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THE USE OF HEAT PUMPS IN THE CLIMATIZATION OF THE LOCATIVE AGGREGATES

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Abstract: *This paper presents the heat pump as a solution to producing heat in the locative aggregates. A comparative study is being carried out, based on the thermodynamics and ecologic efficiency proportions, which stressed upon the efficiency of the heat pumps compared to the other heating alternatives.*

Key words: *heat pump*

1. Introduction

The thermal energy generated by the combustion of fuels is produced at thermal capacities frequently surpassing 1500°C. The values of the exergy at this level of temperature are very high and its use for the thermal agent production is accompanied by important exergetic debasements and consequently a decrease in the economic effectiveness. This is the reason why, both from the thermodynamic and economic point of view, it is more efficient to supply the energy consumers with a reduced thermal potential by processing the secondary energetic resources, as well as those of the surrounding environment. This can be achieved when using an equipment which, through the consumption of mechanical energy, will generate an energetic transfer from the low thermal potential source to the high thermal potential one, an equipment also known as a heat pump.

The main advantage of these kinds of equipments is that the consumed energy is at least three times smaller than the energy transferred from the cold source to the warm one.

Taking into account that there are numerous cases where there is no secondary source with a sufficient thermal potential in order to meet the demands of the thermal energy consumers, the only solution remains the use of the heat existing in the surrounding environment. Depending on the features of the heat sources, the heat pumps can be divided in:

- **air-air heat pumps/air-water heat pumps;**

The heat is taken from the atomsphere and directed towards the working agent (freezing agent) of the heat pump. Based on the mechanical energy consumption, it will heat up the air or the water (in case of an air-water pump) existing in the climatized chamber.

- **water-air heat pumps/ water-water heat pumps;**

The most efficient heat source for a heat pump is water, due to its high thermal capacity and excellent thermal transfer abilities. When used as a heat source in the heat pump equipments, the surface water

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induces several problems, such as: the freezing possibility during winter, various sediments leading to the pipes of the vaporizer's pipes no longer being proper and consequently a drop in the heat transfer coefficient and the negative impact on the aquatic flora and fauna. The most efficient source for an ecologic heating is the phreatic water.

A constant temperature ranging from +7°C to +12°C turns the phreatic water into a thermal energy carrier throughout the whole year, without any climate change interference.

The productivity of the equipment, when using the ground water as a thermal energy source, reaches the highest values compared to the other unconventional energy sources (the air or the soil).The digging of two shafts becomes mandatory, provided that they are dug at a 20m distance one of the other, in order to prevent the thermal equalization.

- **soil-water heat pumps/ soil-air heat pumps;**

The use of the soil as a heat source is conditioned by the existence of one or more parallel shafts, of around 100 m in depth, where probes carrying a working agent (the antifreeze combine water type) are introduced. The advantage of this kind of equipment is based on the fact that at a 15 m depth, the geo-thermal temperature is constant all around the year, the temperature increasing directly proportional to the depth of the shaft.

Concerning the heat pumps that take the heat out of the soil, the probe-type collectors have proven to be the most reliable system so far.

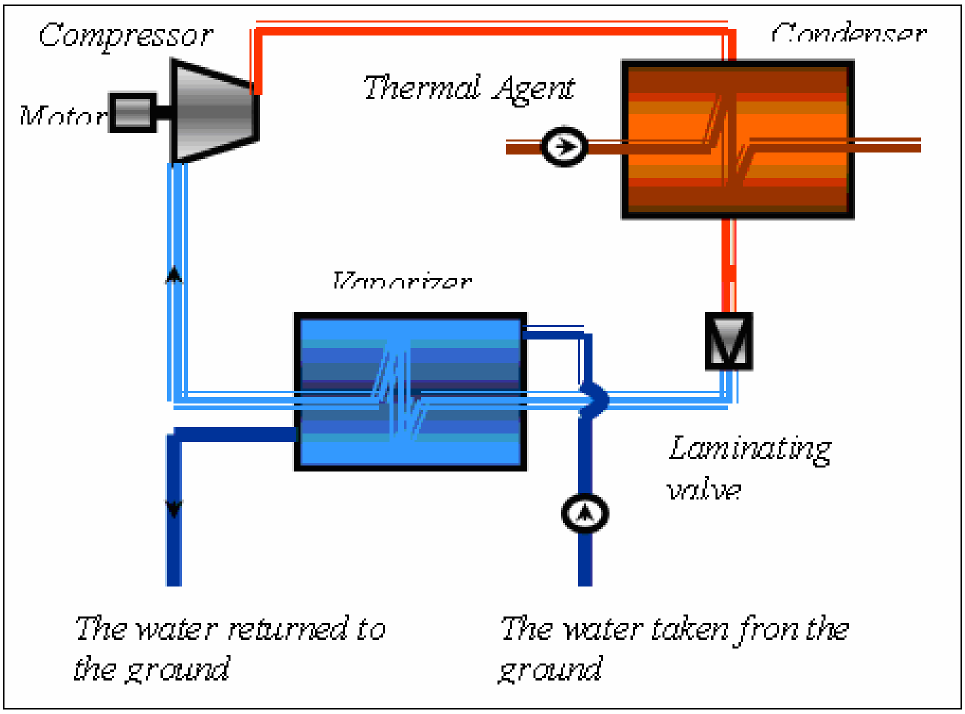

Fig. 1. *The water-water heat pump*

Another alternative of using the heat from the soil involves the placement of serpentine pipes at the depth of 1,5 m (the distance between them will be of at least 50 cm), which consist of the circulation of a working agent that takes the energy formed underground and carries it to the heat pump.

The plane collector stands as an effective solution provided that the land surface be sufficiently large, in order to avoid harming the plants.

The 4 stages of the processes which take place in the heat pump graphic above are:

- The liquid freezing agent at a temperature of -2°C which enters in the equipment's vaporizer where the heat transfer from the water taken from the ground to the freezing agent takes place (the phreatic water enters the vaporizer at a temperature of +12°C and exits at a temperature of +7°C). Upon leaving the vaporizer, the freezing agent is in a vaporous phase, at a temperature of +3°C.

The hot freezing agent vapours enter the equipment's condenser where the heat transfer between the hot vapours and the water from the closed circuit of the house's heating system takes place (the temperature of the water of the water in the heating circuit is of +35°C for the floor heating and +50°C in the radiators).

Upon leaving the condenser, as a result of having released the heat, the freezing agent is in a liquid state, at a temperature of +48°C.

The liquid freezing agent, at a temperature of +48°C, enters the laminating valve where, though the lamination process, it will extend until having reached the temperature of -2°C.

2. Thermodynamic efficiency proportions

The study of heat pumps frequently uses the following thermodynamic efficiency coefficients:

- the performance coefficient, determined by the energy transferred to a warm source and the energy consumed by the compressor ratio:

$$COP = \frac{\phi_H}{P_c} \tag{1}$$

- the specific energy consumption, expressing the energy consumption required for the production of one kWh of energy:

$$c = \frac{1}{COP} = \frac{P_c}{\phi_H} \; [kWh/kWh] \tag{2}$$

- the energetic fuel specific consumption, expressing the energetic fuel consumption required for the production of one kWh of thermal energy (an extremely useful criteria when comparing the effectiveness of various climatization solutions):

$$c_c = \frac{\phi_{cb}}{\phi_H} = \frac{P_c}{\phi_H} \cdot \frac{\phi_{cb}}{P_c} = c \cdot \frac{1}{\eta_{CET}} \tag{3}$$

[kWh fuelsl / kWh produced energy].

Where η_{CET} is the efficiency of the electric energy production in a plant.

3. The Comparative Study Of The Diverse Heating Solutions

Considering the fact that the electric energy is produced in thermoelectric plants with average productivities of 33 %, three household climatization alternatives shall be analyzed as follows:

- the heating with electric resistances;
- the heating with a wall-hung gas boiler;
- the heating with a phreatic water-water heating pump;
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Study comparative Table 1

Solution	*a*	*b*	*c**
Performance coefficient[%]	*100*	*90*	*500*
Specific energy consumption [kWh consumed energy/kWh produced energy]	*1*	*1,1*	*0,2*
Fuel specific consumption [kWh fuel / kWh produced energy]	*3*	*1,1*	*0,6 6*

* The heat pump runs on R 407 C, disposes of a scrooll compressor and works on a floor heating system

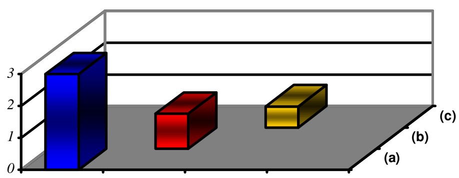

Fig. 2. *The energetic fuel specific consumption*

It is concluded that in order to produce one kWh of heat, a 3kWh fuel energetic equivalent is consumed in case of with electric resistances, 1.1 kWh in case of heating with a wall-hung gas boiler and 0.66 kWh in case of heating with a phreatic water-water heating pump.

In other words, the proposed solution will lead to an energetic fuel consumption six times smaller than the electric resistances heating and two times smaller than the wall-hung gas boilers heating, thus proving to be the most viable climatization alternative.

4. Conclusions

The heat production with the aid of heat pumps can be found in the national strategy regarding the thermal energy supply for the following years, which disposes the following:
- the appliance of the UE 93/76 EEC Directive regarding the carbon dioxide emissions reduction by upgrading the energetic efficiency and the 2001/80/EC Directive regarding the reduction of the polluting funnel emissions;
- the competitive production and distribution of the thermal energy at prices within the range of the buyers' possibilities;

The permanent search for new technologies that will put an end to the energetic problems claims for new solutions of energy production that will meet the global demands, in such way it will not affect the evolution of the future generations.

People must make the right choices and in order for this to take place, they need to be very well informed, as to be able to foresee the impact of the use and production of energy on the development of mankind.

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