What is considered when sizing an electric process heater

Sizing an electric process heater requires thought and experience. The basic formula of Q=mCpΔT is only the basics of sizing a heater duty. This will determine a kilowatt rating, but the process parameters will determine the details of the heater design.

Required information to properly size a heater

- Flow Rate (m) mass flow (lb/hr or kg/hr)
- Specific heat of the fluid (Cp) (kJ/(kg·K or Btu/(lb·°F))
- Temperature Difference (ΔT) (Inlet/outlet or Tank beginning temperature and desired temperature.
- Fluid Thermal Conductivity (W/(m·K) or Btu/(hr·ft·°F))
- Fluid Viscosity (cP)

Useful Definitions:

Thermal Conductivity (k) – The ability of a material to transfer heat through conduction between a temperature gradient. Hydrogen has a very high thermal conductivity while insulation materials has a very low thermal conductivity.

Viscosity (cP) – A fluids resistance to flow. Dynamic Viscosity measures how the fluid layers move past each other. Thick fluids such as molasses and heavy oil have a high viscosity while thin fluids such as water have a low viscosity. Think of drinking water in a straw. The fluid moves easily up the straw when you drink. A milkshake on the other hand requires a lot more effort to pass the fluid up the straw and is very viscous.

Fluid Flow Velocity (v) – The speed at which a fluid moves through a pipe, duct or a tank in a given time (m/s or ft/s). Even stagnant tanks have a velocity when heating called natural convection when the hot fluid rises and the cold fluid falls.

Reynolds Number (Re) – The Reynolds Number is an important dimensionless number that identifies the type of flow in a pipe, duct or tank. It uses the density, velocity, viscosity of the fluid and shape of the surface it is flowing through or over. It determines:

- Whether the flow is laminar, transitional or turbulent.
- It is used for several purposes
    - Pressure Drop
    - Heat Transfer Coefficient
    - Flow Erosion

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Heat Transfer Coefficient (h) – How effectively the heat is transferred from the heating elements to the fluid being heated. A high coefficient means the fluid is effectively heated from the heater elements. A low coefficient means the fluid does not accept the heat very well and heat transfer is poor. Flowing water over the heating elements remove the heater very effectively and flowing air is not as effective since air is an insulator.

Watt Density – The amount of power in a fixed area of the heating element. Typical units include watts per square meter, centimeter or square inch. Fluids with a high viscosity will require a lower watt density than a fluid with a low viscosity

All of these factors determine the physical size of the Heater. High watt density heaters are smaller in diameter because the require less surface area of the heating elements. Low watt density heaters are much larger because they require much more surface area to transfer the heating elements effectively to the fluid.

The heater data sheet should have the results of the calculation:

- Heater Duty (kW)
- Expected heating element surface temperature.
- Expected Pressure Drop
- Expected Shell Temperature

Gaumer has developed a proprietary sizing program to quickly calculate all of the parameters. We take pride in selecting the most suitable process heater based on the process conditions.