Useful formulas: Help yourself.

Most industrial processes require energy. Bringing energy into processes requires power and time. The following there are some simple, basic calculations that can give first estimations on required heating power. Additional application tests are always recommended and supported by Leister.

The following formulas are meant as rules-of-thumb. They can be employed as first estimations to plan equipment. The calculated values serve as approximate values. Losses are not considered.

Electric power, current and voltage

$$V = R * I$$

$$P = V * I$$

V = Voltage [V]
R = Resistance [Ohm]
I = Current [A]
P = Power [W]

Example single-phase:
V = 230 V
P = 1 kW (e.g. LHS 21S CLASSIC, 139.869)

$$I = \frac{1000}{230} = 4.35\ [A]$$ ➡ single-phase

$$I = \frac{P}{V}$$ ➡ single-phase

$$I = \frac{P}{V * \sqrt{3}}$$ ➡ three-phase

Example three-phase:
V = 3 * 400 V
P = 6 kW (e.g. LHS 61S SYSTEM, 3 x 400 V / 6 kW, 142.496)

$$I = \frac{6000}{400 * \sqrt{3}} = 8.66\ [A]$$ ➡ three-phase

Electrical output with voltage differences

$$P_{act} = \frac{V_{act}^2}{V_{nom}^2} * P_{nom}$$

P_{act} = effective Power [W]
P_{nom} = nominal Power [W]
V_{act} = effective Voltage [V]
V_{nom} = nominal Voltage [V]

Example:
V_{act} = 200 V
V_{nom} = 230 V
P_{nom} = 1 kW (e.g. LHS 21S CLASSIC, 139.869)

$$P_{200V} = \frac{200^2}{230^2} * 1000 = 756\ [W]$$

Do not reduce voltage to control power with air heaters from the LHS PREMIUM or the LHS SYSTEM line!

Heating power calculated from air flow and temperature difference

$$P = c_{air} * \frac{1}{60\,000} * \dot{V} * \rho_{air} * \Delta T$$

P = Power [kW]
c_{air} = Heat capacity of air [kJ/kgK]
$\dot{V}$ = Air flow [l/min]
ρ_{air} = Density of air [kg/m^3]
ΔT = Temperature difference [°C]
$\frac{1}{60\,000}$ = Conversion factors due to chosen units

Specific heat capacity of air c_{air}: 1.005 kJ/kgK
Density of air (at 20°C and 101.3 kPa) ρ_{air}: 1.204 kg/m^3

Example:

Air flow	$\dot{V}$	= 1200 l/min
Temp. of environment	T_{start}	= 25 °C
Target temperature	T_{end}	= 500 °C

$$P = 1.005 * \frac{1}{60000} * 1200 * 1.204 * (500–25) = 11.5 \text{ [kW]}$$

11.5 kW is the power required to heat the air to the target temperature.

For estimating the needed heating power, please consider: Your process may also need energy for other wanted or unwanted effects (losses etc.).

Heat loss via Isolation

$$\frac{Q}{t} = \lambda * \frac{A}{d} * \Delta T = P$$

P = Power [W]
Q = Heat energy [J]
t = Time [s]
λ = Heat transfer coefficient [W/m*K]
A = Surface [m^2]
d = Thickness of wall [m]
ΔT = Temperature difference [°C]

Example:

Box made from Styrofoam

Dimensions (H*W*T)	= 0.5 m x 1 m x 1 m
Wall thickness of box	= 5 cm
T inside box	= 80 °C
T outside box	= - 20 °C
Heat conductivity for Styrofoam	= 0.05 W/mK
The surface of the box is A = 2*(1*1)+4*(0.5*1)	= 4 m^2

$$P = 0.05 * \frac{4}{0.05} * 100 = 400 \text{ [W]}$$

400 W are required to hold the temperature inside the box on 80°C with an environment temperature of -20°C.

Useful Formulas