IMPROVING THE EFFICIENCY OF ACCUMULATION OF COLDNESS IN AGRICULTURE

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Abstract. *Accumulation of natural cold is the use of the phenomenon of heat absorption (release) during the phase transitions of a substance. The article discusses the use of renewable energy to reduce energy consumption for cooling in agriculture, the creation of cooling systems based on the seasonal accumulation of "natural cold" accumulated in the hot season. There is a talk about the possibilities of storage of natural cold in the storage of goods and heat – insulated storage, the world experience in improving its efficiency.*

Keywords: *natural cold, batteries, ice ponds, iceboxes, seasonal ice and snow, environment, compressor.*

ПОВЫШЕНИЕ ЭФФЕКТИВНОСТИ НАКОПЛЕНИЯ ХОЛОДА В СЕЛЬСКОМ ХОЗЯЙСТВЕ

Аннотация. *Аккумуляция природного холода – это использование явления поглощения (выделения) тепла при фазовых переходах вещества. В статье рассматривается использование возобновляемых источников энергии для снижения энергозатрат на охлаждение в сельском хозяйстве, создание систем охлаждения на основе сезонного накопления «естественного холода», накопленного в жаркое время года. Рассказывается о возможностях аккумулирования естественного холода при хранении товаров и теплоизолированных складах, мировом опыте повышения его эффективности.*

Ключевые слова: *естественный холод, батареи, ледяные пруды, холодильники, сезонный лед и снег, окружающая среда, компрессор.*

INTRODUCTION

The increasing load on the power grid as a result of the increasing use of air conditioning systems in buildings and refrigeration plants for the storage of agricultural and other products requires the search for and development of new energy – saving cooling sources. The problem of cooling is especially relevant in rural areas, especially on farms and subsidiary farms (dairy farms, etc.) that specialize in the production of products that require storage at low temperatures. Existing restrictions on the connection of low – capacity rural power grids and electricity is available, tariff increases and high connection costs are serious limitations.

MATERIALS AND METHODS

The traditional technical solution used to supply consumers with refrigeration today is to use refrigeration units, as a rule, steam compressors that operate in accordance with the current refrigeration load schedule. With this solution, the capacity of the refrigeration unit is selected based on the maximum cooling load, which usually corresponds to the hottest days of summer for typical cold consumers (air conditioning of buildings, storage of agricultural products, etc.). The maximum power consumption of the refrigeration unit occurs during the day, which increases the maximum daytime load on the mains. In the case of a multi – tariff system of payments for electricity, the operation of the refrigeration unit occurs mainly during the hour with the maximum tariff values. This leads to an increase in operating costs. It should also be noted that the operation of the refrigeration unit during the day with the maximum ambient temperature, in which the condensing heat of the working fluid is released during the cooling cycle, reduces the cooling coefficient of the equipment and leads to increased power consumption. Refrigeration coverage is becoming more and more important in the energy balance of settlements, agricultural complexes and farms, as a result of which the search for more efficient ways to ensure cold supply is an important component of industrial energy saving and energy efficiency policies. The problem of air conditioning in the facilities of the recreation sector, which seeks to improve the quality of services for vacationers, remains very relevant due to the limited capacity of existing power grids.

Below we look at the possibilities of creating cooling systems based on the seasonal accumulation of “natural cold” accumulated as a result of ice production in winter and storing it in a heat – insulated storage area by gradually consuming the “cold” accumulated during the hot season. This approach has a number of positive potential advantages over traditional cooling systems. Cooling machines used for cooling have a relatively low cooling coefficient, which means that when the cooling water temperature reaches + (5.5-10) °C at an ambient temperature of 20 – 30 °C, it does not exceed 2.5 – 3.5, only 2.5 – 3.5 kW of cooling power can be obtained for 1 kW of electricity consumed by the drive of the refrigeration machine compressor. The seasonal cold storage systems described below provide a several - fold reduction in electricity costs for cold delivery to different consumers. In cold periods when the outside air temperature is below (5-10)°C, the articial formation of snow (ice) is carried out by spraying finely dispersed water into the cold air from time to time. Freezing of water as a result of cooling of micro – sized droplets (diameter about 20 microns) during stay in cold air ensures that natural cold accumulates in proportion to the mass of ice obtained and the specific crystallization heat of water (33.3x104 J/kg).

RESULTS

The resulting ice is collected in special places (trench, pit or specially designed tank) insulated from heat. Once the ice – forming processes are complete, the battery is periodically covered with thermal insulation materials from above. In winter, ice production takes place during the coldest times, mainly at night. Preliminary calculations show that the proposed method of ice formation can give a positive result when the outside air temperature is below – (5 h - 10)°C. The size of the cold accumulator is selected taking into account the annual load on the cold supply of the consumer, taking into account the inevitable losses of cold through the battery cabins during the year. To “carry” the refrigerant to the consumer, the heat exchanger is placed inside an accumulator created by the described method, through which the coolant (antifreeze or water) is pumped. It should be noted that the cooling coefficient achieved in the device, calculated as the ratio of the crystallization heat of accumulated ice to electricity, can reach 50-100, according to preliminary calculations, which is ten times the cooling coefficient of traditional refrigeration machines high Second, it means a several - fold decrease in electricity consumption for cooling needs, and since ice is formed mainly at night, the load on the power grid will be lower as a result of connecting water sprinklers. At peak load during the day, the load in the network is only related to the operation of the pumps that supply the battery with cooling water to the consumer.

The seasonal accumulation of natural cold discussed in this paragraph is the best solution for use for a short period of the year with the low negative temperatures of the outside air and the preservation of snow cover in the climatic conditions of the southern regions. Such places cover a large part of the territory of Uzbekistan, where the problem of air conditioning in buildings is especially acute in the hot season. These include, as a rule, areas where the most developed agricultural products are produced, which require cooling for storage of agricultural products. The technology of cold reception can be effectively used to create a comfortable environment for vacationers in the hot season, even in the area of fast – growing resorts in these areas. The idea of storing in the refrigerator using frozen water is not new. In many countries, snow and ice are collected and stored for cooling. In Greece, for example rivers and lakes that freeze in winter are cut from ice collected and covered with sawdust. The same thing happened in many countries in Europe and North America until the early 20th century, when electric refrigerators gradually replaced this labor–intensive method.

Today, the interest in ancient (but using modern technical solutions) technologies to get cold is being renewed in connection with the development of energy saving and energy efficiency programs and renewable energy sources. “Natural cold ” is characterized by environmental friendliness, renewal, its production does not require large energy consumption. The use of ice as a cold accumulator is widely used today in a number of countries around the world (Sweden, Canada, China, Japan, etc.), including in the development of large – scale projects for air conditioning and agricultural storage in buildings (hospitals, offices and residences).

An analysis of the literature allowed to identify several main options for the use of ice in refrigeration systems (Table 1).

Table 1

Variant	Short explanation	Advantage	Disadvantage
1	Only the cooling device is used	No additional costs are required for system compactness, refrigeration storage system and additional engineering equipment	The increase in the installed capacity of the cooling device, the high load on the power grid, corresponds to the maximum load, the high tariff increases the operating costs of electricity
2.	A cooling device and a short – term cold	Decrease in the installed capacity of the refrigeration	Additional costs for the cold

	accumulator (ice) are used. Ice is produced by the cooling machine at low electricity tariffs during power outages. Cooling during the day is mainly done by melting the ice	unit and its costs, decrease in the operating costs of electricity due to the operating costs of the refrigeration unit, mainly with low tariffs per hour and high cooling coefficient (at lower outdoor temperature), decrease in peak load in the power grid	storage system, the need for new areas to accommodate the refrigerator and additional engineering equipment.
3.	Cooling device is not used. Ice /snow is taken at outside air temperature and seasonal heat is collected in an insulated warehouse in one of the following ways: *Collecting surrounding snow and (or) freezing water from layer to layer* *Artificial formation of snow/ice as a result of fine dispersion of water by artificial generation*	There are no costs for the cooling device, energy consumption for cooling is significantly reduced Water spraying system and the cost of its use Ice can be produced at relatively high temperatures, the technology is suitable for areas with low snow, short duration of snow cover, low cost of ice production	Additional space is required for a seasonal cold battery, as well as the cost of creating it Snow collection and transportation costs are required, the technology is only suitable for areas with heavy snowfall and long duration of snow cover, ice freezing continues slowly, low outdoor temperatures are required for a long time Costs for the creation and maintenance of a finely dispersed water spray

			system, as well as energy costs for water spraying (small)

The option under consideration does not involve the use of any refrigeration machine. Cold delivery to the consumer is made during the cold winter due to ice or snow accumulated in one way or another in a special warehouse. This saves on the cost of the cooling machine and its operation, but it is necessary to create a large enough cold battery and collect ice or snow in the winter and ensure the operation of the cold exhaust system from the battery in the warm season. The battery is a key component of the cooling system, on which, first of all, its efficiency and economy depend.

Numerous technologies are known to create seasonal ice and snow accumulators. The most common are called "ice ponds". Glacial water basins are created to store snow, ice or a mixture of ice and water with snow for a long time. The bottom and side walls of the pool are waterproofed to prevent water from falling to the ground and the pool is carefully insulated from above. The size of the pool is filled with ice or snow in the winter using snow – making devices of various designs. Electricity consumption for the production of ice or snow varies from 0.5 to 2 kWh per 1 ton of ice for various devices, the cooling coefficient is 50-200.

Another popular technology of making ice abroad was called Iceboxes. The essence of this technology is that water is poured into specially designed heat – insulated and waterproofed structures in thin layers (usually a few millimeters thick) in winter at low negative air temperatures. As a result of contact with cold air, the water layer freezes, after which the next thin layer of water is poured. In such devices, the ice freezing process is much slower, however, in some regions where the winter is very cold during the cold period of the year, it is possible to freeze a layer of ice up to 20m thick. Ice freezing technology in "ice boxes" can be fully automated. With large volumes of frozen ice, attention must be paid to its thermal expansion, which requires the presence of temperature compensators in the "box" structures. Compared to "ice pools", this technology is more expensive, but at the same time has high values of performance (up to 100). The known designs are designed for cooling capacity from a few units to 250 MW, with an estimated cooling capacity of 8-1600 kW.

In Japan, natural cold storage is widely used to store vegetables and fruits and they are called Himuros. Typically, these batteries are part of a building or vegetable store. The buildings are connected to each other by an air space and the temperature and high humidity are maintained at 0°C due to the natural circulation of air in the store, resulting in ideal conditions for long – term storage of agricultural products. Ice is produced artificially or loaded from the outside. Hundreds of Himuros were built in Japan. The largest have a refrigeration capacity of up to 25,000 MW / h.

DISCUSSION

The use of accumulated cold in agriculture ensures the safety of agricultural products, reduces the consumption of electricity for production needs and reduces operating costs for refrigeration equipment, including field storage equipment. The operation of the developed equipment allowed to reduce the specific consumption of electricity for cooling milk by 10 times in the warm season, reduce the installed capacity of electrical equipment and increase the cooling capacity of refrigeration equipment by 3 times and reduce losses of agricultural products by at least 30 – 40%

CONCLUSIONS

Thus, the use of natural cold and its long - term accumulation to deliver cold to different types of consumers in modern conditions will lead to a sharp increase in electricity consumption this summer, reducing energy efficiency and saving energy.

REFERENCES

1. Taylor T.B. Ice ponds // AIP Conference Proceedings. 1985. P. 562 – 575
2. Abdelnour R., Labrecque B., Underdown A. Technoeconomic analysis of three seasonal cooling technologies; ice block, frozen pond and waste snow pit // Calorstock 94, Conference on thermal energy storage. 1994
3. Morofsky E.L., developing an Innovative Building Cooling Technology // ASHRAE Trans. 1987. NY 87-21-1. P. 1741 – 1748.
4. A cold storage for foos using only natural energy/K. Okajima, H.Nakagawa, S.Matsuda, T.Yamasita// Snow Engineering 1997.
5. Лыков А.В. Теория теплопроводности. М.: Высшая школа, 1967