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THE THERMAL MANAGEMENT OF BUILDING SECTOR ENERGY SAVINGS USING ELECTRICAL DEVICES FOR HEAT TRANSFER

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Abstract: *The article relates to methods and apparatus for promoting heat transfer management. More particularly, the article relates to methods and apparatus for promoting an increase of convection heat transfer in systems employing electronic components. A few methods and/or apparatus are commonly employed for providing such thermal management.*

Some of those include: heat conduction, where through a material, such as copper, heat flows from a warmer temperature to a cooler temperature; natural convection, which relies on airflow for cooling without any external forces applied to the air; The present electric heater provides a novel method and apparatus to increase convection heat transfer in an electrical system. The increase in convection heat transfer is achieved by introducing a heat source in the vicinity of an element to be cooled, thereby increasing convection heat transfer, i.e. increasing the amount of airflow across the element.

Keywords: *heat transfer, convection, Coanda effect, best board heating*

1. INTRODUCTION

Recent increased interest in the development of high-performance buildings is strongly related to the *world-wide* efforts to reduce greenhouse gas emissions and to increase fissile and fossil energy savings facing fissile and fossil resources depletion. The building sector constitutes one of the most significant energy consumers, and energy reductions combined with diversification of energy production through renewable energy will have a major impact on energy savings and by reducing greenhouse gas emissions could limit actual fast climatic change (see figure 1).

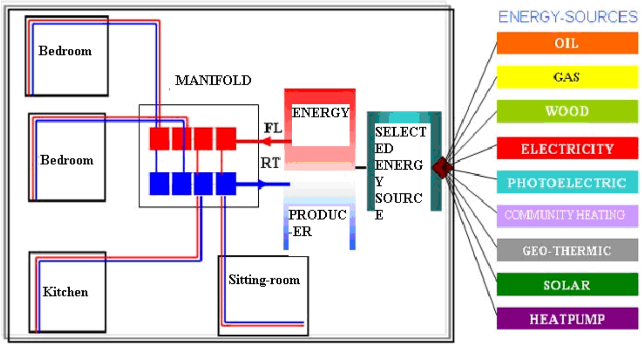

Figure 1. Alternative energy sources

Electricity is an alternative energy source [3]. The present electric heaters will become more fully understood from the detailed description given herein below and the accompanying drawings which are given by way of illustration only and thus are not limitative of the present electric heaters.

The use of a specific heat conducting material is useful to maximize a high efficiency thermal interface between the electrical device and the environment.

The heat source may be a heating device that converts electric current to heat by means of resistors that emit radiant energy. Resistors may be composed of metal-alloy wire, nonmetallic carbon compounds, or printed circuits. Heating elements may have exposed resistor coils mounted on insulators, metallic resistors embedded in refractory insulation and encased in protective metal, or a printed circuit encased in glass.

2. CONVECTIVE HEAT TRANSFER AS THERMAL MANAGEMENT

2.1 Convective heat transfer. Convective heat transfer is one way of addressing thermal management. Convective heat transfer is the heat transfer process that is executed by the flow of a fluid over a surface of a medium. Convective heat transfer includes advective heat transfer, which is based on the velocity of the fluid flow compared to the medium, and conductive heat transfer, which is based on static fluid adjacent to the medium. In convective heat transfer, the fluid acts as a carrier for the energy that it draws from (or delivers to) the surface of the medium.

There are many ways to specify the types of convection. The flow over the surface can be specified as internal, e.g., with pipes or ducts, or external, e.g., with fins. The motive force behind the bulk fluid motion can be forced, e.g., by a fan or pump, or natural, e.g., driven by buoyancy forces caused by fluid density changes with temperature. The flow can be further classified as single-phase, wherein the fluid does not change phase or multi-phase, e.g., boiling or condensation.

There are many specific characteristics of the flow of a fluid that greatly affect the heat transfer rate from/to the medium's surface, but the two categories that govern the effectiveness of single-phase forced convective heat transfer are:

1) the rate of conduction of energy (heat) to/from the medium surface; and

2) the rate of conveyance of energy toward/away from the surface with the mass flow of the bulk fluid.

The rate of conduction is dictated by both the thermal conductivity of the fluid and the temperature of the fluid in the boundary layer. The thermal conductivity of the fluid is a temperature dependent physical property of the fluid that is being used in the convection process. The temperature of the fluid in the boundary layer is influenced by the amount of heat transferred, the specific heat of the fluid and the flow characteristics in the boundary layer. Poor flow characteristics will not allow the fluid in the boundary layer to be replaced by the bulk fluid. The major factors that determine the rate of energy conveyance are the mass flow rate of the bulk fluid and the specific heat capacity of the fluid.

2.2 The Coanda effect. The Coanda effect [1] consists of the attachment of the flow on the wall, when it has a particular shape, known as volet, or Coanda surface (figure 2). This is a cause for the presence of a force between the wall and the jet. Considering the actuator (torque motor, proportional electro-magnet, piezo-dynamic, magneto-stricter or electro-chemical actuator) make the displacement of the piston, it is very important that the resistance forces on it to be as small as possible.

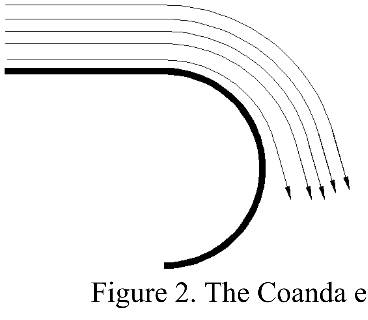

Figure 2. The Coanda effect

The name *Coanda effect* is properly applied to any situation where a thin, high-speed jet of fluid meets a solid surface and follows the surface around a curve. Depending on the situation, one or more of several different physical processes might be involved in making the jet follow the surface.

2.3 **Sensible heat from electric equipment.**

Heat transferred from electrical equipment [4] can be calculated as:

$$\mathbf{H_{eq} = P_{eq}\, K_1\, K_2} \qquad (1)$$

where

H_{eq} = heat transferred from electrical equipment (W)

P_{eq} = electrical power consumption (W)

K_1 = load coefficient

K_2 = running time coefficient

Energy efficiency is a prime consideration these days when trying to determine the best solution for temperature control in homes. Everyone wants to conserve power, save money and be kind to the environment but there is an invisible line beyond which it's not possible to save.

Table 1.
Parameters and Variables used in convective heat transfer

A_i	Area of heated panel i (m2)
F_{ij}	Gray interchange factor between panels i and j (m2)
h_i	Convective heat transfer coefficient for panel i (W/(m2/°C))
q_{i-s}	q_{i-s} = net rate of radiation heat transfer from panel *i* to all other surfaces in enclosure (W/m2)
q_{i-conv}	Rate of convective heat transfer from panel i (W/m2)
q_{i-pwr}	Rate of electrical resistance heat transfer to panel i (W/m2)
q_{i-hl}	Rate of heat transfer from panel i to guard space (W/m2)
R_t	Thermal resistance of wall (m^2 °C/W)
σ	Stefan-Boltzmann constant (W/(m2/K4))
T_{ref}	Reference temperature (°C)
$T_i \cdot T_j$	Average surface temperature of panels *i* and *j* (°C)
T_{gs}	Guard space temperature (°C)
V_i	Line voltage on panel *i* heater (volts)

For a heated surface, assuming no participation of the enclosure air in the radiant exchange, the energy balance is:

$$q_{i-conv} = q_{i-pwr} - q_{i-s} - q_{i-hl} \qquad (2)$$

where:

q_{i-pwr} is the rate of heat transfer to the panel from the electrical resistance heaters,

q_{i-s} represents the radiant exchange between room surfaces, and

q_{i-hl} is the "back loss" to the guard space.

The electrical power input to each panel was calculated from the measured voltage, the measured resistance of the heated panel, and the measured area of the panel:

$$q_{pwr} = \frac{V^2}{R \cdot A_i}\left(W/m^2\right) \qquad (3)$$

The net radiant heat transfer from the *ith* room surface to all the other surfaces in the enclosure is given by Hottel and Sarofim (1967) as

$$q_{i-s} = \frac{1}{A_i}\sum_{j=1}^{56}\left[F_{ij}\cdot\sigma\cdot\left(T_i^4 - T_j^4\right)\right]\left(W/m^2\right) \qquad (4)$$

Finally, the rate of heat transfer from the inside surface to the guard space (the "back loss"), q_{hl}, is calculated from the measured surface temperatures and the thermal resistance of the surfaces:

$$q_{i-hl} = \left(\frac{T_i - T_{gs}}{R_t}\right)\left(W/m^2\right) \qquad (5)$$

Thus, the convective flux was explicitly calculated from experimental measurements for each surface in the room. Since the guard space was controlled to the inside surface temperature, for the isothermal room configuration the only significant term on the right-hand side of the equation is q_{i-pwr}.

The convective heat transfer coefficient was calculated from the rate of convective heat transfer and the temperature difference between the surface and an arbitrarily selected reference temperature.

$$h_i = \frac{q_{i-conv}}{\left(T_i - T_{ref}\right)} \qquad (6)$$

The selection of the reference temperature was arbitrary in the sense that for enclosure heat transfer, a clear and obvious choice for a temperature reference does not exist. An important part of the investigation was to examine the impact of various reference temperatures on the proposed correlations and on the experimental uncertainty associated with the heat transfer coefficients. The room inlet temperature, the room outlet temperature, and spatially averaged planar and bulk air temperatures were examined as possible references.

2. THE BASEBOARD HEATING SYSTEM BY A PLINTH

Heating system by a plinth is elegant and efficient way to heat any space being oriented to the future in terms of new trends in the construction effective.

Best Board heating technique offers the highest quality and is different in ease and speed of automatic regulation in each room, thus obtaining a significant saving of energy.” Due to the possibility of self-regulation in each room, to obtain a significant saving of energy, both with a high optimum comfort. Ascent phase, the heat distributed dry exterior walls, thus eliminating the heat and humidity and heat in the irradiant inside.

The baseboard heater is now the only way to create interior climate economically and without a big investment. The part of the wall heated surface, becomes the source of radiant heat transmitted into the room. The walls are heated to a temperature of 40 ° C, 10 cm above the baseboard heater, and up to 20 ° C below the ceiling (see fig. 3)

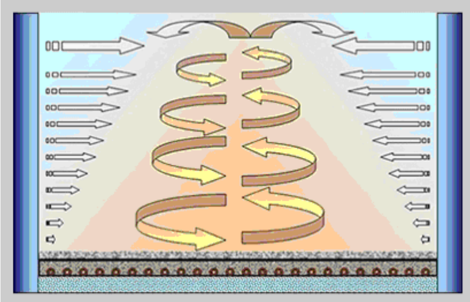

Fig.3 The wall heated surfaces

The curtain of warm air leaving the baseboard heaters (thermal veil) is issued against the wall, up and book gradually while its heat content to the inner surface of the outer wall.

The thermal veil acts as a barrier against cold, giving to the room a comfortable fit (see fig. 4).

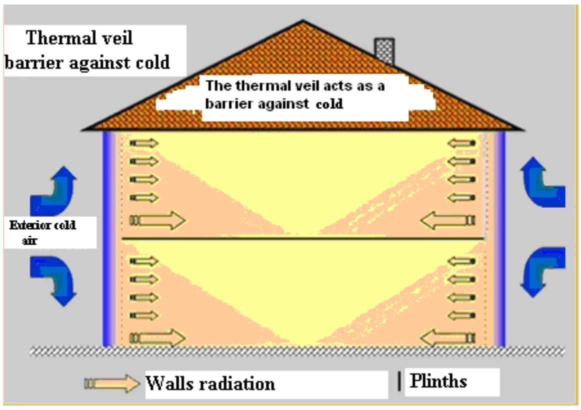

Fig. 4 The thermal veil acts as a barrier against cold

The heat content of the veil is no heat when it has cooled and has reached room temperature. Generally, this happens before the curtain air reaches the ceiling. That is why it does not accumulate any hot air under the ceiling (no cushion of surplus heat) which would be warmer that the air located in the lower layers (see fig. 5). Thus, we found only a homogeneous temperature in rooms heated by electric baseboards. It is just as hot over the floor and below ceiling. Baseboards absorb a small amount of air they spread upwards, their air movement production is barely perceptible above the floor, just before the intake of air. This very low air flow prevents dispersion of dust. The dust content in the air remains very low.

The humidity rate of ambient air is also ideal. It is always between 50 at 60%. The physics of these baseboard heaters has long remained hidden.

Their operation is very simple. The hot water heating spreads in copper or aluminium pipes (and back) battery heater and flows inside the baseboard heater. The air heats up between the fins (consisting of a bonding antistatic. No accumulation of dust), undergoes a load-bearing and passes through the top slot of the plinth. The aluminium coating emits in lowlands ideal warmth that will act against the cold down.

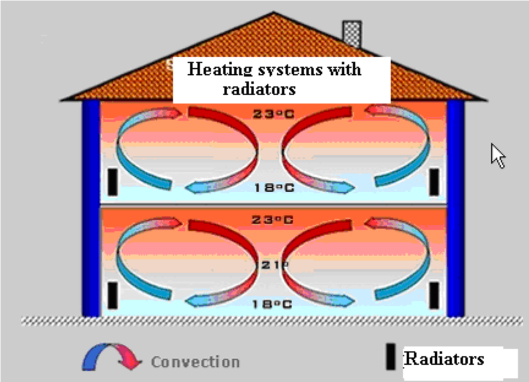

Fig. 5. The homogeneous temperature in rooms heated by electric baseboards

Thus, no cold air can circulate in the room. The rising hot air heats the wall surface on which the baseboard heater is installed (see fig. 6).

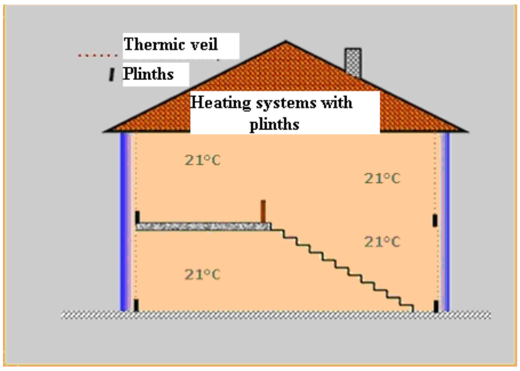

Fig. 6 The rising hot air heats the wall surface on which the baseboard heater is installed

2.1 Electrical and water plinths characteristics [5].

Table 2. Technical characteristics of electrical plinths (230 V)

Length of resistors	mm	2500	1500	1000	700
Power	W	500	300	200	140

Table 3. Cable fireproof silicone 300°C in parallel

Thermostat dimensions BB -75	mm .	width x height x depth	75 x 77 x 26
Transformer dimensions	mm	width x height x depth	107 x 125 x 161
Plinth dimension	mm	width x length	137 x 28

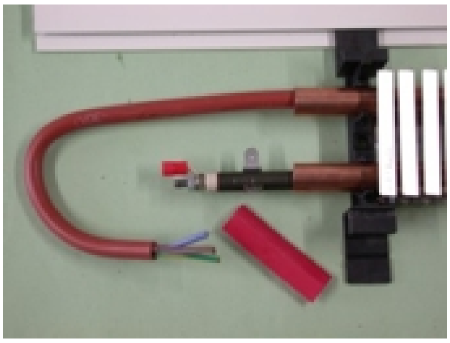

Fig. 7 Electrical plinth mounting in a house

Fig. 8 Water plinths mounting in a house

Fig.9 Water plinths mounting in a house corner

Table 4 temperature of the plinth in °C and Power [6]

Departure temperature of the plinth in °C	40	45	50	55	60	65	70	75	80	85
Power parameter in Watt	88	105	132	149	178	197	226	246	277	294

Table 5. The recommended temperature for sizing installations

Temperature difference between departure / return	5	°C
Quantity of water per meter of skirting departure / return	0.34	m
Maximum length of a circuit (ref. WH)	12.5	m
Exterior diameter of Reflon feeding pipe	13	mm
Inside diameter of Reflon feeding pipe	10	mm
Diameter of protective sheath	20	mm
Reflon tube resistance against temperature	-50°V/+130	°C

Table 6 Dimensions Thermostat,transformer/plinth for installations

Thermostat dimensions BB -75	mm .	width x height x depth	75 x 77 x 26
Transformer dimensions	mm	width x height x depth	107 x 125 x 161
Plinth dimension	mm	width x length	137 x 28

3. CONCLUSIONS

The plinth is a space heater (group) connected to a distributor (VT). The flexible pipes from the distributor to the plinth heating is up to 30 mtr. long. In some cases the distributor must be placed an additional pump. It depends on the size of that house and desired temperatures. It is also possible the plinth heater in the wall integration. It is possible to arrange a room temperature. This is the appropriate group (s) of the distributor drive an electric top. This is controlled by the thermostat in the room. It is thus possible to switch the boiler directly. The Best Board plinth electric heater is also used. This is the bottom tube of the heat-resistance element a rod pushed. This is with or without a thermostat connected to 230 volts. The bar maintains a constant temperature of 60 °C and then delivers the same performance as with water of 60° C.

The best convective heat transfer occurs when the fluid properties and flow conditions are optimized. The optimal fluid properties are high thermal conductivity and high specific heat capacity. The flow conditions that favour optimal convective heat transfer include high local fluid velocity at the medium's surface. Unfortunately, it is difficult to optimize both the thermal conductivity and specific heat capacity of a fluid, and the naturally occurring boundary layer limits the flow near the medium's surface.

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