 6.7 10 13.3   300 5.0 10.0 15 20.0   400 6.7 13.3 20 26.7   500 8.3 16.7 25 33.3   600 10.0 20.0 30 40.0   700 11.7 23.3 35 46.7   800 13.2 26.7 40 53.3   900 15.0 30.0 45 60.0   1000 16.7 33.3 50 66.7   1100 18.3 36.7 55 73.3   1200 20.0 40.0 60 80.0	mt. of Air CFM 50 100 150 200 250   100 1.50 200 250 250 250   100 1.7 3.3 5 6.7 8.3   200 3.3 6.7 10 13.3 16.7   300 5.0 10.0 15 20.0 25.0   400 6.7 13.3 20 26.7 33.3   500 8.3 16.7 25 33.3 41.7   600 10.0 20.0 30 40.0 50.0   700 11.7 23.3 35 46.7 58.3   800 13.3 26.7 40 53.3 66.7   900 15.0 30.0 45 60.0 75.0   1000 16.7 33.3 50 66.7 83.3   1100 18.3 36.7 55 73.3 91.7   1200 20.0 40.0 60 80.0	mt. of Air CFM 50 100 150 200 Z50 300   100 1.7 3.3 5 6.7 8.3 10   200 3.3 6.7 10 13.3 16.7 20   300 5.0 10.0 15 20.0 25.0 30   400 6.7 13.3 20 26.7 33.3 40   500 8.3 16.7 25 33.3 41.7 50   600 10.0 20.0 30 40.0 50.0 60   700 11.7 23.3 35 46.7 58.3 70   800 13.3 26.7 40 53.3 66.7 80   900 15.0 30.0 45 60.0 75.0 90   1000 16.7 33.3 50 66.7 83.3 100   1100 18.3 36.7 55 73.3 91.7 110   1200<	$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	Imt. of Air CFM 50 100 150 200 250 300 350 400   CFM 50 100 150 200 250 300 350 400   CFM Kilowatt Hours to Heat Air   100 1.7 3.3 5 6.7 8.3 10 11.7 13.3   200 3.3 6.7 10 13.3 16.7 20 23.3 26.7   300 5.0 10.0 15 20.0 25.0 30 35.0 40.0   400 6.7 13.3 20 26.7 33.3 40 46.7 53.3   500 8.3 16.7 25 33.3 41.7 50 58.3 66.7   600 10.0 20.0 30 40.0 50.0 60 70.0 81.7 93.3   800 13.3 26.7 40 53.3 66.7 80 93.3 106.7	Int. of Air CFM 50 100 150 200 Temperature 250 Rise (°F) 300 400 450   00 1.7 3.3 5 6.7 8.3 10 11.7 13.3 15   200 3.3 6.7 10 13.3 16.7 20 23.3 26.7 30   300 5.0 10.0 15 20.0 25.0 30 35.0 40.0 45   400 6.7 13.3 20.2 26.7 33.3 40 46.7 53.3 60   500 8.3 16.7 25 33.3 41.7 50 58.3 66.7 75   600 10.0 20.0 30 40.0 50.0 60 70.0 80.0 90   700 11.7 23.3 35 46.7 58.3 70 81.7 93.3 105   800 13.3 26.7 40 53.3 66.7 80 93.3	Int. of Air CFM 50 100 150 200 250 300 350 400 450 500   CFM 50 100 150 200 250 300 350 400 450 500   100 1.7 3.3 5 6.7 8.3 10 11.7 13.3 15 16.7   200 3.3 6.7 10 13.3 16.7 20 23.3 26.7 30 33.3   300 5.0 10.0 15 20.0 25.0 30 35.0 40.0 455 50.0   400 6.7 13.3 20 26.7 33.3 40 46.7 53.3 60 66.7   500 8.3 16.7 25 33.3 41.7 50 58.3 66.7 75 83.3   600 10.0 20.0 30 40.0 50.0 60 70.0 80.0 90 100.0   <

**Note:** For additional information or help with your application please consult TEMPCO.



**Duct Heaters** 

English



## **Checklist – Selecting the Proper Duct Heater,** *continued*

### Element Watt Density vs. Air Temperature and Air Velocity

#### Use graph (English or Metric) to plot

#### Outlet Air Temperature vs. Outlet Air Velocity to determine Element Watt Density

The recommended watt density is based on a maximum element sheath temperature of 1400°F (760°C). Air and other gases that are poor conductors of heat require watt densities matched to the velocity of the gas flow to prevent element overheating. Selecting a lower watt density for the heating elements will extend heater life expectancy.





Process Temperature °F – Approximate Sheath Temperature 1400°F





**Element Watt Density** is the wattage dissipated per square inch of the element sheath surface and is calculated with the following formula.

Watt Density =  $\frac{\text{element wattage}}{\pi \times \text{element dia.} \times \text{element heated length}}$ 

View Product Inventory @ www.tempco.com



# **Checklist – Selecting the Proper Duct Heater,** *continued*

### Element Watt Density vs. Sheath Temperature and Air Velocity

Use graph (English or Metric) to plot

 $\mathbf{V}$ 

Watt Density vs. Air Velocity to determine Sheath Temperature or

Watt Density vs. Sheath Temperature to determine the required Air Velocity





Sheath Temperature (°C)

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**Duct Heaters** 



# **Checklist — Selecting the Proper Duct Heater,** *continued*

### **Pressure Drop vs. Air Velocity**

#### Use graph (English or Metric) to plot

Pressure Drop vs. Air Velocity for standard duct heaters sizes used to properly Size Blowers



### **Calculating Air Velocity**

Velocity (feet/minute) =  $\frac{\text{SCFM}(\text{CFM} \text{ measured at standard conditions})}{\text{Duct cross sectional area at heater in square feet}}$ 



Approximate Pressure Drop (Kilopascals)