HEAT SYSTEMS OF THE GLASS HOUSE

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Abstract

This paper deals with a series of problems regarding analysis, evaluation and improvement of the performance of heat installation of the complex functional glass house. Design and execution of this type of constructions must take into account a number of important factors for providing thermal comfort. Due to their architectural structure, constructive and functional, glass house impose some conditions for an optimal and economic system for heating and air - conditioning. Our case study put an emphasis on the specific problems of analysis and their solutions for a new glass house.
Key words: heat systems, glass house, installation

INTRODUCTION

Modernization of economic sectors requires the use of heating performance with low power consumption and advanced automation modes. In this direction is part of the heating and cooling glass houses and solariums. Analysis, evaluation and control of the energy performance of a building glass house and heating, ventilation and air conditioning should be a constant concern in the design, implementation and operation of this type of economic objectives. For buildings such as glass house and solariums and their particular mode of operation involved a number of internal and external factors involving energy envelope differentiated structure and facilities providing thermal comfort. Glass houses and solariums, unlike most construction have a number of peculiarities in the way of architectural structure and design, interior space planning, assurance of achieving thermal comfort and special operating conditions.

The design, implementation and operation of the heating system of glass house are done based on accepted norms and standards, coupled with requirements and standards. By its provisions are rationally trying to strike a balance between cost and optimal operating condition, coupled with high safety heating and air conditioning systems in the operation.

The last time you made the design and execution of glass house - glass house with performance and operating parameters with a high degree of automation in the process of heating and air conditioning. The use of modern solutions in the development and operation of glass houses requires proper design of facilities serving such building.

How to achieve constructive structure and mechanical parameters of the materials used, systematization arranged space, imposing certain temperatures differentiated production space, operating periods, the automation of key functions, the impact of external environmental factors and so on, requires special consideration the design parameters of the heating and how to exploit it.

MATERIAL AND METHODS

Glass house and solariums have a special structure which allows for a differentiation construction of heating methods and specific arrangement of system components in space. Technical development in the delivery of this type of construction has reduced structural differences between glass house and solariums. Constructions to achieve modern glass houses have a number of parameters which determine the design of the heating and ventilation, including specified:

- Infrastructure glass house foundation consists of continuous or individual generally placed on a flat surface.
- The superstructure can be made of light metal structures made of galvanized steel profiles.

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- Closures side and roof of the glass house can be made of composite structures with thermal characteristics and resistance.
- Infrastructure and superstructure span glass house is standardized manner in length and width, in which effective adaptation is performed land area available on site.
- Volume glass house is relatively higher than the classic type. This is achieved by raising the ceiling at higher rates, which allow buffer volumes and maintaining a stable air over a period of time.
- The absence of rigid elements with high mechanical properties, which are located on the perimeter of the glass house, and its location, requires some restrictions on the positioning of heating and ventilation.
- Architecture glass house requires a large glazed surface that can reach about 95 ... 99% of the superstructure, with immediate effect on energy balance.
- Glass house behind the operation is differentiated by season and time, something that requires a diversification of the heat and the distribution thereof.
- The glass house has a modern automation system ventilation system, something that directly affects the heating operation.

Those listed above require a special analysis design conditions and design of heating the glass houses of the new type. Standardized and modular structure imposes a certain way of placing the whole glass house heating system. Also be achieved some hot air distribution in collaboration with attached glass house ventilation system parameters.

RESULTS AND DISCUSSION

Glass house construction has a structure of metal resistance of galvanized steel profiles per module 9.60m x 2.50m and placed on insulated foundations (superstructure imported from the European Community). Characteristic heights are the coping 3.50m - 6.00m ridge. The greenhouse is made of eight modules with size 9.60m x 2.50m, resulting in a surface plane rectangular area 76.80 x 60.00m^2 and a volume of 22.000 m^3.

Perimeter enclosures (front, side walls) and roof are made of double diaphragm type inflatable PE Coex - Eva - 200μ, transparent. Each section emissions by 9.60m width module is mechanically ventilated roof. About 35% of the glass house roof or part width of 3.40m is pivoted vertically and is driven by electric motors. This mode is in the process of ventilation and indoor microclimate change. Microclimate parameters are analyzed based on glass house requirements in conjunction with the outdoor climate, by a process computer, making the decision to open or close a movable roof sections. Inflatable double membrane is tightly closed contour inside a glass house and maintained at that pressure controllable air volume. Air pressure and volume change is accomplished by pumping equipped with a network of air channels made of PVC and comes with a fan. Functional process is computer controlled process. Glass house construction has fire resistance grade II, category importance of fire hazard "C" (cf. P.118/99) important class IV and class D. The important glass house climatic conditions specific to the site are:

- winter temperatures $t_e = -18$°C; area III - the climate for winter;
- summer temperatures $t_e = 24.3$ °C; area III – the climate for summer;
- thermal zone III wind zone II (STAS 1907/1/1997, STAS 6648/2/82);
- the area C for snow action ($g_z^n = 150$ daN/m^2);
- the area C for wind action ($gv^n = 55$daN/m^2);
- the IV area - the exposure in terms of maximum intensity and simultaneity of rain and wind.

Under specific climatic conditions of the site (STAS 1907/1/1997, STAS 6648/2/82), and destination parameters given by construction (glass with steel foil coated in double PE), corresponding to the period of cold weather (winter minimum temperature for calculating glass house = +12 °C, night mode without solar heat inputs) were determined heat loss. The calculations took into account the general orientation of the glass house (NS) and its location in the wind IV. They had the structure provided by architectural designers and resistance and sealing elements of the greenhouse. For the volume of the glass house of 22.000 m^3 during the night resulted in one winter season heat demand of 520 kW. During the same period during the day resulted in an average of 280 kW required.

The choice and design of heating were analyzed following:

Variant I. Heating system with static objects placed around the perimeter and powered by a network of transmission and distribution pipes connected to a boiler made outside the glass house. disadvantage of this solution is given by the absence of any supporting perimeter heating system.

Variant II. Heating with heaters placed around the perimeter and powered by a network of transmission and distribution pipes connected to a boiler made outside the glass house. Heaters are located on the ground on a concrete pedestal, given the absence of any viable support the backbone of the greenhouse.

Variant III. Heating system with ductwork and air distribution grid at a certain temperature. The installation consists of a number of air heaters located in central positions and perimeter inside the glass house.

The techno-economic analysis of the three alternatives proposed to achieve heating in conjunction with the site conditions and methods of purchase fuel for boilers require a second variant as the most economical and appropriate to the project. At the request of the beneficiary was designed variant III reasons to purchase and fuel cost. Beneficiary has high calorific solid fuel at low cost.

Thermal parameters were calculated according to C107/1-97 design of glass house structure, namely double glazing made of PE foil:

- The structure of roof: double PE foil parcel with an air gap inside of about 10-15 cm, where $R_{0, min}$ = 1.63 m^2 K/W, according to norm C107/1-97.
- Exterior wall glazing, structured as double PE foil with a layer of air inside of about 10-15 cm, where $R_{0, min}$ = 1.63 m^2 K/W.

Structure constructive contact with the foundation soil: natural ground thermal resistance $R_{0, min}$ = 4.5 m^2 K/W.

Resulting from the calculation made for exterior wall-roof made of PVC thermal resistance with value of 0.367 m^2 K/W. The minimum value allowed for the location and construction parameters analyzed is 1.629 m^2 K/W.

Calculations for the structural and functional parameters of glass house structure presented above indicate wholly inadequate in terms of thermal envelope.

Parameters heating - Air Conditioning: In accordance with the requirements of the beneficiary and covered by normativule I.5-98 and I.13-02, flows were sized for heating the interior temperature necessary to ensure plant development during winter.

Air heating during the cold season resulted in a minimum of 516.5 kW heat load to ensure a minimum temperature of + 12 °C in the glass house. During the day, in the winter, due to external heat input, heat load is reduced to about 260 kW, and the interior temperature in the greenhouse can grow to + 20 ... 22 °C.

Fresh air flow is the value of 45.000 m^3/h and will be circulated through six fans, each with a flow of 7.500 m^3/h and 245 Pa pressure. Discharge temperature of hot air in the room will be 28°C. Computation of air channels to limit speeds achieved provided unsurpassed air out of the grid in order to protect plants from drafts. Speed limit air transport tubing was 5.0 to 7.0 m/s. Diameter ducts resulted in values of 400 ... 630 mm. The heating system consists of the following structural elements:

1. Hot air generators on solid fuel. Glass house heating is done with a number of hot air generators. They have in their structure a system of production and a hot air fan discharge. Generators hot air escapes from its upper part, where it is assumed the role of network distribution channels. Is the type of fuel used, sawdust, wood waste, but the calorific value boiler efficiency imposed.

For maximum heat output of 520 kW total glass house warming should have selected six hot air generators, each an installed capacity of 80.000 Kcal/h (93 kW). The emissions resulting a total installed capacity was 558 kW. Hours is achieved over a two-shift warm air inside the glass house (total volume of air circulated is about 44.000 m^3).

Hot air generators are located along the central alley of the glass house, so a volume approximately equal to heat air. Generator location near driveway allows easy transport and supply solid fuel, disposal of ashes, its control interventions exploitation situations. The position and mode of operation, hot air generator does not affect plant development.

Stack of hot air generator is made of stainless steel pipe Dn 200 mm. Cart is anchored to the metal structure of the glass house (pole + bays) by steel elements at distances of 0.50 to 1.0 m transition basket with double PE film is made with a special shift kit D = 200 mm.

Hot air generator is connected to the electrical system of the glass house.

2. Distribution of hot air. To achieve a uniform distribution of warm air along the walls, roof and inside the greenhouse was designed a network of transportation and distribution channels. Hot exhaust air is taken from a generator through a plenum and tube axial fan is discharged into a tubing fitted with exhaust grid in the space glass house.

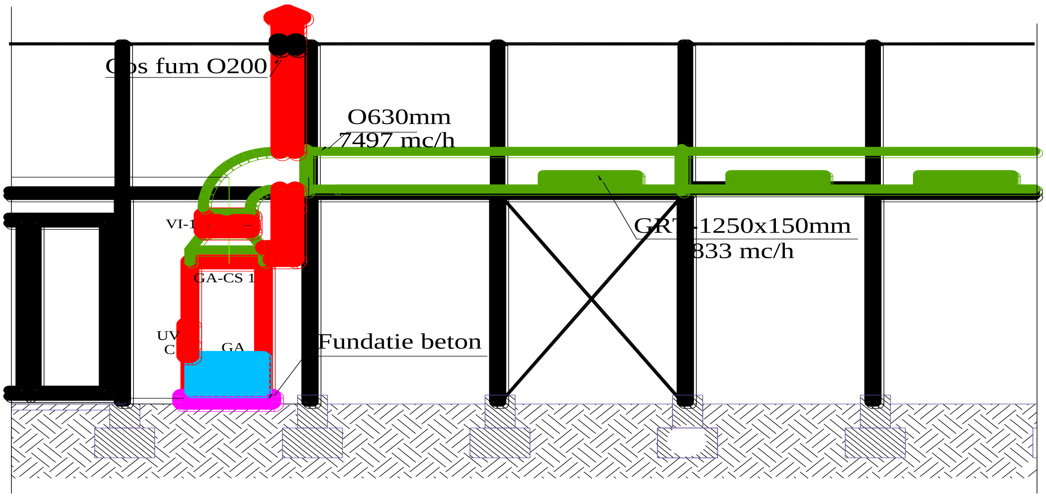

Figure 1 **Transverse section layout hot air generators distribution channels and metal structure of the greenhouse**

Coverage pressure air transport tubing is achieved by using additional axial fan mounted tube (air flow 7500 m³/h, pressure 220 Pa). The fan is mounted and anchored on the generator. Through an elbow and flexible connector, fan hot air escapes Spiro duct type.

Distribution tubing hot air type Zn Spiro OL and has a variable diameter in length (630 mm ... 400 mm) depending on the flow rate. Air emission rate was limited to no influence plant development (v = 2-4 m / s).

Hot air outlet grilles are kind GRT mounted on tubing and the dimensions 1250 x 150 mm, discharged air flow of 833 m³/h. In each air channel powered by a generators mounted exhaust grilles 9 and the heating of the glass house are mounted 56 grid. Hot air outlet grilles are mounted on the side of the pipe at an angle of 450, so that the air discharged to warm layer of air near the wall and roof made of PE foil. The air flow is directed to soil and plants with decreasing temperature and speed.

CONCLSIONS

- Installation of modern heating glass houses should be optimally integrated into the architectural design of the standardized modules and correlates operation of ventilation.
- The heating and air conditioning for glass houses modern type must be designed according to the manner of the glass surfaces (material, thickness, number of rooms and so on) and meet functional and operational requirements of the spaces served by finding the optimal position location horizontally and vertically.
- Design channel transmission and distribution grids will be made at speeds that do not influence the development of the plants growing seasons.
- Ensure the heat requirement can be achieved by using the optimal types of fuels available in the geographical and economic location of the glass house.
- Heating system designed to integrate into the overall glass house plants serving and can be controlled by the automation system.

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