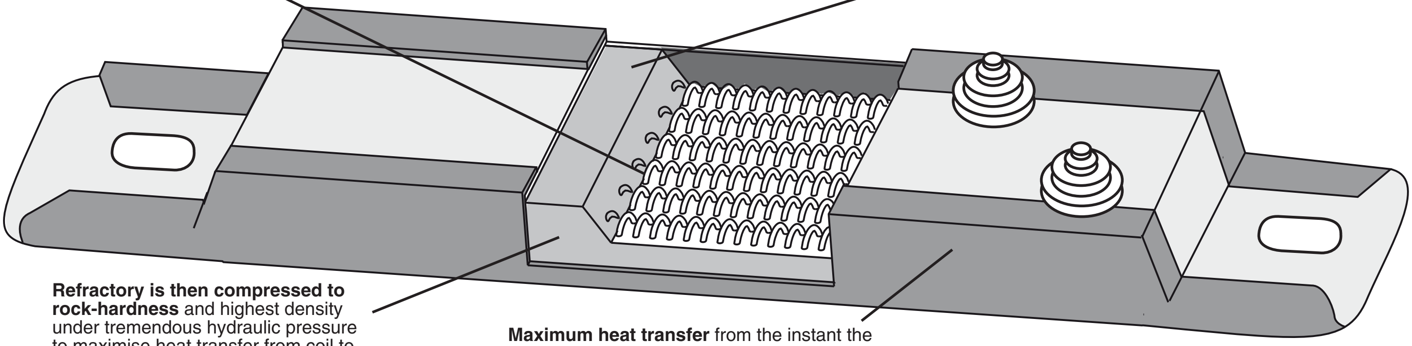
OMEGALUX® PREMIUM QUALITY STRIP HEATERS



FEATURES

A choice of sheath materials capable of operating up to 1500°F sheath temperature to heat various processes economically include rust-resisting iron sheath (750°F), chrome steel sheath (1200°F), Monel (950°F) and Incoloy (1500°F).

Refractory-insulated construction exclusively. By far the most rugged and best for long, dependable service.

More types and ratings. More precise matching to your power service and work load requirements. Special ratings and sizes can be manufactured readily.

More stocked models. Over 500 models are stocked and are available for immediate shipment.

Lengthwise and cross section curving. Available on made-to-order only for efficient heat transfer. Strip and ring heaters can be factory formed to fit the shape of the surface to be heated.

Easy installation. OMEGALUX clamping devices and mounting tabs speed installation. Mounting studs are readily available from OMEGALUX stock.

More choices of strip heater terminal locations. To simplify wiring layout between elements and to power cables.

Many additional features. Available to adapt heaters to suit special applications--made to order.

Trouble-free installations. Little or no maintenance costs.

Controls are part of the total OMEGALUX package for your heating job regardless of its type or the temperature precision you need.

OMEGALUX technical assistance. Your OMEGALUX representative will be glad to answer your questions, to assist in the selection of heaters, and recommend methods of installation to assure a satisfactory installation

Strip Heater Selection Guide

Product to be Heated	Temperature Desired for Products	Sheath Material	Product Temp	Allowable Watt Density
Solids				
i.e. mould platens, dies pipes, tanks	Up to 1400°F clamp-on applications	Rust Resisting Iron Chrome Steel	560°F 150°F 850°F 700°F 400°F	3 8 7 10 15
		Incoloy	200°F 750°F 1100°F 1350°F 1400°F	28 20 8 3 2.5
Air/Gases				
Free Air Velocity 1 ft/sec.	Up to 1400°F Bracket Mounted	Rust Resisting Iron Chrome Steel	500°F 100°F 950°F 800°F 500°F	3 8 7 10 15
		Incoloy	1400°F 400°F	3 34
Free Air Velocity 4 ft/sec.	Bracket Mounted	Rust Resisting Iron Chrome Steel	500°F 250°F 1000°F 850°F 550°F	3 8 7 10 15
		Incoloy	1400°F 600°F	5 34

STRIP HEATERS

A Technical Review

APPLICATION OF OMEGALUX® STRIP HEATERS

OMEGALUX® strip heaters are used principally for convection-type air heating and clamp-on installations. When selecting strip heaters for either, two important factors must be considered:

1. The proper sheath material for resisting any rusting and oxidising inherent in the process or environment and for withstanding the sheath temperature required. Standard sheath materials are rust-resisting iron, chrome steel and Incoloy (NS Series only.) Stainless steel and Monel sheaths are available at an additional charge. Maximum work and sheath temperatures are below.

2. The watt density of the element, or watts per square inch of heated area. This should be low for heating asphalt, molasses and other thick substances with low heat transferability; it can be higher for heating air, metals and other heat-conducting materials. (See curves on following pages for determining allowable watt densities.)

When high operating temperatures are needed, watt density must be limited in order not to exceed the maximum sheath temperature. Watt density is given in the How To Order table for each strip heater.

In general, a viscous material with low thermal conductivity requires a low watt density. High watt densities can be used with thinner liquids and with materials of high thermal conductivity. Premature loss of the element due to excessive temperature may result if the material's heat-take-away ability is low. Also, the material may be charred, carbonised or its chemical makeup altered by overheating.

Installation

OMEGALUX® strip elements in most cases can be applied with standard hardware. However, for firm contact and best heat transfer, stocked OMEGALUX® strip heater clamps are recommended.

Maximum Sheath Temperature	
Rust Resisting Iron	750°F
Monel	950°F
Chrome Steel	1200°F
Incoloy	1500°F

Clamping bands can be used to firmly fasten strips longitudinally to large-diameter cylindrical surfaces.

OMEGALUX® Strip Heaters shown here with clamping bands.

Connecting Lead Wire

Should be nickel-plated copper, nickel or alloy. Copper will oxidize and loosen connections. Utility clamps secure strip elements to flat surfaces with large radii such as large tanks. Threaded studs are welded to surface, heaters are positioned, then clamps are bolted down. Where more than one clamp is used, tighten nuts and then back off ½ turn to allow for expansion.

Heaters may be held in position in platens and similar objects with a steel plate recessed to heaters width, thickness and positions, then screwed to the working plate or surface.

Easy application of strip elements to ovens may be made simply with the use of welded-on studs and secondary insulation bushings (see Strip Heater Modications and Accessories) Mounting holes in tabs are slotted to allow for expansion.

CAUTION AND WARNING
Fire and electrical shock may result if products are used improperly or installed or used by non-qualified personnel. See inside back cover for additional warnings.

SELECTING SIZES AND RATINGS

The calculation of total heat requirements for an application is outlined in the Technical Section. For assistance, get in touch with an OMEGALUX applications engineer who will be glad to help solve your heating problem. Once total heat requirements are established, the quantity, size and ratings can be decided. Plan for enough heaters to permit even temperature as required by the process. The sensor for the temperature control should be clamped to the working surface for accurate control. In the case of air heating, place sensor where the desired temperature is needed, but not too far from heater to help avoid undershoot and overshoot.

After the specific heater size and rating has been tentatively selected, the watt density must be checked against the appropriate curves. For example, the OT-4315 chrome steel sheath heater rated 1500 watts has a watt density of 11 watts/sq. in. and can be operated at 1200°F sheath temperature. If clamped to a work surface operating at 600°F, Figure C-1 shows that the maximum allowable watt density is 12 watts/sq. in. Since the watt density of the OT-4315 is below the maximum allowed, good clamping will provide long service. If the heater selected has a watt density higher than that stipulated by the graph, then these alternatives could be considered:

1. Use more heaters of a low watt density to obtain the required kW capacity.

2. Reduce the kW capacity needed by reducing heat losses and allowing for a longer heat-up time.

EXAMPLES OF HEATING VESSELS

With Clamp-On Strip Heaters

VESSEL HEATING--CALCULATIONS

A steel melting pot or crucible weighing 150 lbs. contains 400 lbs. of lead, and is insulated by 2 inches of rock wool and a sheet steel outside shell of approximately 20 ft^2 area. Three sq. ft. of lead surface are exposed to the air. Sufficient kilowatt capacity must be installed to bring the material and container from 70°F to 800°F in one hour, and to heat 250 lbs. of lead per hour from 70°F to 800°F thereafter.

Melting point of lead = 621°F
Specific heat of solid lead = .031 Btu/lb/°F
Specific heat of molten lead = .040 Btu/lb/°F
Heat of fusion/lead = 10 Btu/lb
Specific heat of steel crucible = .12 Btu/lb/°F
Radiation loss from molten lead surface = 950 W/ft^2 (see Heat Loss Curves)
Surface loss from outside shell of pot = 66 W/ft^2

TO FIND INITIAL HEATING CAPACITY IN kW:

$$kWh = \frac{(Q_S + Q_F + Q_L\ Q_C)}{3412} + \frac{(Ls)\ (H)}{2000}$$

Where:

Q_S = BTU to heat lead to melting pt. = (400 x .031 (621 - 70))

Q_F = BTU to melt lead = (400 x 10)

Q_L = BTU to heat lead from melting pt. to 800°F = (400 x .040 (800 - 621))

QC = BTU to heat container to 800°F = (150 x .12 (800 - 70))

L_S = Surface losses/lead and container = (950 x 3) + (66 x 20)

H = heating time/hrs

$$kWh = \frac{26836.4}{3412} + \frac{4170}{2000}$$

$$= 7.87 + 2.09$$

$$= 9.96$$

$$kW = \frac{9.96}{1\ \text{(hrs. allowed for heating)}}$$

$$= 9.96$$

To Find kW Operating Requirement:

$$kW = \frac{Q_S + Q_L + Q_F}{3412} + \frac{L_S}{1000}$$

Where:

Q_S = kW to heat added lead to melting pt. = (250 x .031(621 - 70))

Q_L = kW to heat melted lead = (250 x .040 (800 - 621))

Q_F = Heat of fusion = (250 x 10)

L_S = Losses = (950 x 3) + (66 x 20)

$$kW = \frac{8560.25}{3412} + \frac{4170}{1000}$$

$$= 2.5 + 4.17$$

$$= 6.67\ kW$$

Therefore, install 9.96 + 20% (contingency factor) 12 kW and use automatic temperature control. By allowing a longer heat-up period the installed capacity may be reduced. By allowing 2 hours for this initial heat-up period, only 6.01 kW would be required. †However, operating heat requirements are now larger than heat-up requirements, consequently use 6.67 x 120% or 8 kW. This method results in lower installation costs and is preferable when rapid heat-up is not of prime importance.

†If heat-up is allowed in 2 hrs, for example, surface losses are multiplied by 2 and and total kWh is divided by 2 to calculate required kW.

FOR CLAMP-ON STRIP AND RING HEATERS

It was determined above that 12 kW heating capacity was needed for lead melting. It was decided to use Type OT strip heaters clamped to the thermally insulated crucible or pot. Since material is heated to 800°F chrome steel sheath strip heaters must be used. Refer to Figure C-1 on this page. For a maximum sheath temperature of 1200°F the ambient temperature inside the space between thermal inside the space between thermal insulation and vessel will be (800°F + 1200°F) ÷ 2 = 1000°F.

From the curve the allowable watt density is 8 W/in2. Based on size of the crucible, Type OT chrome steel sheathed strip heaters, 24 inches long without mounting tabs, are selected. To determine the number of strips needed, and the wattage of each use the following formula. Allowable watts per strip is (overall length minus 4" cold sections) x 3.45 in^2 per lineal inch of sheath x 8 allowable watts/in^2. Thus (25½ - 4) x 3.45 x 8 = 600 watts rounded off to nearest higher 10 watts. The total number of strips required is 12,000W ÷ 600W = 20 strips. Order strips similar to OT2507 in size but rated 600 watts. Stock delivery could be obtained by using 24 standard OT-2405, 500 watt strips which would have a watt density of:

$$\frac{500W}{(23¾ - 4) \times 3.4} = 7.35\ W/in^2$$

If application is to employ 3 phase power source, total element count should be a multiple of 3 to permit balanced electrical load. Strip heaters should be applied to tank surface by using applicable utility clamps on 5-inch centre.

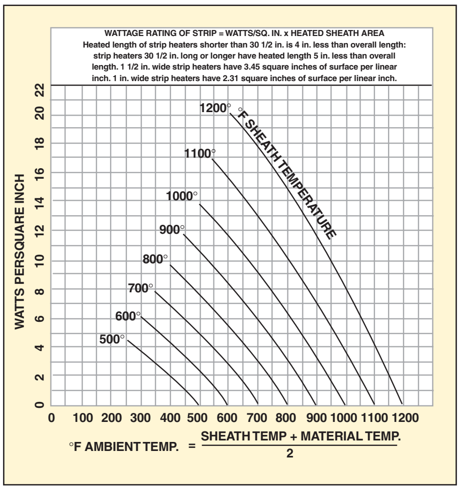


Figure C-1: Sheath Temperature of clamped-on OMEGALUX® Strip Heaters for various ambient temperatures and wattage ratings.

EXAMPLES FOR HEATING AIR/GASES

C

HEATING AIR IN DUCTS

Problem: A special drying process requires that we raise 450 cfm of air from 70° to 150°F. The existing ductwork which will be used for this purpose is insulated (negligible losses) and measures 2 ft. wide by 1 ft. high. Power available is 240 Volts, 3 phase. Calculate the required kW and select a compatible heater for this application.

Solution: Under standard conditions air has a specific weight of .08 lbs./ft³ and a specific heat value of .24 Btu/lb/°F.

$$kW = \frac{W_T \times C_P \times \Delta T \times 1.2}{3412}$$

Where:

W_T = Wt of air/hr = (450 x 60 x .08) = 2160

C_P = Spec. heat of air = .24

ΔT = Temp. rise °F = 80

3412 = BTU to kWh conversion

1.2 = Safety factor

$$kW = \frac{2160 \times .24 \times 80 \times 1.2}{3412}$$

$$= 14.85$$

For quick estimates, the following formula may be used where 3000 is a conversion factor in units of ft³ - °F/min-kW.

$$kW = \frac{\text{cfm} \times \text{temp. rise}}{3000}$$

= 450 x 80 = 12 x 1.2 = 14.4

Or: When airflow (ft³/min) and temp. rise are known, figure C-7 (which shows 15 kW for this example) may be used. This curve does not include contingency allowance.

To select the heater:

In this application there are a few choices to be explored. First consider OMEGALUX® CAB Series heaters. Knowing the application required, 15 kW leads us to select either the CAB-1511 with chrome steel elements or the CAB-152 with iron sheath elements rated at 26 W/in². The maximum operating sheath temperatures are 750°F for iron and 950°F for chrome steel.

Calculate air velocity through the heater to verify maximum operating sheath temperatures will not be exceeded.

$$kWh = \frac{V\,F}{A \times 60}$$

Where:

V = Air velocity in ft/sec

F = Air flow in ft3/min = 450 cfm

A = Area of htr. = (15⅜" x 21⅝"=2.3 ft²)

$$V = \frac{450}{2.3 \times 60}$$

= 3.3 ft/sec

Using Figure C-5, page C-7, based on an outlet temperature of 150°F and a watt density of 26 W/in², a velocity in excess of 9 ft/sec is required to keep the sheath temperature at permissible levels for the CAB-152. This is well above the actual velocity and rules out the use of the CAB-152. By applying the watt density and outlet air temperature to Figure C-2 (shown below) we see that we need a minimum of approximately 3 ft/sec air velocity to maintain a maximum of 900°F sheath temperature. Since this is lower than actual velocity, the use of CAB-1511 is acceptable.*

*Use of CAB-1511 will require a transition in the existing ductwork to accommodate the heater.

An alternative method to be considered would be mounting banks of finned strip heating elements in the ductwork. Knowing that 15kW is required and that our duct measures 2 ft. wide x 1 ft high and that a chrome steel sheath is required, we can select the proper finned strips.

Using figure C-2 (shown above), the maximum allowable watt density is 26 W/in². Elements with watt densities of 26 W/in² or less are suitable. Since the duct is 2 ft. wide, consider using OTF-2101, 21 inches long, 240 Volts, 1250 watts at 21 W/in².

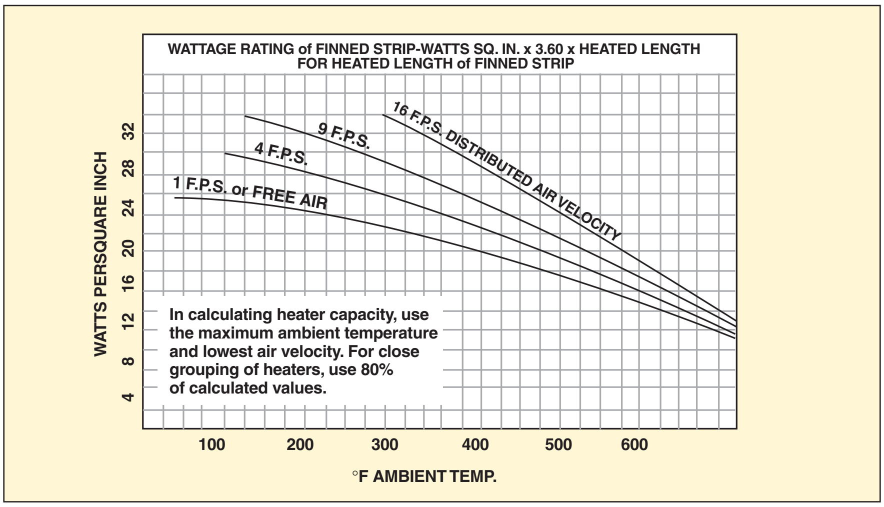
No. finned strips required:

$$= \frac{\text{Operating watts}}{\text{Rated W/elem.}}$$

$$= \frac{15{,}000}{1250}$$

= 12 finned strips

Use 12 OTF-2101 finned strips mounted sideways with narrow edge facing airstream. Total number of elements installed must be divisible by 3 so they can be connected in a 3 phase delta circuit.



ALLOWABLE WATT DENSITIES/FINNED STRIPS

Figure C-2: Allowable finned strip wattage ratings for 800° to 900°F sheath operating temperature at different air temperatures and velocities

ALLOWABLE WATT DENSITIES

ALLOWABLE WATT DENSITIES/STRIP HEATERS

1½" wide strip heaters have a 3.45 square inches of surface per linear inch; 1" wide strip heaters have 2.31 square inches of surface per linear inch. Heated length of strip heaters shorter than 30½" is 4" less than overall length; strip heaters 30½" or longer have heated length 5" less the overall length. In calculating heater capacity, use the maximum ambient temperature and lowest air velocity. For close grouping of heaters, use 80% of calculated values.

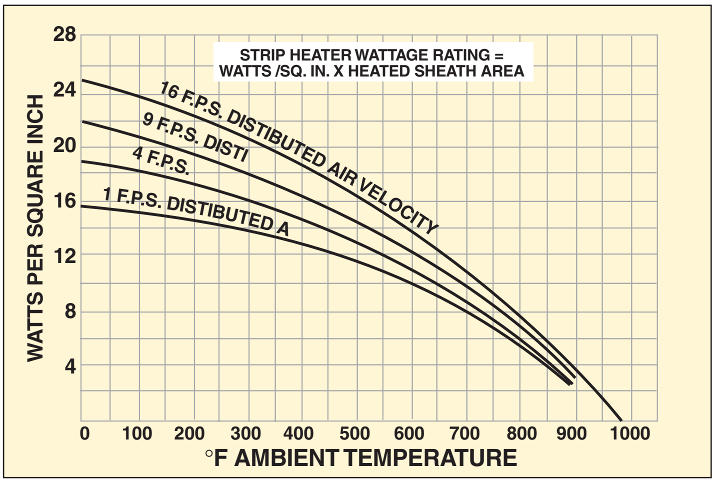


FIGURE C-3: Allowable Wattage Ratings that develop 1000°F strip heater surface temperature at different air temperatures and velocities.

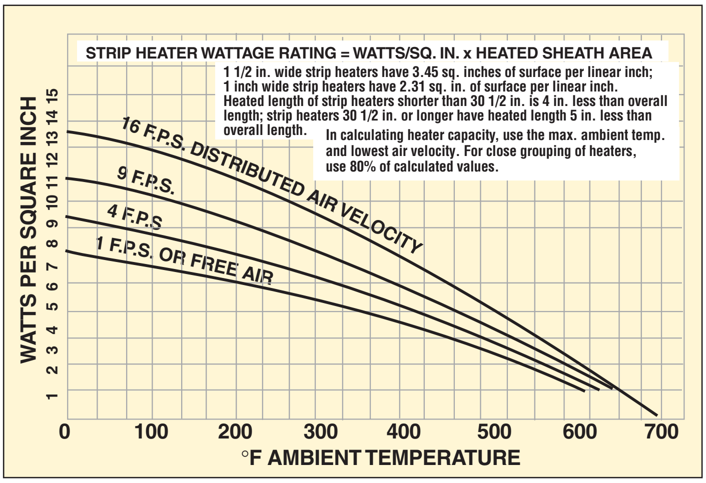


FIGURE C-4: Allowable Wattage Ratings that develop 700°F strip heater surface temperature at different air temperatures and velocities.

ALLOWABLE WATT DENSITIES/FINNED STRIPS

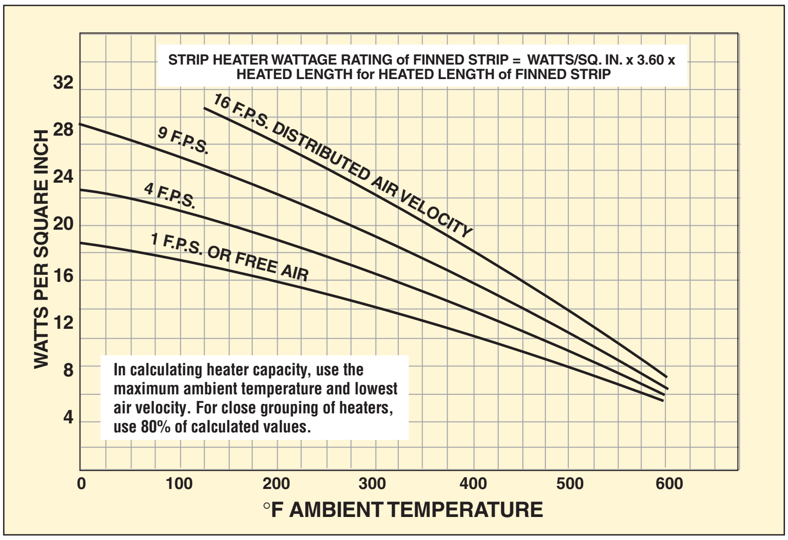


FIGURE C-5: Allowed Finned Strips Wattage Ratings for 600°F sheath operating temperature at different air temperatures and velocities.

STRIP HEATERS FOR AIR HEATING

Properties of Air/Pressure Drop Curves

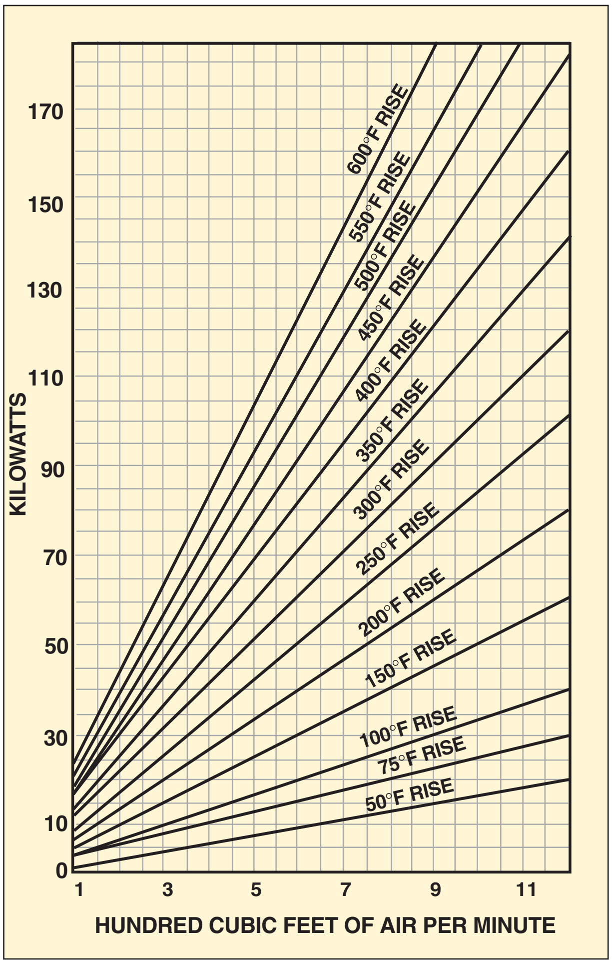


FIGURE C-7: Heat Requirements for Air.
Based on .08 lbs/cu. ft. Weight and a Specific Heat of .237 BTU/ lb/°F

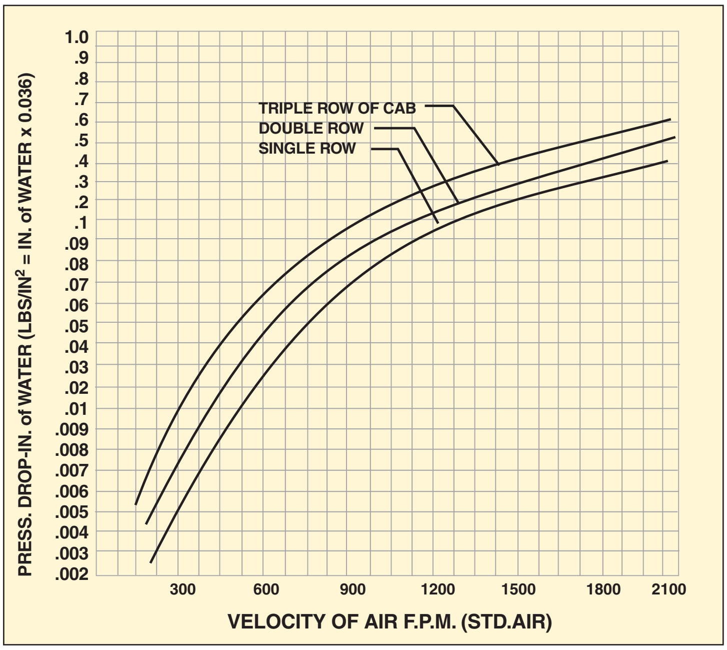
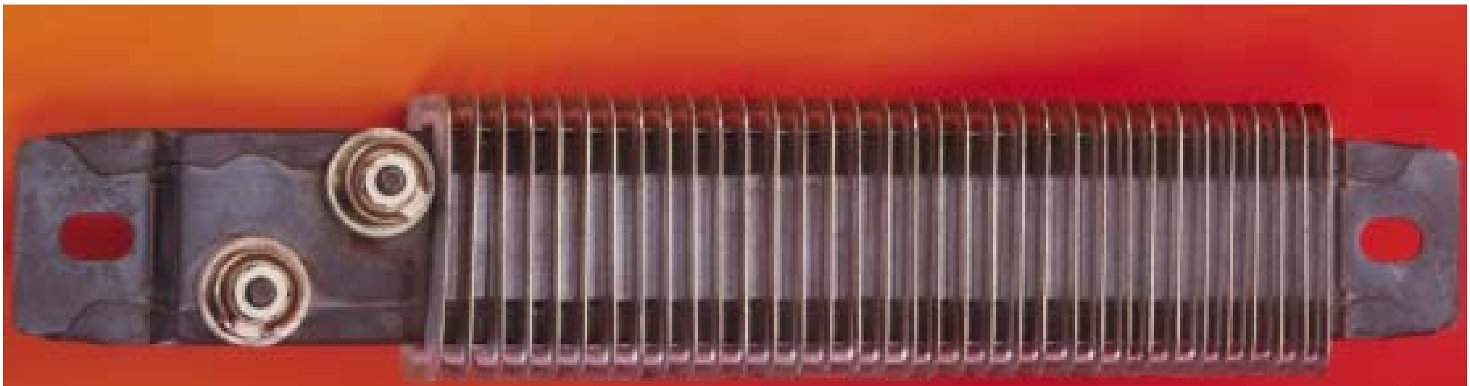


FIGURE C-6: Resistance to Air Flow over OMEGALUX® Finned Strip and CAB Air Heaters



OTF Series Finned Strip Heater, £45.50 shown smaller than actual size.

HEATER SELECTION NOMOGRAPHS

TO USE CURVE (FIGURE C-8)

1. Select maximum desired operating air temperature on (D).
2. Choose either chrome steel sheath or rust-resisting iron sheath (points E) on basis of operating conditions.
3. Draw straight line through points (D) and (E) to reading on (F) giving maximum allowable watts per square inch.
4. Select desired length heater with equivalent watt density or less.

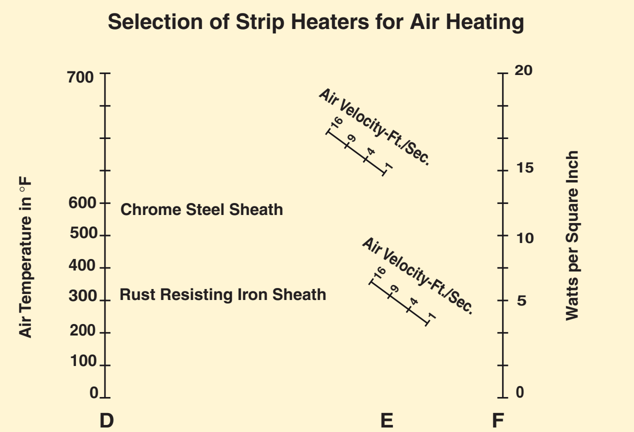


Figure C-8

TO USE CURVE (FIGURE C-9)

1. Select maximum desired work temperature on (A).
2. Choose either chrome steel sheath or rust-resisting iron sheath (points B) on basis of operating conditions.
3. Draw straight line through points (A) and (B) to reading on (C) giving maximum allowable watts per square inch.
4. Select desired length heater with equivalent watt density or less.

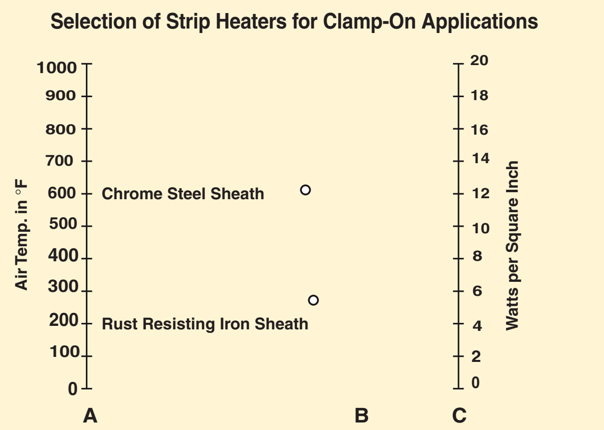


Figure C-9

TO USE CURVE (FIGURE C-10)

1. Select a maximum desired air temperature on A.
2. Choose sheath material to suit operating conditions.
3. Select minimum anticipated air velocity on B. Note: Natural circulation is equal to one foot per second.
4. Draw straight line through the points selected on A and B--read C for allowable watt density.
5. Select required length heater with equivalent watt density or less.

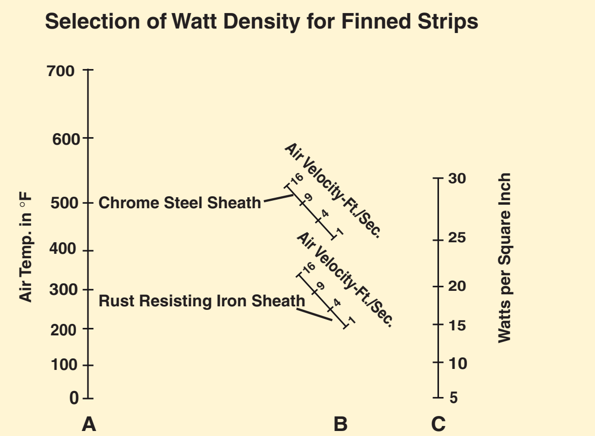


Figure C-10