HEAT PUMP APLLICATION OF THE DEHUMIDIFICATION INSIDE THE THERAPY SPACES.

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Abstract: We present an energetically efficient method of reducing the humidity in the hydrotherapy centers. There are presented some theoretical consideration regarding the air cooling and dehumidification and also its re-heating. It is presented the principle of dehumidification device of the heat pump circuit. The using of the heat pump for dehumidification shows technical and economical advantages comparing with other dehumidification technical solution.

1. Introduction

The main elements which determine the effect of comfort inside rooms are: indoor air temperature and air humidity areas, limitation, and the speed with which he is displaced in the room.

In the halls of hydrotherapy, covered piscine and in other places with the excessive humidity is advisable to reduce it, in order to conduct in dune conditions of the various activities [1].

Reducing moisture content of air can be achieved on several processes:

- by absorption with solids,
- by treatment with liquid solutions
- by air, détente
- with ice,
- with water spray;
- cooling with batteries.

Of all the methods presented above, the most efficient in terms of energy has proven to be the battery cooling. If our battery cooling is even evaporator an air heat pumps air-air which is the subject matter presented in the article.

2. Technical Considerations

Dehumidification equipment, works by the principle of condensation from the air when you get in contact with evaporator heat pump whose temperature (t_0) is lower than the dew point temperature (t_τ) and warming the air in contact with the condenser whose temperature (t_k) is greater than the air temperature at the entry in the device (t1). Cooling and drying air is conducted after segment 2-3, and the warming after segment 1-2, refrigeration and condensation water vapor is made after 2-F-1 (fig. 1).

Load thermal of evaporator and implicit refrigeration power of the heat pump is:

$$\Phi_0 = \dot{m}\,(i_1 - i_2) = \dot{V}\cdot\rho\cdot(i_1 - i_2),\quad \hat{i}n\ W\ sau\ kcal/h \qquad (1)$$

With: $\dot{V}$ - flow rate by volume, of m^3 / s;

$\dot{m}$ - masic flow air entering the apparatus, in kg / s;

ρ – the average density of the air, by kg / m^3;

i_1 – specific enthalpy at evaporator inlet air, by kJ / kg or kcal / kg;

i_2 – specific enthalpy at evaporator output air, by kJ / kg or kcal / kg.

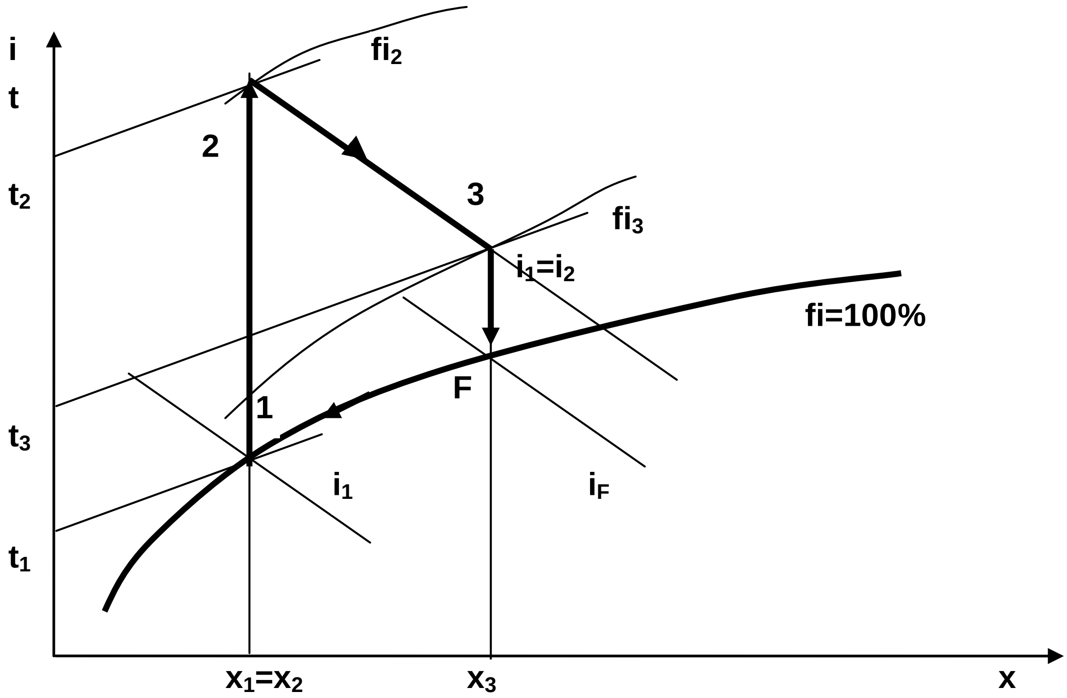

Fig. 1. Drying and heating air in chart x-i

The final air temperature at the exit of the condenser battery of heat pump [2] is:

$$t_1 = t_2 + \frac{\Phi_k}{(c_{pa} + c_{pv} \cdot x_2) \cdot \dot{m}}, \quad in \quad °C \tag{2}$$

Where: t_2 – air temperature at the exit of the battery of vaporization (cooling), in ºC;
Φ_k – thermal load of the condenser, in W or kcal / h;
c_{pa} = 1,005 kJ / kg K = 0,24 kcal / kg K – specific heat (average) mass of dry air at constant pressure;
c_{pv} = 1,84 kJ / kg K = 0,44 kcal / kg K – specific heat of water vapour at constant pressure;
x_2 – the water vapour content in the kilogram by a kg of dry air.

The dehumidification designed in heat pump system offers the advantage that the dry air that comes out, it is approximately 6-10 ° C warmer than the air entering. This extra heat flux is obtained by taking account of a physical effect; during the evaporating water absorbs more heat from the environment first. This is called latent-heat this is reputed in freedom during recondensation water in the dehumidification apparatus.

In addition to the latent heat, the engine ventilator fan and refrigeration compressor contributes to warming the air through the equivalent power consumption of calorie. Theoretical heat balance of the heat pump is:

$$\Phi_k = \Phi_0 + P_a \,, \quad inW \quad or \quad kcal/h \tag{3}$$

With: P_a – adiabatic power refrigeration compressor, W or kcal/h.

Coefficient of performance of heat pump is:

$$COP = \frac{\Phi_k}{P_a} \tag{4}$$

3. Presentation of apparatus

Dehumidification has all the functional installed in a metallic frame at outdoor panels, detachable coils [3].

In the figure 2 the principle scheme of dehumidification valve air functioning as a heat pump air-air is shown.

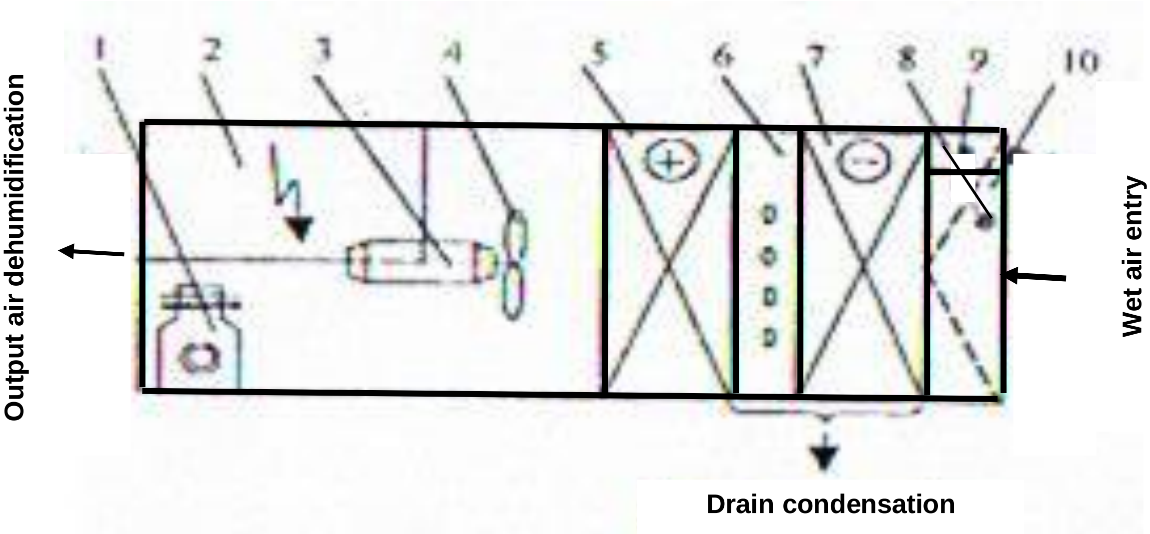

Fig. 2. Diagram of dehumidification
1- Refrigeration Compressor; 2- Control and force electrical panel; 3 – Electric Motor; 4- Axial ventilator; 5 – Condenser; 7 – Evaporator; 8 – Air filter; 9 – Hygrostat; 10 – Frame.

Damp air is drawn in by the ventilator 4 and goes through evaporator 7 where it is cooled and dehumidification. Condensed water dripping into the tank, under him and is discharged from the device with flexible conduit.

Air cooled and dehumidification passes through the separator drops (6) where any more drops of water collects driven by the airflow through condenser with slides which heating.

So what comes out of the air absorbs a quantity dehumidification more heat from the electric motor of the fan (3) and from refrigeration compressor (1).

Evaporator and heat pump condenser are heat exchangers in the copper pipes Cu and aluminum Al are the lobed.

Refrigeration scheme of heat pump is shown in Figure 3 [4].

In situations where dehumidification has other uses, such as: deposits, deposits for movies, skin drying rooms etc. and indoor air temperature is between + 12 ° C and + 2 ° C is needed a defrosting periodic evaporator, which is carried out with the hot gases. In this situation the electromagnetic valve for refrigerant liquid (8) is closed and the electromagnetic valve for hot gas defrosting (3) is closed.

As a practical data of the method of dehumidification air heat pump is the following:

- Consumption of cooling power per unit volume of space dehumidification 2,6-3,6 W/m^3;
- Installed power per unit volume of space dehumidification: 0.0018 – 0,003 kW/m^3;
- The flow volume of air circulated by the fan relative to the volume space: 1.0 – 1.1 $m^3/h/m^3$;

- The relative humidity of the air in the room to be dehumidification: 40-100% rh;
- The flow of water removed relative to 1 kW refrigeration power: 0,7-1,0 l/h/kW.

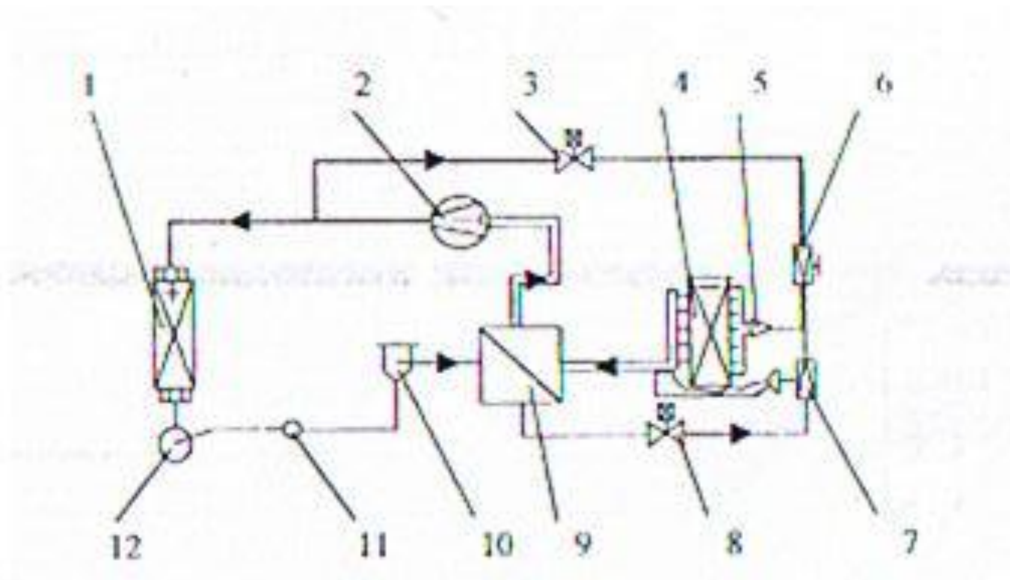

Fig. 3. The Refrigeration Diagram of the Heat Pump
1-Condenser; 2 - Refrigeration Compressor; 3 – Electromagnetic valve for hot gas defrosting; 4 – Evaporator; 5 – Distributor of liquid; 6-Manually adjustable valve; 7 – Expansion valve with pinch of outer equalization; 8 – Electromagnetic valve for fluid; 9-Internal heat exchanger; 10 – Filter for dehydration; 11 – Viewfinder flow and humidity; 12 – Tank of liquid.

4. Conclusions

Dehumidification appliances are used everywhere where must we avoid discomfort caused by damage or excessive humidity.

Dehumidification shall be done by the condensation of humidity from the air in contact with a cold surface cooling. Recovery of the heat that results is based on the principle of the heat pump and is the solution most favorable in terms of economy of energy.

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