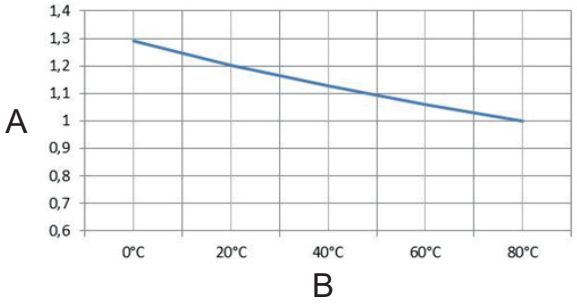
1 DEFINITIONS

Appliance / Unit / Gas unit heater = equivalent terms, used to refer to the wall-mounted gas unit heater.
BMS (Building Management System) = plant or building supervisor controller not supplied by Robur.
TAC = Technical Assistance Centre authorised by Robur.
External request = generic control device (e.g. thermostat, timer or any other system) equipped with a voltage-free NO contact and used as control to start/stop the gas unit heater.
Chronothermostat = control device that integrates the functions of room temperature control, programmable timer and indication of any operating errors.
First start-up = appliance commissioning operation which may only and exclusively be carried out by a TAC.
Occupied area = area of the building to be heated/cooled (generally because it is occupied by people).

2 ROBUR GAS UNIT HEATER TECHNOLOGY: THE GROUND EFFECT

Air heating systems, especially those for large rooms, offer a number of important advantages, both in terms of plant engineering, economics and overall efficiency. The air heating system, however, also has a specific characteristic that, in the past, has been one of the reasons for criticism against this heating system: heat stratification (Figure 2.1 *p. 1*).
As is well known, warm air does not have a fixed density, but this changes with the variation of its temperature (even at the same atmospheric pressure): the hotter the air, the lower its density, as represented by the following graph.

Figure 2.1 *Air density vs temperature*



A Density (g/dm^3)
B Air temperature

This means that warm air heating is affected by a negative effect on the overall efficiency of the system: heat stratification.
In the first industrial air heating systems, direct exchange heaters were able to emit a significant amount of heat in the form of warm air. Since the air has a rather low specific heat, to reduce the volume of air flowing through the fans, the air was heated to very high temperatures.
The result of this operating characteristic was a considerable stratification of the warm air produced. The high height typical of industrial sheds significantly accentuated this phenomenon. In the technical literature of the 1980s it could be read that the air stratification to be considered in industrial buildings heated by direct exchange air heaters such as those described above was about 1,5 °C for every metre of building height.
The accumulation of heat in the high parts of the buildings constituted, in this way, two critical points: the heat emitted by the heaters did not remain in the occupied areas, therefore near the floor, moreover the accumulation of heat under the roof led to an increase in heat loss from it, since the losses are a direct function of the temperature differential between the internal part of the ceiling and the external part (i.e. the outdoor winter temperature).
Much has been done to improve the efficiency of heating systems described above, which retain important energy advantages over heat transfer fluid heating systems.

At the end of the 1970s Robur launched the first direct-exchange wall-mounted gas unit heaters on the market. Among the advantages of these devices we mention, in this section, only the modularity and the low thermal jump: lower heat output concentrated in a single point, therefore more localized heat distribution and lower temperature output from the gas unit heater, therefore less stratification (Figure 2.2 *p. 1*).

Figure 2.2 *Robur gas unit heater*

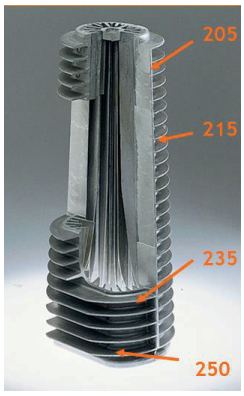
As mentioned at the beginning, the (dry) air temperature affects its density: warmer air is lighter and tends to move upwards. This means that the emission of warm air by gas unit heater, even with little difference in temperature compared to the room temperature, generates a tendency to stratify the heat in the heated room. In order to minimize this well-known phenomenon it is not enough to reduce the emission temperature, other measures must be taken.
On this phenomenon Robur has invested heavily in research and study, finally designing and manufacturing a special heat exchanger (patented) that allowed, and still allows, to obtain a almost null heat stratification in the room. To understand what has been done, it is necessary to make some clarifications regarding the heat exchange, which is directly dependent on some variables: the temperature difference of the fluids, the material with which the exchanger is made and the contact surface of the exchanger.
The exchange temperature between the combustion flues and the room air to be heated can be considered almost the same for all types of gas unit heaters. What changes in an important way is the material with which the heat exchanger is built: Robur has made an exchanger in aluminium die-cast alloy, a material that has an exchange capacity about 10 times higher than steel.

With aluminium alloy, there is therefore a greater capacity for heat transfer from the flues to the room air to be heated. But it was still not enough: the exchange also depends on the surface of the exchanger and this is why the Robur exchanger consists of a truncated cone-shaped element with double finning, horizontal external and vertical internal. In this way, the heat exchange between the flues coming from the combustion chamber underneath the exchangers and the room air to be heated pushed on the exchangers in a perpendicular way by a fan has been increased to the maximum (Figure 2.3 *p. 2*).

Figure 2.3 *Robur patented heat exchanger*

Result: at a height of about 30 cm the contact temperature difference between the base and the head is about 50 °C, exactly because the combustion flues entering the lower part are quickly cooled as they rise into the exchanger (Figure 2.4 *p. 2*). This difference in temperature on the heat exchanger has a positive effect on the air flow that invests the exchanger: this is in fact warmer in the lower part than in the upper part.

Figure 2.4 *Robur heat exchanger temperature*

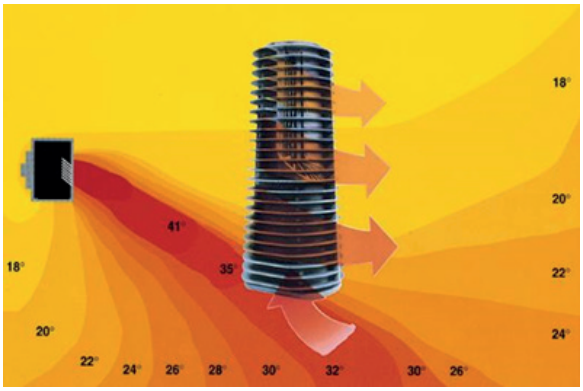


The realization of the truncated cone shape of the exchanger also accentuates this difference: in the upper part of the ventilation air crossing window, the finning is less dense, thus allowing more air to pass through than in the lower part.

Figure 2.5 *Air passage between 2 Robur exchangers*

All this results in a flow of warm air that is hotter at the bottom and less warm at the top. Due to the play of densities exposed above, the warm air would tend to go upwards, but it is held down by the cooler air flow with a higher output velocity above. The warm air flow therefore tends to dissipate its heat in the lower part of the room, reducing its temperature and therefore its stratifying effect.
This effect, which has been defined by Robur "ground effect" is well represented by the thermographic image, in which the flow out of the gas unit heater and its mixing in the room is clearly visible (Figure 2.6 *p. 2*).

Figure 2.6 *Robur heat exchanger ground effect*



Obviously the heat stratification is not cancelled, but much reduced compared to an air heating system with a "traditional" heat exchanger type. From the value, as said, of about 1,5 °C/m the ground effect of the Robur gas unit heaters allows to obtain a heat stratification equal to 0,3 °C/m of height.

3 THE ARCHIMEDES ROOM

But how can we indicate this stratification value, which certainly could not have been calculated theoretically? The most effective way, of course, was practical experimentation on the field. It was therefore necessary to record the behaviour of warm air in a real building, in a very precise way, also comparing alternative heating systems in the same room.

Figure 3.1 *The Archimedes room*

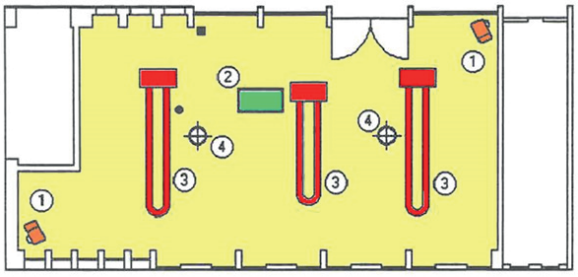
Robur has therefore realized in a small industrial shed a real laboratory for testing, called Archimedes room (Figure 3.1 *p. 3*), in which 3 different types of heating systems have been installed (Figure 3.2 *p. 3*):

- 2 Robur wall-mounted gas unit heaters
- 1 foor standing air heater
- 3 radiant tubes

The heat output of all 3 systems was about 60 kW and was the same for all.

In addition, 2 air destratifiers have been installed (detail 4 of Figure 3.2 *p. 3*) to verify the opportunity/convenience of a mechanical destratification system.

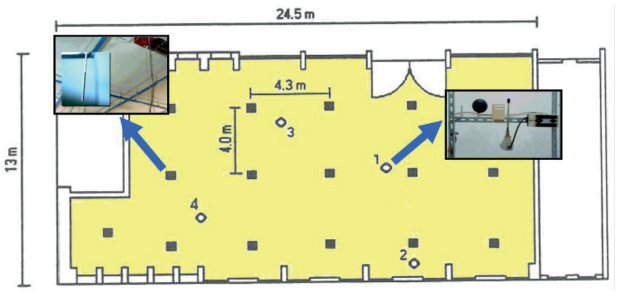
Figure 3.2 *Heating systems position*



1 Robur wall-mounted gas unit heaters
2 Foor standing air heater
3 Gas-fired radiant tubes

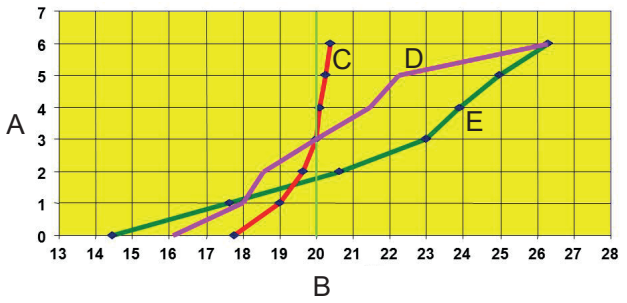
A series of temperature probes (144 temperature probes) and 2 comfort sensing stations (air temperature, radiant temperature, relative humidity, air speed probes) were then installed in the room (Figure 3.3 *p. 3*).

Figure 3.3 *Temperature probes position*



In summary, the results obtained are shown in the graphs in Figures 3.4 *p. 3* and 3.5 *p. 3*, which show minimal heat stratification for the Robur gas unit heaters, greater stratification for the floor standing air heaters and strong heat stratification at the installation height of the radiant tubes.

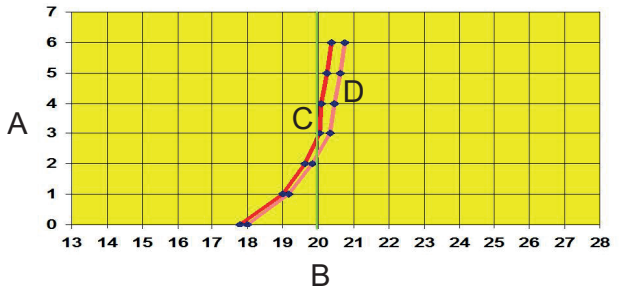
Figure 3.4 *Heating appliances stratification diagram*



A Height (m)
B Temperature (°C)
C Robur gas unit heaters
D Gas-fired radiant tubes
E Foor standing air heater

Finally, air temperatures at various heights were measured with the air destratifiers in operation. The results showed that in this application, the destratifiers do not bring any benefit in terms of reducing heat stratification in the heated room.

Figure 3.5 *Stratification of Robur gas unit heaters with and without destratifiers*



A Height (m)
B Temperature (°C)
C Robur gas unit heaters with destratifiers
D Robur gas unit heaters without destratifiers

The experimentation of the thermal gradient and the stratification made by Robur was not limited, however, to that carried out in the Archimedes Room, but also moved to the field, on real installations serving buildings of different shape, volume and climatic conditions. From the results obtained, however, it was possible to note that the value of 0,3 °C/m of stratification height remained practically unchanged in the various cases examined, thus confirming a heat stratification, thanks to the special heat exchangers used by Robur, significantly lower than that of alternative air systems, which therefore allows a significant reduction in heat loss of the building.

4 THE GAS UNIT HEATERS RANGE

Currently, the range of Robur gas unit heaters includes three distinct product series, each with specific features and models.

1. Gas unit heaters Next-G: condensing modulating gas unit heaters, also available in centrifugal version.
2. Gas unit heaters Next-R: gas unit heaters modulating on two heat output levels, also available in centrifugal and vertical downflow versions.
3. Gas unit heaters M: gas unit heaters for process systems, also available in centrifugal version.

4.1 NEXT-G SERIES GAS UNIT HEATERS

The gas unit heaters of the Next-G series represent the excellence of the air heating systems proposed by Robur.
Their very high efficiency (up to 106,8 %), obtained thanks to the recovery of the condensing heat of the flues, is added to the high comfort offered by the modulation of the heat output and the availability of both versions with a fixed speed fan (Next-G series) and with a variable speed brushless fan motor (Next-G EC series), which make it possible to obtain a constant temperature leap, reduced sound pressure and reduced electricity consumption.
The room probe is supplied as standard, to allow full control of the room temperature, even without the addition of other control systems, while still guaranteeing modulation of the gas unit heater's heat output, for the benefit of greater seasonal efficiency.
The Next-G gas unit heater provides Modbus communication as standard.
The wide choice of optional control systems, including the OCDS015 Modbus remote control with colour touch screen and optional internet connection, allows the basic functionality to be extended to meet a wide range of requirements.
The choice of Next-G series condensing gas unit heaters allows obtaining the maximum performance and comfort in the room, as the gas unit heaters have a sophisticated level of management and heat delivery to the room. In addition, they have access to incentives and tax benefits (which vary depending on the country of installation) thanks to their efficiency.
The Next-G series condensing gas unit heaters are approved for use with a gas mix with a 20% maximum of hydrogen.

- ► Condensing modulating gas unit heaters.
- ► 7 sizes of heat output: from 19,0 to 87,3 kW.
- ► 7 axial fan models with brushless EC motor, 4 axial fan models with fixed speed, 2 centrifugal fan models.
- ► Modulating premix burner.
- ► Possibility to operate with fixed or modulating air flow.
- ► Supplied room temperature probe.
- ► Modbus communication as standard.
- ► Condensate drain siphon (supplied as standard).
- ► Wide range of optional control devices that also allow the centralized management of several gas unit heaters.

4.2 NEXT-R SERIES GAS UNIT HEATERS

The gas unit heaters of the Next-R series represent the basic model of gas unit heater in compliance with current regulations. Their efficiency (up to 97,8 %) is added to the high comfort offered by the burner power modulation on two levels.
The wide choice of optional control systems allows you to choose the most suitable control for your needs.
The choice of Next-R series gas unit heaters is indicated when you want to use a direct exchange air heating system without requiring particular complexity and performance. With the wide choice of accessories for management, you can choose a simple and minimal control system, up to a centralized remote control of dozens of gas unit heaters (up to a maximum of 100) controlled and regulated via PC.

- ► Gas unit heaters with automatic modulation on two heat output levels.
- ► 7 sizes of heat output: from 14,1 to 76,4 kW.
- ► 7 axial fan models, 4 centrifugal fan models, 5 vertical downflow models.
- ► Premix burner modulating on two heat output levels.
- ► Fixed air flow.
- ► Wide range of optional control devices that also allow the centralized management of several gas unit heaters.

4.3 M SERIES GAS UNIT HEATERS

The gas unit heaters of the M series are dedicated exclusively for use in process applications, or in any case for systems that do not have a thermal comfort of human beings function.
The atmospheric type burner with fixed power allows a very reliable operation even in production contexts, where the operating conditions are more demanding.
The wide choice of optional control systems allows you to choose the most suitable control for your needs.
The M series gas unit heaters are designed for the realization of a direct exchange heating system at the service of industrial and process plants (drying rooms, rooms for thermal maintenance of materials, greenhouses and livestock farms, etc.). The simplicity of the gas unit heaters, equipped with an atmospheric forced draught burner, ensures high reliability, a feature highly appreciated in this kind of application. With the wide choice of accessories for management, you can choose a simple and minimal control system, up to a centralized remote control of dozens of gas unit heaters (up to a maximum of 100) controlled and regulated via PC.

- ► On/off gas unit heaters.
- ► 7 sizes of heat output: from 18,3 to 63,8 kW.
- ► 7 axial fan models, 3 centrifugal fan models.
- ► Atmospheric burner.
- ► Fixed air flow.
- ► Wide range of optional control devices that also allow the centralized management of several gas unit heaters.

5 GAS UNIT HEATER SELECTION GUIDE

The criteria to be used for the choice of the most suitable gas unit heater for your needs are summarized in Table 5.1 *p. 4* below.

Table 5.1 *Gas unit heater selection guide*

	Next-G	Next-R	M
Efficiency	up to 106,8 %	up to 97,8 %	up to 88,8 %
Burner type	premix	premix	atmospheric
Burner modulation	30÷100%	two power levels (60÷100 %)	on/off

	Next-G	Next-R	M
Air flow	modulating or fixed	fixed	fixed
Air flow	axial centrifugal	axial centrifugal vertical downflow	axial centrifugal
Models	4 axial fan models with fixed fan speed 7 axial fan models with brushless variable speed fan motor 2 centrifugal fan models	7 axial fan models 4 centrifugal fan models 5 vertical downflow models	7 axial fan models 3 centrifugal fan models
Control	supplied room temperature probe Modbus communication as standard possibility of using different control systems	possibility of using different control systems	possibility of using different control systems
Price range	€€€	€€	€