LOW CAPACITY SPACE HEATING SYSTEMS

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Keywords: Heaters, fireplaces, combustion chamber, air heaters, furnaces, autonomous heating units, heat accumulators.

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Summary

Heating and air conditioning systems are expensive installations to construct as well as to operate. In particular, it may be argued that a well studied and expensive installation provides higher comfort at relatively small operational cost, whereas a cheap and improvised installation provides less comfort at higher operational cost.

This chapter deals with heating systems considering only financial criteria. Such low capacity space heating systems are heaters, fireplaces, heat accumulators and power conductors incorporated in the floor, the walls or the ceiling.

Their operational principals are described in this chapter

1. Heaters

Heaters are autonomous, usually easy to transport, heating units, which are used to satisfy local needs and may be power supplied or operating on other combustible materials (wood, coal, oil, gas etc.)

Choosing among the wide variety of types and sizes of commercially available heaters depends on the type of the building, the size of the area(s), its usage, the available combustible materials as well as the user's preferences and habits.

In small areas or buildings, the problem may be solved with a single heater of relatively large size or several small, usually mobile, ones.

To heat separate areas or sections of large areas, radiation heaters (power or gas operated) are to be preferred. With this type of heaters, heat is being delivered only while they are turned on and only to the area covered by the special funnel or the reflector which control the direction of the radiation. When turned off, heat-supply ceases immediately.

On the contrary, the so called "central heaters" exhibit heat build-up behavior due to their significant mass and, thus, heat capacity. Furthermore, due to their significant volume, they come in contact with significant amount of mobile air in the area.

When contacting the hot parts of such heater, air moves upwards (towards the ceiling) whereas fresh air from the floor moves towards the heater ("natural circulation" effect). Thus, the whole amount of air in the area is gradually heated and, when the heater is turned off, heat will have been accumulated in the body of the heater, in the air, in the walls, in the furniture etc. Consequently, the temperature in the area drops gradually.

Assuming that the heater operates via combustion, it is self-evident that this creates a need for air rich in oxygen. Therefore, operating such a heater in a sealed area is not permitted, due to the consequent formation of carbon monoxide.

The thermal efficiency achieved depends on the location of the heater with respect to the exhaust system (flues and chimneys) and to the (daily and regular) maintenance of the system.

1.1 Power Heaters

Power heaters' operation is based on Joule’s law, i.e. the transformation of power into heat as electric current flows through a resistor. They usually comprise of an ohmic resistor and a reflector which directs the heat radiation where required. In some cases, the resistor heats the air, which circulates either by natural flow (gravitation), or by means of a fan (power air heaters).

The effort to reduce the cost of the power consumption required resulted in the invention of the heat accumulators, which are complex power heating devices.

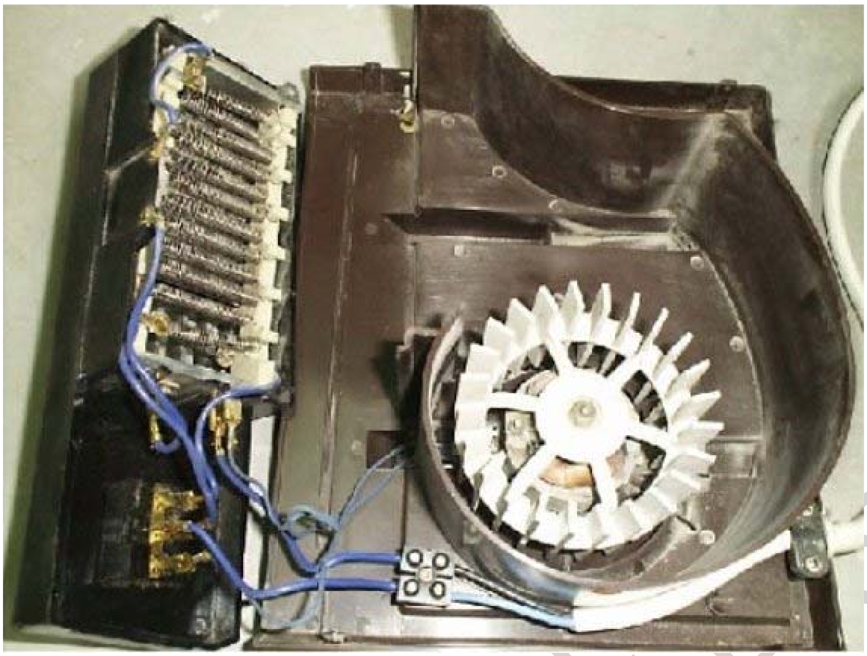

Figure 1: Typical power heater

Heating areas by means of power devices is generally acceptable only in special cases, mainly due to the high cost of power. However, their significant advantages often lead to selecting them as an additional or back-up heating source. Power heating is “clean” heating featuring direct output and might be used as an excellent and simple method for heating areas, should nuclear power ensured low-cost power generation in the future.

- **Power radiation heaters**

An electric spiral resistor is a direct output powerful heating source. This resistor is wound around a ceramic core (of high strength at high temperatures) and is combined with a round or parabolic reflector, which directs heat radiation where required.

At low ratings of 0.5 – 1 kW, these devices are extremely simple (a half sphere or a parabolic reflector) with some protective grid, floor base (feet) and a power supply cord.

Larger units (1 up to 4 kW) usually have an orthogonal shape, multiple rows of spiral windings and switches allowing for separate power supply to each resistor (usually of 1 kW each).

The heating elements are either exposed resistors (as mentioned above for the simplest constructions), or tubular heating elements with magnesium insulation, installed inside a round or oval or flat steel tube. Other types have the resistor incorporated in glass or quartz or some special ceramic material. The maximum temperature reached on these resistors is 2000 °C or 600 to 700 °C for the tubular systems.

- **Power radiators**

Apart from the local, mobile, power heater units, efforts are occasionally made to manufacture ceiling or wall power radiators. In some occasions, such power radiators are based on the direct radiation of the heat or on air streams, whereas in other occasions they incorporate fans.

The so called “power air heaters”, i.e. power heaters with one- or two-speed incorporated fan, are more popular. The power air heaters are capable of achieving fast heating of small areas, but their non-stop operation is extremely costly.

- **Local heat accumulators**

Local heat accumulators are autonomous power heating units with great mass of high heat accumulation capability.

These units usually store heat (produced by power resistors) in special bricks or oil of high heat accumulation capacity during the night (low power rates periods) and deliver it during the day (when the small fan incorporated in these units is turned on).

The local heat accumulators may be considered as separate units of a central heating system operating on heat accumulation.

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Bibliography

Kittle L.J. (1990). *Home Heating and Air-Conditioning Systems.* Mc-Graw Hill Companies. [This book gives detail information on heating systems for domestic use].

Saunders A., Lasalva C., (1993). *Radiant Floor Heating: The Best Systems for Home, Farm or Workplace.* Daedalus & Sons. [This is a basic work on heating systems using radiation processes].

Little & Ives. (1963). *Complete book of Science Illustrated.* J.J. LITTLE & IVES CO., INC., New York. [This is a basic reference work on science and engineering].

Biographical Sketch

Mrs. Irene Koronaki is an associate of the Department of Building Applications. She is a Mechanical Engineer and obtained her PhD in the Thermal Section of the Mechanical Engineering department of the National Technical University of Athens. She has experience in the field of Energy Efficiency in the building sector, regarding both building shell and services. She has participated in several research EC programmes (THERMIE, JOULE, SAVE, CRAFT) during her collaboration with the University of Athens, Department of Physics, as also as a collaborator of CRES. She is a member of ASHRAE and a registered engineer (Technical Chamber of Greece).