

Engineering Information

Before selecting a standard circulation heater from the catalog listings, or customizing a design with any of the options and accessories, check the engineering information to assure proper heater design and performance for your application.

Calculating KW Requirements

When calculating the power required to heat a material flowing through the circulation heater, the KW equation shown below can be applied. This equation is based on the criteria that there is no vaporization occurring in the heater. The KW equation incorporates a 20% safety factor, allowing for heat losses of the jacket and piping, variation in voltage and wattage tolerance of the elements.

$$KW = \frac{M \times \Delta T \times Cp \times S.F.}{3412}$$

Where:

KW = power in kilowatts

M = flow rate in Lbs/Hr

ΔT = temperature rise in °F

(The difference between the minimum inlet temperature and maximum outlet temperature.)

Cp = specific heat in BTU/Lb °F

S.F. = safety factor, 1.2

3412 = conversion of BTU to KWH

Water Heating Example:

Application data: 8 GPM flow with an inlet temperature of 65° F and an outlet temperature of 95° F. First, convert the flow rate to Lbs/Hr.

$$\frac{8 \text{ Gal}}{\text{Min}} \times \frac{1 \text{ Ft}^3}{7.48 \text{ Gal}} \times \frac{60 \text{ Min}}{1 \text{ Hr}} = 64.17 \text{ Ft}^3/\text{Hr}$$

Obtain the specific heat (Cp) and density from Table III, page 7.

$$64.17 \text{ Ft}^3/\text{Hr} \times 62.4 \text{ Lbs}/\text{Ft}^3 = 4004 \text{ Lbs}/\text{Hr}$$

Now calculate KW:

$$KW = \frac{4004 \text{ Lbs}/\text{Hr} \times (95-65)^\circ\text{F} \times 1 \text{ BTU}/\text{Lbs}^\circ\text{F} \times 1.2}{3412}$$

$$KW = 42$$

Oil Heating Example:

Application data: SAE 30 lubrication oil with a flow rate of 135 GPM, an inlet temperature of 45° F and an outlet temperature of 55° F. First, convert the flow rate to Lbs/Hr.

$$\frac{135 \text{ Gal}}{\text{Min}} \times \frac{1 \text{ Ft}^3}{7.48 \text{ Gal}} \times \frac{60 \text{ Min}}{1 \text{ Hr}} = 1083 \text{ Ft}^3/\text{Hr}$$

Obtain the specific heat (Cp) and density from Table III.

$$1083 \text{ Ft}^3/\text{Hr} \times 55.4 \text{ Lbs}/\text{Ft}^3 = 60,000 \text{ Lbs}/\text{Hr}$$

Now calculate KW:

$$KW = \frac{60,000 \text{ Lbs}/\text{Hr} \times (55-45)^\circ\text{F} \times .45 \text{ BTU}/\text{Lbs}^\circ\text{F} \times 1.2}{3412}$$

$$KW = 95$$

Gas Heating Example:

Application data: Air is flowing at 187 ACFM and 5 PSIG pressure. The inlet temperature of the air is 90° F and the outlet temperature is 250° F. First, convert the flow rate to SCFM.

$$SCFM = ACFM \times \frac{PSIA}{14.7 \text{ PSIA}} \times \frac{530^\circ\text{R}}{(T^\circ\text{F}+460^\circ\text{R})}$$

Where:

T = Inlet temperature in °F

ACFM = Actual cubic feet per minute (This is the actual volume flow rate value at inlet temperature and operating pressure, PSIA.)

SCFM = Standard cubic feet per minute (This is the volume flow rate value at 70° F and atmospheric pressure, 14.7 PSIA.)

PSIA = Pounds per square inch, absolute

PSIG = Pounds per square inch, gauge

PSIA = PSIG + 14.7 (Note: If value is given as psi, it is implied to be PSIG.)

$$187 \text{ ACFM} \times \frac{19.7 \text{ PSIA}}{14.7 \text{ PSIA}} \times \frac{530^\circ\text{R}}{(90^\circ\text{F}+460^\circ\text{R})} = \text{SCFM}$$

$$241.5 = \text{SCFM}$$

Now convert to Lbs/Hr.

$$241.5 \text{ SCFM} \times \frac{60 \text{ Min}}{1 \text{ Hr}} \times \frac{.073 \text{ Lbs}}{\text{Ft}^3} = 1057.7 \text{ Lbs}/\text{Hr}$$

Reference Table I for the density and specific heat (Cp) of air.

Circulation Heaters

Engineering Information (continued)

Properties for Gases Table I

Gas	Density (Lbs/Ft ³)	Specific Heat (BTU/Lb °F)
Air	0.073	0.24
Nitrogen	0.073	0.25
Steam	0.037	0.49

Densities and specific heats are at atmospheric pressure (14.7 PSIA) and 70° F, except the temperature for steam is 212° F.

Now calculate KW: (Specific heat of air at average temperature of 170° F is also .24.)

$$KW = \frac{1057.7 \text{ Lbs/Hr} \times (250-90)^\circ\text{F} \times 0.24 \text{ BTU/Lbs}^\circ\text{F} \times 1.2}{3412}$$

$$KW = 14.3$$

Pressure Drop

Pressure drop through the heater is a function of many variables, including type of liquid or gas, flow rate, temperature and vessel size. Use the information on this page as a guideline for common applications where water, lube oil, fuel oil, or ethylene glycol are heated from 60° F. For other applications, including heating gases, contact INDEECO, and we will determine the pressure drop for you.

The curves on Chart A indicate the pressure drop for the different diameters of catalog listed heaters. The curves are based on water at 60° F, and the heaters having the standard inlet and outlet sizes as listed on page 10.

Table II gives correction factors for Chart A when these other liquids are being heated from 60° F.

Pressure Drop Correction Factors Table II

Liquid	Correction Factor
SAE 30 Lubrication Oil	1.6
No. 2 Fuel Oil	1.4
Ethylene Glycol (50% Solution)	1.7

Example:

Flow rate: 100 GPM

Liquid: SAE 30 lubrication oil

Inlet Temperature: 60° F

First, select the vessel size by determining the KW rating and watt density and referring to the oil heater listings. For this example, we will select a 5" flange heater.

From the water pressure drop curves, we get a 2 psi pressure drop, then we multiply that value by the correction factor for SAE 30 lubrication oil. This gives a 3.2 psi pressure drop through the heater for this application.

The viscosity of oil can change dramatically with a 30° F change in temperature. If your inlet temperature is different than 60° F, or the graphs indicate a pressure drop is too high for your system, please contact INDEECO. We can evaluate your exact requirements and offer alternatives to meet your needs.

Chart A

