OPPORTUNITIES OF THE NATURAL COLD APPLICATION

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Due to considerable increase in prices of fuel and energy resources, and stricter requirements to environmental protection, interest to the use of the natural cold in air-conditioning systems in industrial and living premises has regenerated.

Earlier, systems were developed using the natural cold [1,2] but because of high intensity of the processes of production and further transportation of ice to destination and because of lack of equipment that would ensure effectiveness of the ice withdrawal process, they were displaced from the market of refrigerating equipment.

In many parts of Russia, the atmospheric temperature stays below zero for longer periods, and this allows to apply the natural cold in air-conditioning systems.

This paper considers a system of accumulation and use of the natural cold, shown at drawing 1.

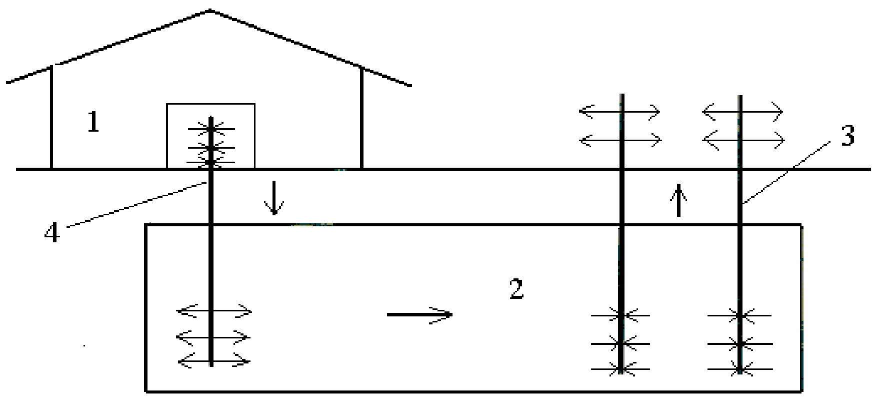

Fig. 1 System of accumulation and use of the natural cold.
1 - refrigerated space, 2 - storage heater, 3 - bi-phase thermosiphons,4 - electrohydrodynamic cooling condenser

The proposed system works as follows. When the outer air temperature decreases, the temperature of the condenser of the thermal siphon becomes lower than the temperature of heat-storage substance of the storage heater. The heat-transfer liquid in the thermosiphon starts boiling, while cooling the heat-storage substance, i. e. the charge of the storage heater takes place. Besides, due to features of the thermal siphon, the difference between the air temperature and the temperature of the heat-storage substance is minimal and may reach degree fractions.

Application of the thermal siphon provides for automatic heat removal from the storage heater when the air temperature goes lower than the temperature of the heat-storage substance, and its shutdown when temperature difference between the evaporator and condenser reverses. The shutdown excludes off-cycle cold removal from the storage heater into the air.

To reduce heat losses, the storage heated is located in the earth and insulated against loss of heat to soil.

Heated air of the refrigerated chamber is transferred to the storage heater by portions through electrohydrodynamic evaporating-condensation system. Unlike the thermal siphon, evaporation area in the electrohydrodynamic evaporating-condensation system is higher than condensation area. Therefore, to secure working capacity of the cooling condenser the heat-transfer liquid should move to the evaporation area from the condensation area. An electrohydrodynamic pump effects this process through a condensate pipeline. The entire surface of the evaporation area is evenly moistened by liquid since it has capillary structure.

The electrohydrodynamic pump allows to adjust consumption of the heat-transfer substance within a wide range, from the maximum consumption to complete stoppage, while changing the heat flow from the refrigerated chamber to the storage heater and supporting the needed operation of the coolant system in general. “Freon-142” can be applied as heat-transfer liquid for the electrohydrodynamic cooling condenser. It is not a poisonous gas, the boiling temperature under atmospheric pressure amounts to –9,8°C, and condensation pressure under 40-50°C does not exceed 0,7°C. In addition to this, the said coolant possesses sufficient dielectric rigidity. This feature is rather important since the voltage of the given system varies from 0 to 30 kilovolts.

Application of electrohydrodynamic pumps expedites the creation of an automated system regulating thermal condition of a refrigerated body, however, regulation of heat-transfer characteristics of the cooling system is done through operating pressure and consumption characteristics of the electrohydrodynamic pump.

Dependent on overall dimensions of the cooling chamber and the mass of refrigerated bodies or consumption of condensed air, the system may switch on needed number of electrohydrodynamic evaporating-condensation system, thermosiphons and a storage heater with a relevant heating capacity. Balancing of temperature in accordance with the capacity of a storage heater can be done by wick heat pipes. It is most reasonable to use water as heat-storage substance because it is most accessible and cheapest heat-storage substance, and has good heat-transfer properties, such as: melting (freezing) temperature is 0°C; heat of melting is 335 kilojoule/kg; heat capacity is 2.1 kilojoule/(kg·kelvin).

The proposed system for accumulation and application of the natural cold can be used both as an independent coolant system, or in combination with refrigeration chambers for preliminary cooling of products by accumulated natural cold before placing the latter into refrigeration chambers for the purpose of power saving.

From the said above it can be concluded that the said system of accumulation and use of the natural cold removes a number of significant deficiencies that were intrinsic to earlier natural cold-operated systems. The said system removes such intensive processes as withdrawal and transportation of ice, makes it possible to computerize the whole process.

Let us assess energetic opportunities of a storage heater with the volume of 12 cubic meters where water is used as heat storage element. Let us assume that in wintertime water would freeze up to -30°C, what is realistic for the Karelian context. Then, when discharging the storage heater to 0°C (taking into account melting), 4,78*10^9 joules will be needed. Let us compare the obtained value with the cold generated by a modern domestic refrigerator, which consumes approximately 5,4*10^6 joules. In the view of the efficiency factor of the refrigerator (25%), the energy withdrawn by the refrigerator from a refrigerated product will make up to 4,9*10^8 joules. Thus, in our example a storage heater will substitute for some nine domestic refrigerators. But it should be borne in mind that the efficiency factor of the storage heater is less than 1, and part of electric power will be used for the transfer of the heat-transfer liquid to the evaporation area in the electrohydrodynamic cooling condenser.

To widely apply the proposed system, it is necessary to explore and optimize working practices of the electrohydrodynamic cooling condenser and the system in general.

<u>References.</u>

1. Bobkov V., ″ Producing and using ice ″, Moskow, 1977, pp. 62-90.
2. Malgina E., Malgin U., Suedov V., ″ Refrigeration″, Moskow, 1980, pp. 485-511.