

Cartridge Heaters - Overview

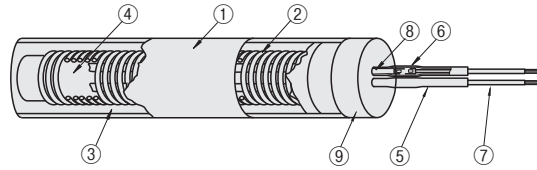
Software for simple selection of cartridge heaters can be downloaded from the following URL.
<http://fa.misumi.jp/ht/>

Features

- This heater has long-life and high-power density and is the best suitable for heating metal plates.
- For the maximum operating temperature, refer to specification of each product. A High Temperature Type with up to 900°C operating temperature is also available.
- Maximum Operating Temperature means value at the sheath part. Please pay attention to Lead Wire Heat Resistance Temperature and be sure to put the lead wire and the insulator out of the mounting hole.

Basic Structure

Compression type heater with ceramic core of high temperature property wrapped with Nickel-chrome wires and isolated by magnesium oxide.



- 1 Stainless Steel Sheath (Incoloy for High Temperature Type)
 - 2 Heating Coil (Nickel-chrome Wire)
 - 3 Insulation Powder (Magnesium Oxide)
 - 4 Ceramic Core
 - 5 Silicon (Insulation) Tube
 - 6 Crimp Terminal
 - 7 Lead Wire Film
 - 8 Nickel Pin
 - 9 Insulator
- * O.D. of Lead Wire varies depending on the current voltage / electric power volume, but is approximately in the range of $\phi 2 \sim \phi 4$.

How to Mount

- The Clearance of the mounting hole of heated metal block should be as small as possible. Recommended clearance of hole machining is 0.05 or less (one side).
- * The degree of adherence between a heater and heated object affects the life of heater. Also, a large clearance increases the time needed to raise the temperature and creates a slow response speed for temperature control. When the temperature of heating object is 300°C or less, it is possible to use drilled holes, but reamed holes (H7) for the mounting hole of all heaters are recommend.
- * The life span of the heater largely depends on the operating environment. Wires might be broken in a short time depending on the operating temperature and the adjustment of the temperature. Preparing new cartridge heaters for replacement is recommended.

Precautions for Use

- 1 Do not let the heaters run idle in the atmosphere. Breaking of wire and ignition may occur by abnormal heat if the heater is used by leaving the heating element projected from the heated object even partly.
 - 2 Prevent the lead wire of the heater from getting wet. Leakage or short circuit may result.
 - 3 Remove machine oil and grease used at the time of hole machining of heated parts. It may carbonize and can be a cause of abnormal heating.
 - 4 When the ON-OFF cycle is extraordinarily short, it affects the life of a heater. Use of PID control is recommended.
 - 5 When the nickel pin is bent many times, it may be broken.
 - 6 Do not use over the rated voltage (V).
 - 7 When removing the heater from the heated object, make sure the power is turned off. Do not touch the heater immediately after the power is turned off.
 - 8 Keep the temperature around the lead wire exit at 130°C or less.
 - 9 Keep the temperature around the flange at 180°C or less when using Flanged Type.
 - 10 Do not use in vacuum.
 - 11 Heaters will expand by heating and heating element may project from mounting hole. Installation with screws, etc. is recommended.
- * Refer to Cautions of each type of heaters and ensure a proper and safety use of the heaters.

Cartridge Heater Selection Chart

	Shape	Shape		
		Straight	With Flange	L-Shaped
Products with short delivery time are desired. (Select from Standard sizes)	Reduces cost	Standard L & W (P.1607)		
	Higher electrical power density		High Temperature Type (P.1609)	
Want to choose the length, power, and etc. freely	Reduces cost	Configurable L & W (P.1607) Lead Wire Selectable (P.1611)	Flanged (P.1613) Flanged, Lead Wire Selectable (P.1613)	L-Shaped (P.1622) L-Shaped, Knurled, Flanged (P.1622)
	Avoid Breaking	Flex-Resistant (P.1614) Wire Breakage Resistance, Stranded Wire (P.1615) Lead Wire Protection, Internal Connection (P.1616)		
	Lead wire protection	Flexible Hose (P.1617) Lead Wire Protection Type with Knurled Flange (P.1619)		
	Sensor embedded	With Sensor (P.1618)		
	Usage at high temperature (800°C or more)	High Temperature, Configurable L & W (P.1612)		
	Make the temperature on the heated object more uniform.	Uniform Heating Type (P.1620)		
	Warms the tip only	Heating Length Configurable (P.1621)		

Selecting Method

1 Determine the heat quantity (W) required for the heater.

Based on the mass, thermal capacity, temp. rise, and time required to reach the targeted temperature of the heated object, the following formula is used for the calculation.

$$\text{Calories Required for The Heater (kW)} = \frac{\text{Weight of Heating Product (kg)} \times \text{Specific Heat of Heating Product (kcal/kg}^\circ\text{C)} \times \text{Increased Temperature (}^\circ\text{C)}}{860 \times \text{Heating Time (h)} \times \text{Efficiency (}\eta\text{)}}$$

It is difficult to calculate the Efficiency (η) precisely because it varies by heat-retention, insulation, arrangement of heaters but the suitable value is generally about 0.2 ~ 0.5.

Specific Gravity and Specific Heat of Major Materials

Material	Specific Gravity (g/cm ³)	Specific Heat (kcal/kg°C)
Aluminum (A7075P Type)	2.80	0.230
Steel	7.85	0.113
Stainless Steel	7.82	0.110
Brass	8.70	0.100

Ex.) When heating the heater block made of 200x100x50 (mm) stainless steel material weighted as approx. 8kg to 180°C. (It is assumed that the temperature of the heater block is 20°C, and the heating time until the setting temperature is 30 minutes.)

$$\text{Calories Required for The Heater (kW)} = \frac{8 \times 0.11 \times (180 - 20)}{860 \times 0.5 \times 0.3} = 1.1 \text{ (kW)} = 1100 \text{ (W)}$$

* Efficiency is assumed to be 0.3 as the standard. * Refer to Actual Measurement Data: Temperature Rise Time / Power (Electrical Power Density).

2 Determine the number of heaters and the quantity of heat (W) per one heater.

Determine the number of heaters based on the size of the heated object, so the total calories (W) become identical to the quantity of heat required for the heated object.

Ex.) Using 2 heaters of 550 (W) (Total 1100W)

Selection of Cartridge Heater (P.1607 MCHS)

- 1 Determine the diameter and length of the heater.
- 2 Determine the voltage (V) to use.
- 3 Determine the calories (W) required for the heated object.

Ex.) MCHS12 - 200 (D) (L)

Ex.) MCHS12 - 200 - V200 (D) (L) (V)

Ex.) MCHS12 - 200 - V200 - W550 (D) (L) (V) (W)

- 4 Check if required heater diameter (D), length (L), voltage (V) and calories (W) are available in L Dimension - W (electrical power) Fixed Type (P.1607) and High Temperature Type (P.1609).
Caution: Select the larger electric power (W) than the required for L Dimension - W (electrical power) Fixed Type.

Ex.) MCHS12-200-V200-W550 \Rightarrow L Dimension - W (electrical power) Fixed Type is not available (Go to 5).

- 5 Available for produce when the electrical power density (W/cm²) of the heating element is between 2 and 15 (W/cm²).
- 6 Determine the length of lead wires.

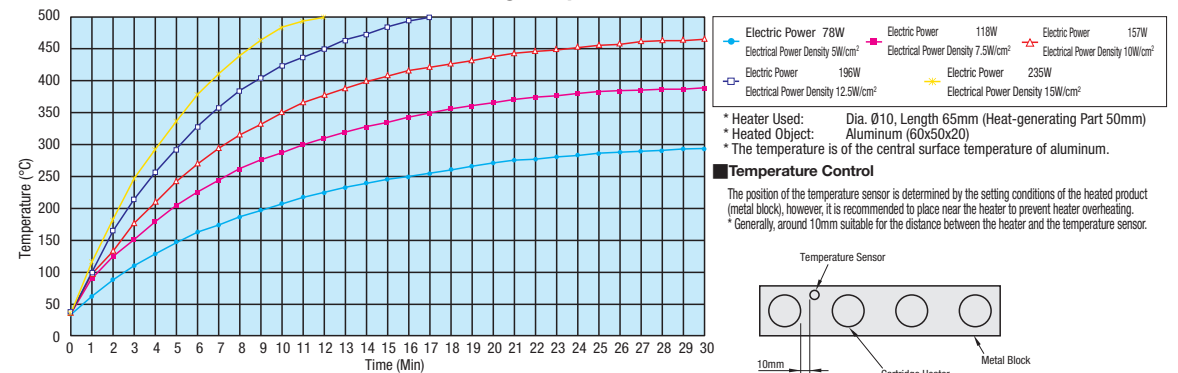
$$\text{Electrical Power Density (W/cm}^2\text{)} = \frac{\text{Electric Power (W)}}{\pi(3.14) \times \text{Heater Diameter (cm)} \times \text{Length of Heat-Generating Part (cm)}}$$

Ex.) Electrical Power Density (W/cm²) = $\frac{550}{3.14 \times 1.2 \times (20 - 1.5)} = 7.9$
 \rightarrow Available to produce * Length of Heating Element = L/10 - 1.5(cm)

Ex.) MCHS12-200-V200-W550-F500 (D) (L) (V) (W) (F)

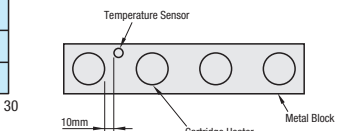
- * When the electrical power density (W/cm²) is not more than 2: 1) Reduce the heater diameter, 2) Shorten the heater length, 3) Reduce the number of heaters to use.
- * When the electrical power density (W/cm²) is not 15 or less: 1) Increase the heater diameter, 2) Increase the heater length, 3) Increase the number of heaters to use.
- * The electrical power density (W/cm²) of heater should be as low as possible, which enables a long-life and stable control.

Actual Measurement Data: Time of Increasing Temperature for Each Electric Power (Electrical Power Density)



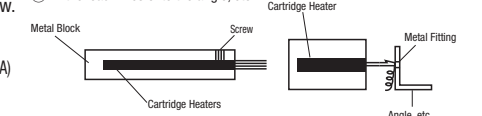
Temperature Control

The position of the temperature sensor is determined by the setting conditions of the heated product (metal block), however, it is recommended to place near the heater to prevent heater overheating.
 * Generally, around 10mm suitable for the distance between the heater and the temperature sensor.



Fixation of Cartridge Heater

In order to prevent the cartridge heater from falling off,
 1) Fix the sheath with screw,
 2) Fix the lead wires onto the angle, etc.



Temperature Controllers

All cartridge heaters are single-phase. Select temperature controllers (P.1674) for single-phase (MTCS, MTC D and MTC RM).

For the possible numbers of cartridge heaters to connect one controller, refer to the example below.
 Ex.) When connecting MTCS (Max. allowable electric current: 20A) to MCHK12-150-V100-W300,

$$\text{the electric current which streams in one cartridge heater is Electric Current (A)} = \frac{\text{Electric Power (W)}}{\text{Voltage (V)}} = \frac{300 \text{ (W)}}{100 \text{ (V)}} = 3 \text{ (A)}$$

$$\text{The possible numbers (N) of cartridge heaters to connect one temperature controller (MTCS) is } N = \frac{20 \text{ (A)}}{3 \text{ (A)}} = 6.7 \rightarrow 6 \text{ pcs.}$$

(However, only 2 cartridge heaters can be connected to a terminal. Please use terminal blocks (P.1672) for branching.)