Calculating KW Requirements for Heating Liquids and Gases

When calculating the required KW, always use the maximum flow of the medium to be heated, the minimum temperature at the heater inlet, and the maximum desired outlet temperature. Also include a 20% Safety Factor to allow for heat losses to jacket and piping, voltage variation and wattage tolerance.

For specific heat and density values see Properties of Materials Tables on page 16-4.
Safe element watt density and sheath material charts are located on pages 16-12 through 16-20.

**Formula for Heating Liquids**

\[
KW = \frac{\text{Flow} \times 60 \text{ minute/hour} \times \text{Density} \times \text{Specific heat} \times \Delta T \times \text{Safety factor}}{3412 \text{ BTU/KWH}}
\]

**Flow** = Flow in gallons/minute

**Density** = Density of liquid in pounds/gallon

**Specific Heat** = Specific heat of liquid in BTU/pound °F

\(\Delta T\) = Temperature rise in °F

**Sample problem for heating water:**
Calculate KW required to heat 5 gallons/minute of water from 50 to 100°F.

\[
KW = \frac{5 \text{ gal/min} \times 60 \text{ min/hr} \times 8.34 \text{ lb/gal} \times 1.0 \text{ BTU/lb°F} \times 50°F \times 1.2}{3412 \text{ BTU/KWH}}
\]

Total KW required = 44

**Water Flow Chart for Tempco 3” and 5” Flanged Circulation Heaters**

Maximum water flow per hour through selected heaters at specified temperature rise.

<table>
<thead>
<tr>
<th>Part Number</th>
<th>KW</th>
<th>20°F</th>
<th>30°F</th>
<th>40°F</th>
<th>50°F</th>
<th>60°F</th>
<th>70°F</th>
<th>80°F</th>
<th>90°F</th>
<th>100°F</th>
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<th>120°F</th>
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</table>

\[(\text{Gallons}) \text{ HR} = \frac{(\text{KW}) (3412)}{(8.34) (\Delta T)}\]

**Formula for Heating Gases**

\[
KW = \frac{\text{Flow} \times 60 \text{ minute/hour} \times \text{Density} \times \text{Specific heat} \times \Delta T \times \text{Safety factor}}{3412 \text{ BTU/KWH}}
\]

**Flow** = Flow in SCFM (standard cubic feet per minute measured at 14.7 PSIA and 70°F)

**Density** = Density of gas in pounds/cubic foot at standard conditions.

**Specific Heat** = Specific heat of gas in BTU/pound °F at standard conditions.

\(\Delta T\) = Temperature rise in °F

**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:

\[
\text{SCFM} = \frac{\text{CFM} \times \text{PSIG} + 14.7 \times 35.37}{T + 460}
\]

\(\text{PSIG}\) = operating pressure (gauge pressure in lbs/sq.in.)

\(T\) = operating temperature in °F

\[
\text{SCFM} = \text{flow rate in CFM at standard conditions of 60°F and 14.7 PSIA.}
\]

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