INFRARED

- Infrared Heaters with Ceramic Insulation -

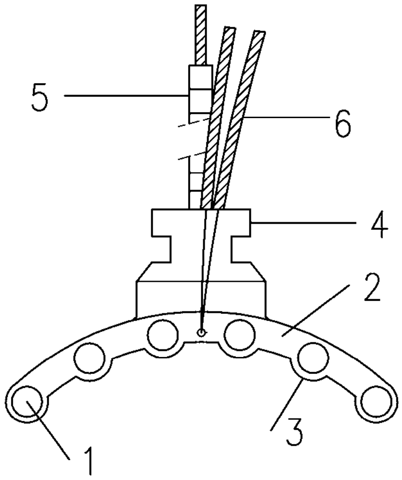


Figure 1

GENERAL CHARACTERISTICS

INFRARED radiators are the best solution to set up radiation heating systems based on the use of infrared rays. Their emission factor is 0.96, i.e. very close to the maximum theoretical value of 1,and their manufacturing standard allows to insure:

- **Long operational life**
- **Fast heat transmission**
- **Constant emission along the operational life**
- **Perfect heating uniformity**
- **Easy installation**

TECHNICAL DATA (see Figure 1)

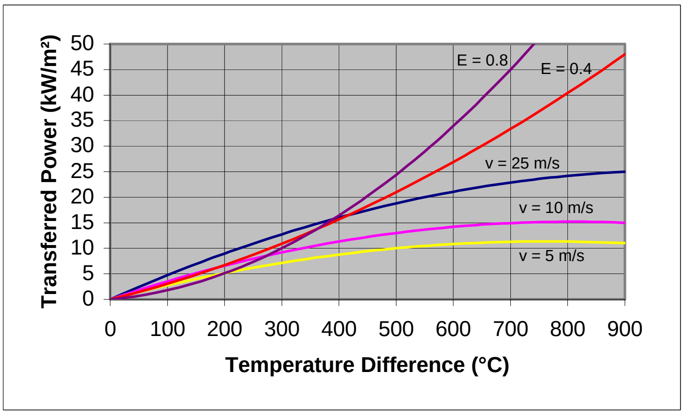
1. **RESISTIVE WINDING** spiral made of Nickel/Chrome 80/20 DIN 17470, material n° 2.4869
2. **INSULATION** made of high purity ceramic which presents a high resistance to thermal shocks and a high dielectrical rigidity
3. **SURFACE FINISH** particular treatment that protects the insulating body from oxidation, corrosion and water sprays.
4. **FIXATION BASE** standard for a 15x41 mm slot
5. **POWER SUPPLY CABLES** made of Nickel, insulated using ceramic bushes resistant to high temperatures
6. **THERMOCOUPLE** type K (Nickel/Chrome-Nickel - optional)

HEATING BY RADIATION

The rapid growth of the technology in the field of plastic materials processing has requested the development a large variety of electric heaters, capable to transfer efficiently the heat in the most different operational conditions.
The most common applications adopt the heat transfer by direct contact or by convection. There are cases, however, in which peculiar process characteristics (rapid working cycle, necessity to heat moving objects, impossibility to seal the heating process inside a volume that is closed to the external environment) do not allow to use effectively the heating by conduction or convection. In these case the most appropriate solution is to adopt a heat transfer by radiation.

The heating by radiation allows to heat easily and quickly moving objects. The dimensional and manufacturing characteristics of the heat radiators allow the construction of "open" ovens, normally installed around mobile surfaces (e.g. conveyor belts) inside which it is possible to reach in a short time the desired temperatures without presenting significant heat losses throughout the oven inlet and outlet sections.
In addition, if the operational temperature is adequately selected, high specific power densities (higher than those typical of conduction or convection heating), can be obtained.

Figure 2:



This last consideration is clearly shown in the graph of Figure 2 where the specific power transferred by forced convection (3 different air velocity values are considered) and the one obtained by heat radiation (2 different values of the emission factor are analysed) are compared.

The selection of the heat radiators operating temperature shall be performed taking into account different and conflicting needs: on one hand the specific radiated power increases at higher radiators operational temperatures and reaches its peak for wavelength values around 2 µm (see graph in Figure 3), on the other hand, the heat absorption by the radiated bodies is higher when the radiators temperature is low (see Figure 4), which correspond to wavelength values in the range 4 ÷ 5 µm.
Since a radiation heating system based on 300 ÷ 400 °C operating temperatures would imply a too long heating time, typically the operating temperature is set to 600 ÷ 800 °C which corresponds to a peak emission wavelength of about 3 µm (see Figure 5).

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Figure 3: radiated power as a function of the operating temperature and of the wavelength

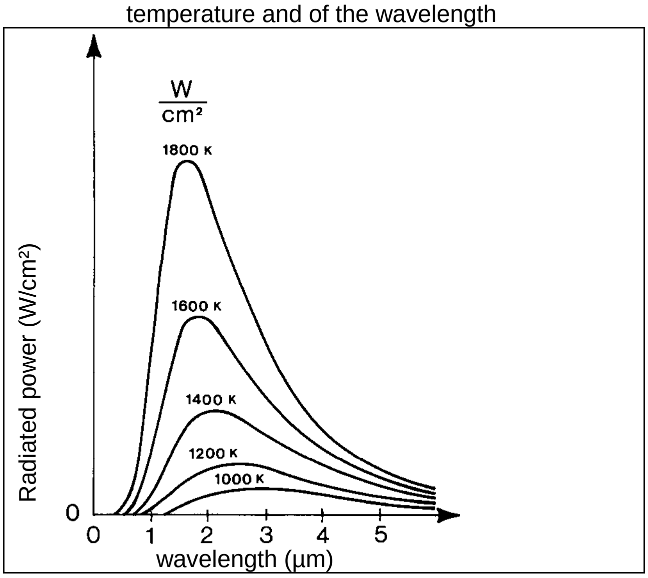


Figure 4: percentage absorbance of radiated energy for different materials

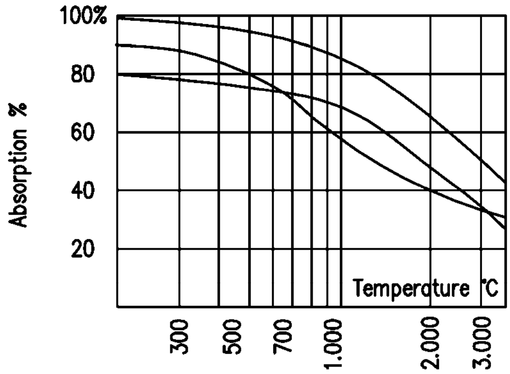
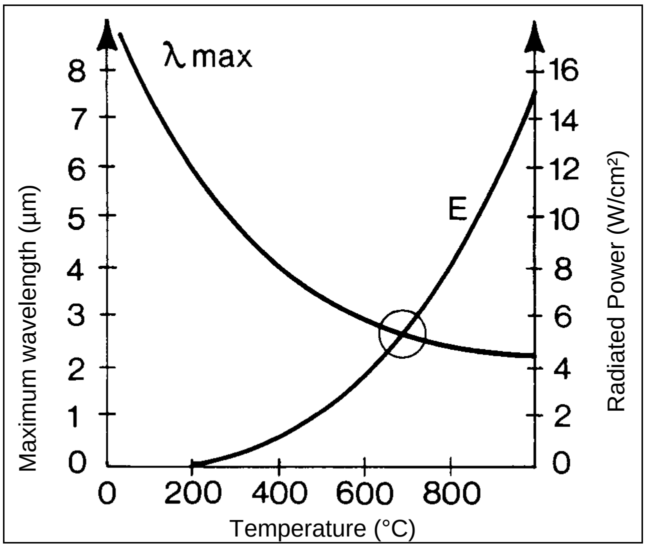


Figure 5 choice of radiators operating temperature



APPLICATIONS

INFRARED radiators are suitable for all applications in which infrared radiation heating is requested. In particular, they are best suited in thermoforming, in the heating of moulds as well as in the drying and thermal fixation processes.

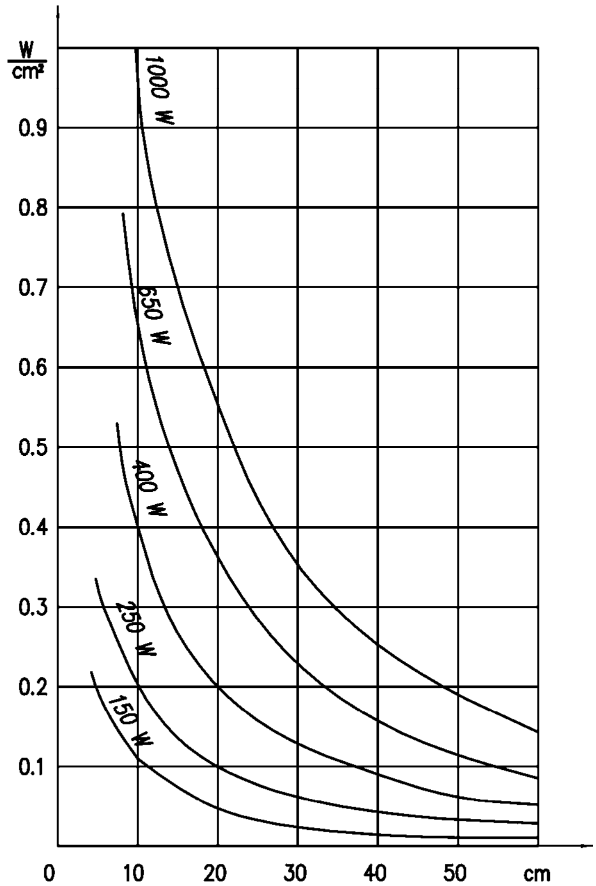
The individual radiators power size is also a function of the application. In fact, depending on the application, radiators with different heating powers are recommended (see Table 1 for the selection criteria).

Table 1: radiators heating power selection criteria

APPLICATION	250 W	400 W	650 W	1000 W
Water Evaporation			⊙	⊙
Drying of plastic or latex coatings		⊙		
Fast drying of glued surfaces		⊙		
Thermoforming, skin-pack		⊙		
Drying of adhesives onto glued parts		⊙		
Heating and drying in shoes fabrication			⊙	⊙
Drying of leather and skins after dyeing	⊙			
Drying of painted metallic parts		⊙	⊙	
Drying of dyes on tissues			⊙	⊙
Thermal fixation, Nylon, Perlon, Tergal	⊙	⊙		
Baking of paints on metal sheets	⊙	⊙		
Heating and drying of food products	⊙			
Thermography			⊙	⊙
Heating of moulds in industrial applications		⊙	⊙	

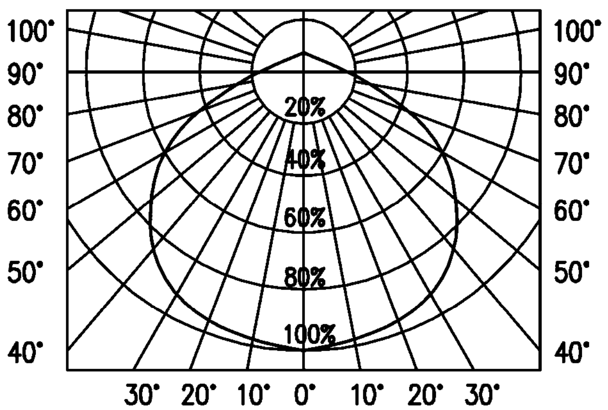
To correctly define the individual radiators heating power size it is also necessary to correlate the specific power of each radiator to the chemical and physical characteristics of material to be heated. In addition, the desired operational temperature and the duration of the heating process shall also be taken into account to make the correct choice.
The graph in Figure 6 shows, for different radiator heating power sizes, the radiated specific power as a function of the distance of the material to be heated.

Figure 6: radiators specific power for different radiator sizes



The distribution of the radiated thermal energy is not constant in the volume around the radiator. It is maximum in the direction perpendicular to the radiator axis and decreases when the distance from this direction increases. Also this aspect shall be taken into account in the choice of the radiators and in the definition of their position within the heating system.
In particular, if the product to be heated has a flat shape and it can be positioned parallel to the radiators assembly, it is more convenient to use flat radiators, placed as much as possible close to the product. In this way the reduction of the radiated power, due to a non perfectly orthogonal position of the product with respect to the radiators, is minimised. In addition, thanks to the reduced distance, the heat transfer is very effective (see also graph in Figure 6) and the plant overall dimensions are limited.
If, on the other hand, the product to be heated has an uneven surface, the only way to obtain a uniform heating is to employ curved radiators placed at a certain distance from the product (in order to reduce the heating non uniformity) and installed in a way that allows to keep the product surfaces, which are nearer to the radiators, as much as possible, far from the radiators perpendiculars (see also Figure 8).
La Figure 7 shows, using a polar diagram representation, the radiated energy percentage reduction, which characterises a curved radiator type IC, as a function of the angle between any given direction and the radiator perpendicular axis. With the help of this graph it is possible to define the radiators layout within the heated volume that best suits the characteristics of the product to be heated

Figure 7:   polar diagram of the radiated energy distribution



INSTALLATION

The radiators shall be mounted onto a reflecting surface. To obtain a good temperature uniformity on the material (± 1 %) it is necessary to distribute them as shown in Figure 8.
To fix the radiator to the reflecting surface, each radiator is provided with 2 fixation springs to be used as shown in Figure 9.

Figure 8: correct radiators layout

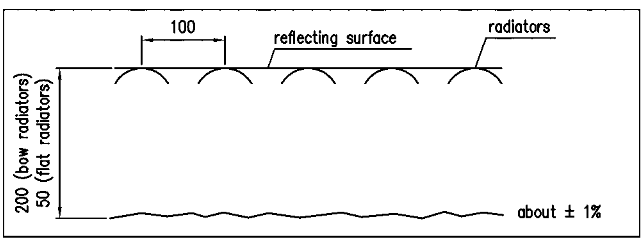
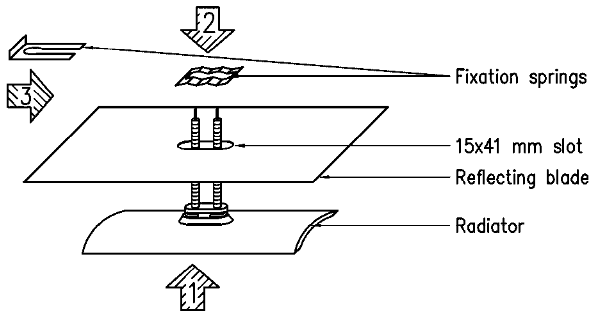


Figure 9: mounting scheme of an INFRARED radiator



STANDARD DIMENSIONS

INFRARED radiators are available on stock. Two typologies can be provided:

- Curved radiators TYPE IC – produced in dimensions 123 x 60 mm and 245 x 60 mm
- Flat radiators TYPE IP – produced in dimensions 123 x 123 mm

To install them, three different mounting panel typologies have been developed. They are available in lengths ranging from 250 mm to 1500 mm:

- RAD TYPE IC for curved INFRARED
- RAD TYPE IP/123 for flat square INFRARED

The electrical and dimensional characteristics of these products are shown in the following pages.

SPECIAL CONSTRUCTIONS

Upon request, INFRARED radiators with supply voltage and heating power different from the standard can be produced.

In addition, it is possible to request mounting panels of the type RAD IC and RAD IP/123 with dimensions different from the standard

Finally, INFRARED radiators with embedded thermocouple type K Nickel-Chrome/Nickel (see next paragraph), can also be provided on request.

INFRARED WITH EMBEDDED THERMOCOUPLE

These radiators shall be used when it is necessary to control the overall performances of the heating system. At changing radiator temperatures, in fact, the radiated power, and, consequently, the temperature reached by the product to be heated, changes. This last parameter, therefore, can be set controlling adequately the radiators temperature.
For an effective temperature control, the number of radiators with embedded thermocouple shall be reasonably proportional to the .dimensions of the radiating system.
As an example, if the system is wide, it is recommended to control separately the radiators placed at the borders of the hot area and those placed at the centre. This allows, in fact, to compensate the higher heat leaks of the border areas.

Attention! *The control system shall be set taking into account that the temperature measured by the thermocouple is about 10 % lower than the radiator surface temperature. The thermocouple electrical connection shall be performed using compensated cable type KX-CHROME-ALUMEL (see thermocouples catalogue).*