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СЕЗОННАЯ ПЛЁНОЧНАЯ ТЕПЛИЦА ДЛЯ МАЛЫХ ФОРМ ХОЗЯЙСТВОВАНИЯ

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В сезонных теплицах в летнее время года температура внутреннего воздуха может значительно превышать её технологически требуемые для сельскохозяйственных культур параметры. В связи с этим возникает необходимость естественной вентиляции культивационных сооружений. По нормам технологического проектирования теплиц площадь вентиляционных проёмов должна составлять не менее двадцати процентов от площади кровли. Вентилирование небольших теплиц предусматривается через дверные проёмы и форточки, что кардинально не решает проблемы снятия перегрева. В плёночных теплицах промышленного типа предусматривается механизированная система вентиляции с элементами автоматики через создаваемые в коньке или скатах кровли сооружения вентиляционные проёмы. При этом общая площадь вентиляционных проёмов может достигать сорока процентов от площади кровельного покрытия. Применяемое в таких системах вентиляции оборудование (валы сворачивания плёнки, мотор – редукторы, карданные валы, зубчатые редукторы и другие устройства) сложно и обусловливает необходимость значительных финансовых затрат. Цель исследования предусматривала разработку конструкции сезонной плёночной теплицы для малых форм хозяйствования с технически несложной системой вентиляции, позволяющей обеспечивать требуемые параметры воздушной среды в сооружении. По результатам работы получен патент на конструкцию теплицы, естественное вентилирование которой

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A SEASONAL FILM GREENHOUSE FOR SMALL FORMS OF FARMING

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In seasonal greenhouses in the summer, the temperature of the internal air can significantly exceed its technologically required parameters for crops. In this regard, there is a need for natural ventilation of cultivation facilities. According to the norms of technological design of greenhouses, the area of ventilation openings should be at least twenty percent of the roof area. Ventilation of small greenhouses is provided through doorways and vents, which does not fundamentally solve the problem of removing overheating. In film greenhouses of an industrial type, a mechanized ventilation system is provided with automation elements through ventilation openings created in the ridge or roof slopes of the structure. At the same time, the total area of ventilation openings can reach forty percent of the roofing area. The equipment used in such ventilation systems (film rolling shafts, motor-reducers, cardan shafts, gear reducers and other devices) is complex and necessitates significant financial costs. The purpose of the study was to develop the design of a seasonal plastic film greenhouse for small businesses with a technically simple ventilation system that allows to provide the required parameters of the air environment in the building. Based on the results of the work, we obtained a patent for the design of the greenhouse, the natural ventilation of which is carried out through openings in the roof formed by movable film inserts. Recommendations are also given on the choice of rational planning parameters of the structure and graphs are given showing the consumption of steel for the frame of an arched greenhouse, depending on the span of the structure and the step of the arches of the frame

осуществляется через проёмы в кровле, образуемые подвижными плёночными вставками. Также приведены рекомендации по выбору рациональных планировочных параметров сооружения и приведены графики, показывающие расход стали на каркас арочной теплицы в зависимости от пролёта сооружения и шага арок каркаса

КЛЮЧЕВЫЕ СЛОВА: ФЕРМЕРСКАЯ ТЕПЛИЦА, КОНСТРУКТИВНАЯ СХЕМА, ВЕНТИЛЯЦИЯ ТЕПЛИЦЫ, РАСХОД СТАЛИ

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Seasonal film greenhouses are operated during the period of the year with positive outside temperatures. The peculiarities of their operation include overheating of the internal air in sunny weather, which reduces the output, and the need to dismantle the film roof for the winter to prevent its destruction by snow load.

To reduce overheating of film greenhouses through ventilation, various engineering solutions are provided and several inventions are proposed for the design of greenhouses. Thus, film greenhouses with a mechanized ventilation system through ridge or side transoms with a total opening area of up to 40% of the roof area are known [1]. The equipment used in ventilation systems (cardan shafts, gear reducers, geared motors, film rolls, etc.) is complex and requires significant costs. The invention [2] proposes a film greenhouse with flat slopes, containing a frame made of pipes, to which a film is attached with clamps, to stabilize which from wind influences, rows of wire stretched from above the film are provided. The disadvantages of the greenhouse design include: flat slopes (not an arched form of the coating), which increase the wind load (suction) on the film roof; the need to use many elements for attaching the film to the frame of the greenhouse: point clamps, stretched wires, wire tension clamps; point fastening of the film fence to the frame of the greenhouse, which contributes to the destruction of the film near the clamps under dynamic wind influences; the provided ventilation through the transoms at the ends of the

structure will not ensure the reduction of overheating of the internal air during the warm period of the year in large-area greenhouses, since according to the design standards for cultivation facilities [3, clause 7.18], the area of ventilation openings should be determined by calculation and be at least 20% of the roofs.

In the invention [4], a film greenhouse is proposed, containing a frame with a translucent coating placed on it, supports and a ventilation device made in the form of a hydraulic cylinder having a piston with a rod and a hydraulic cylinder filled with a working medium, made of a pipe plugged at one end, while the frame of the greenhouse is made in the form of arcuate placed in the supports trusses, the arcs of which are made sectional with the same radii of curvature, are interconnected by upper, lateral and lower longitudinal elements, the arcs being made of corners facing outward with a gutter, and wind cords are placed in the latter, while at the ends there are installed placed in supports and connected between themselves by the upper and lower elements of the rack, on one of which a door with a cross member is fixed, and the upper,the lateral and longitudinal elements of the arcs and the upper transverse elements of the racks are made in the form of narrow straight strips with longitudinal grooves, and the lower longitudinal elements of the arcs and the lower transverse elements of the racks are in the form of an arcuate wide strip, with a bulge facing outward, while to the lower edge of the wide strip along its entire screens are attached to the uprights and along the perimeter of the door frame, an elastic wire is fixed in the form of an arc, one end of which is bent perpendicular to the plane of the door frame, inserted into the holes made in the uprights and the door frame, and fixed by means of a nut and a stud in which a hole is made , and the other end is attached to the racks and doors by means of a stud with a hole and a nut, and the hydraulic actuator is equipped with a branch pipe, at one end of which a flange is fixed and a membrane is placed between the flanges, and a spring is placed on the rod.with a convexity facing outward, while screens are attached to the lower edge of the wide strip along its entire length, and an elastic wire is fixed in the

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the spatial immutability of the frame is not ensured, since there are no connections;

the greenhouse contains about 60 elements, which makes it laborious to manufacture and assemble;

the proposed fixing of the film coating by means of wind cords pulled in the gutters of the trusses is unreliable and will be destroyed by a strong wind due to the following. The film covering is assembled from separate sheets overlapping each other in the trusses, in the overlapping area of which wind cords are pulled along the troughs to secure them. In case of strong wind, a wind suction will appear in the upper part of the roof of the structure, which will tend to bulge the film fence upwards (for example, the tear load in the middle lane can reach 50 kgf/m2). A tensile force will appear in the wind rope, which, in accordance with Hooke's law, will increase the length of the rope and weaken the pressure of the film panels, which will lead to the destruction of the roof;

the intended ventilation of the greenhouse through the doors at the ends of the structure will not ensure a decrease in the internal temperature in the summer, which can exceed 45 ° C, due to the small area of the doors in relation to the area of the enclosing structures.

Taking into account the above disadvantages of film greenhouses, a constructive solution for the greenhouse has been developed that provides the necessary air exchange in the cultivation facility and reliable fastening of the film roof to the frame arches [5]. A greenhouse with a film roof and a steel arched frame consists of sections connected by movable film inserts, while the belts of the arches of the frame are provided from profiles of a trough-shaped section to accommodate wind ropes pressing the film roof, and the movable film inserts are made of a film sleeve with sleeves located inside along the longitudinal sides and fastened with rope cables, placed inside the guide elements and connected to winding drums located on opposite sides of the film insert, while the guide elements repeat the outlines of the arches,

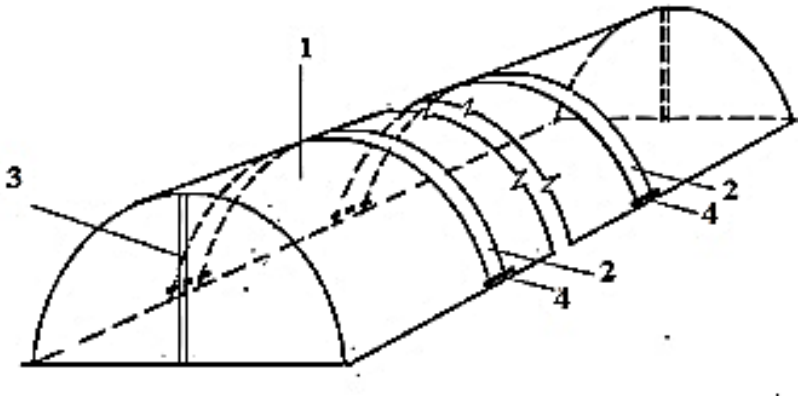


Figure 1 - General view of the developed film seasonal greenhouse: 1 - roof; 2 - film transformable insert; 3- swing gates; 4 - winding drum

The greenhouse can consist of two or more sections connected by film inserts 2, which can be wound on drums 4 made of pipes for ventilation of the greenhouse in the warm season. At the ends of the greenhouse, swing gates 3 are provided, consisting of two wooden planks with a roofing film attached to each plank. The slats are attached to one axis in the ridge of the end arch of the frame and can be moved apart to form an opening [6,7].

The length of the greenhouse section is taken from the condition of its ventilation with open ends of the section approximately equal to two spans of the greenhouse. The frame of each section of the greenhouse is steel, consisting of arches with increased tightening, ties and girders. The connections of the frame elements are welded. Corners and pipes can be used for connections and runs. The arch belts are provided with a trough-shaped section for placing wind ropes pressing the film roof against the frame. As wind ropes, for example, steel cables in a plastic sheath can be used. To fasten the stretched wind ropes in the foundation concrete columns, metal anchors (pieces of reinforcement) are embedded [8, 9].

Film insert 2 consists of a film sleeve of a standard width of 1.5 m, along the longitudinal sides of which there are rope cables, pointwise fastened with a firmware to the film sleeve. The length of the film sleeve is equal to the length of the arch belt, the diameter of the rope cables must exceed the width of the slot

in the guide element made of a bent profile, spot-welded along the contour to the arch belt.

For an arched greenhouse with the required area F, its rational span (width of the greenhouse) L, corresponding to the minimum consumption of material for a translucent roof made of film or polycarbonate sheets, can be determined through the fencing coefficient Kogr (the ratio of the roof area to the area of the greenhouse). With a decrease in the fencing coefficient, the consumption of materials for the roof will decrease.

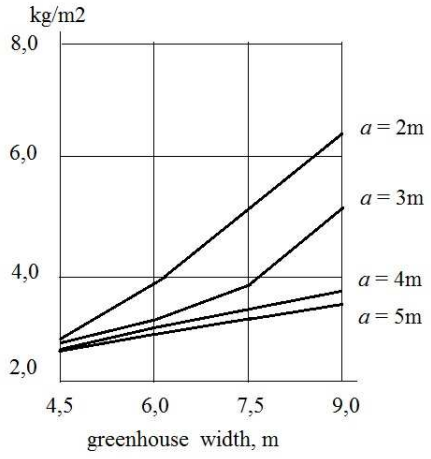
$$К_{огр} = \frac{\pi}{2}\left(\frac{L^2}{2F} + 1\right)\Big) \quad (1)$$

The first derivative of expression (1) does not have a minimum

$$\frac{d\ К_{огр}}{dL} = \frac{\pi L}{2F}$$

Consequently, the lowest consumption of materials for the roof of the structure will correspond to the minimum span of the structure required by the technological requirements.

Figure 2 shows graphs of the established change in steel consumption for the greenhouse frame with circular arches.



Picture 2 - Change in steel consumption for the arched frame of the greenhouse, depending on its width and the distance between the arches of the frame (a)

Conclusions.1. For small forms of management, a constructive solution has been developed for a seasonal film greenhouse, which provides reliable fastening of the film roof to the steel arches of the greenhouse frame, simple dismantling of the film and the possibility of lowering the internal temperature in the structure on hot days.

2. To determine the rational distance between the film inserts and their width, it is advisable to conduct an experiment, the purpose of which should include the establishment of a functional dependence

$$l = f\ (b, L\ ),$$

where l is the distance between the axes of the inserts; b is the width of the insert; L is the span of the greenhouse.

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