размерами и ухудшение условий теплоотдачи по сравнению со вторым типом оребрения для поверхностей большой протяженности.

Ключевые слова: вертикальная поверхность с оребрением, свободная конвекция, теплообмен, тепловой поток, эффективность ребра

COMPARATIVE ANALYSIS OF VERTICAL SURFACES WITH VARIOUS TYPES OF WATER IN CONDITIONS OF NATURAL CONVECTION

V. Gorobets

Abstract. *A comparative analysis of the heat transfer of continuous vertical, discrete vertical and sloping fins under free convection conditions is carried out. It is shown that the use of discrete sharpening significantly intensifies the processes of heat transfer on vertical surfaces. The comparison of discrete vertical and sloping fins indicates the advantage of the first type of sharpening for surfaces with small vertical dimensions and deterioration of heat transfer conditions compared to the second type of sharpening for surfaces of a large length.*

Keywords: ***vertical finned surface, free convection, heat transfer, heat flux, efficiency of fin***

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METHOD OF DESIGNING A RESOURCE-EFFECTIVE CONTROL SYSTEM FOR VEGETABLE GROWING MODES IN GREENHOUSES

A. DUDNYK, PhD
National university of life and environmental sciences of Ukraine
E-mail: dudnikalla@nubip.edu.ua

Abstract. *Greenhouse complexes are characterized by the presence of significant energy streams used to provide technology for cultivation. High energy prices create conditions for the development of special systems that are able to reduce, but better to minimize energy costs. Worthy of note are resource-efficient algorithms for energy flows control throughout the growing season. The results of previous studies have allowed us to conclude that additional information on the predicted values of ambient temperature, solar radiation, information of biological filling states allows us to create a knowledge base and use it for the formation of control impacts on biotechnical objects in order to minimize energy consumption while ensuring production with the required quality and volumes.*

The solution of these problems is possible through the use of modern intelligent algorithms for processing information coming from the control object, and the use of results for the formation of appropriate control strategies in order to maximize the production profits .

The proposed system with the use of intelligent information technologies and software based on the predicted values of external natural disturbances and the current parameters of the technological process will provide the decision making support, monitoring the biotechnical object parameters.

Therefore, it is important to use resource-efficient algorithms for: forecasting of natural perturbations and formation of high reliability of optimum regimes of growing of vegetable products taking into account the states of the biological component of the control and pricing policy in the market of commodity products.

Keywords: greenhouse complex, resource efficiency, methods of designing systems

Topicality. An analysis of existing developments in the field of energy conservation and the study of control systems in the production of vegetable products [5, 6] showed promising measures to reduce energy consumption. The most expedient and effective scientists consider improvement of thermophysical characteristics of fencing constructions, the use of energy-saving screens and the reorganization of traditional microclimate control systems at the expense of new methods and means of automated control in accordance with technological requirements. However, these paths do not take into account the peculiarities of the biological component, the external natural disturbances, resources price changes, and do not allow finding the best control decisions by developing new resource-efficient methods and algorithms for growing vegetables.

It is also important to record the cost of energy resources using real-time monitoring subsystems and databases to store and further analyze the information provided in the paper [7]. However, such measures require the additional attraction of technical means, the availability of additional computer and network support, which requires additional capital investment. In addition, the information support of such systems is valuable and requires constant availability of a specialist.

Thus, the development of methods and algorithms for determining the optimal resource-efficient modes of vegetable products production in greenhouse complexes, taking into account the predicted characteristics of external natural perturbations, states of biological content, and application of the coordination approach is perspective and relevant.

The purpose of research is to increase the resource efficiency of the process of production of vegetable products in greenhouse complexes by developing the method of designing a resource-effective control system, which minimizes resource and energy costs while complying with the requirements for ensuring high quality of products.

Materials and methods of research. The evolution of control systems of electrotechnical complex for technological objects (Fig. 1) started with systems that form the stabilization algorithms (phase I). But even now, despite

sophisticated technological equipment available both in poultry and for greenhouse continue to use simple control algorithms of electrotechnical complexes - stabilizing algorithms. At the same time international and national experience has shown that their application can be justified only to some extent, under conditions of low energy prices. In this case, by technological standards and controls stabilized without taking into account the character of natural disturbances and states of biological objects, which allows in certain seasons to maximize their productivity. But even in these cases often actuators capacity is not enough for the viability of biological filling in optimal in terms of its performance conditions.

In the 90's of the previous century, when energy costs began to rise, offered as a separate development, the use of algorithms that minimize energy use for individual processes (Stage II) [1]. Later, given the properties of objects change their dynamic parameters were tested adaptive systems (Stage III) capable of in service take into account these circumstances, realizing optimum process control algorithms [4]. But systematically tailored to suit biological content, the analysis of natural disturbances, state of the market value on energy production and quality to ensure maximum profit production can only intelligent control system (Stage IV) [5]. As shown in the figure, their advantage is obvious and provided a significant decrease in the energy component in the production costs structure.

According to preliminary research reducing of energy consumption through the development and implementation of intelligent control systems using the latest methods and means of automation, able to predefine control action based on disturbances forecasting, technological requirements and biological object characteristics.

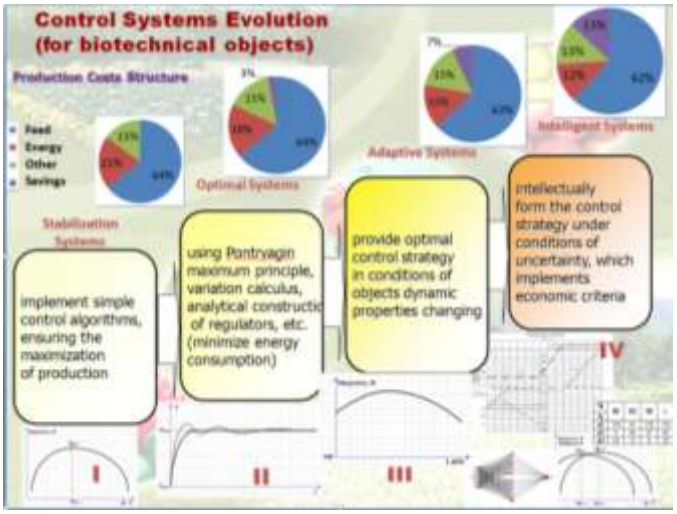

Fig. 1. Control Systems Evolution

Neural network forecasting of external disturbances can increase system performance up to 20 % and can increase technological efficiency up to 13 %. Also, additional energy savings can provide phytomonitoring of

plants. Phytomonitoring can be implemented using modern robotic technical systems to ensure reliability and efficiency of a given measurement.

Review of the functioning of the process facilities along with the peculiarities of the dynamics of natural disturbance sand living organisms states and the rational use of energy resources will increase profits from production. Experimental studies depending on the main quality parameters of biological objects from change of microclimate and establish the most productive growing conditions have provided the mathematical model of states of plants that were later used in the formation of management strategies.

The approach proposed to be used is based on the constructing a conceptual model of the control object with the allocation of technological, material and energy flows, which will allow to describe the process of functioning of the electrotechnical equipment of greenhouse complexes by object-oriented programming methods; construction of an adequate neural network mathematical model of the production process of vegetable products in conditions of uncertainty of the environment factors influence. The development of a model for assessing the resource efficiency of the functioning of greenhouse complexes will be carried out by creating a mathematical apparatus describing the processes taking place during the production of vegetable products, along with the use of a coordinating approach to forecasting external parameters and features of the biological component, taking into account the efficiency of cultivation.

Research results. The most important for the process of growth and development of plants is a temperature-humidity regime, whose maintenance is largely influenced by external natural perturbations. In addition, it is the heating and ventilation process, according to conducted analytical studies, have the largest energy capacity. In order to obtain the operating modes of the equipment, a mathematical model of temperature and humidity variation of the internal air was synthesized in the form of differential equations. It is also known that these technological parameters are interdependent, so we have a system of two differential equations:

$$\frac{dT_{intern}(t)}{dt} = \frac{1}{\rho C_n V_z}\left[Q_n(t) + S_p(t) - \lambda Q_t(t)\right] - -\left(\frac{\nu_v(t)}{V_t} + \frac{k_{t.og.}}{\rho C_p V_t}\right)\left[T_{intern}(t) - T_{extern}(t)\right],$$

$$\frac{d\varphi_{intern}(t)}{dt} = \frac{1}{V_z} Q_t(t) + \frac{1}{V_z}\left[E\left(S_n(t), \varphi_{intern}(t)\right] - \frac{\nu_v(t)}{V_z}\left[\varphi_{intern}(t) - \varphi_{extern}(t)\right],\right.$$

$$E\left[S_n(t), \varphi_{intern}(t)\right] = \alpha\frac{S_n(t)}{\lambda} - \beta\varphi_{intern}(t),$$

where T_{intern}, T_{extern} – air temperature inside and outside greenhouses respectively, (^{o}C); $\varphi_{intern}, \varphi_{extern}$ – relative humidity inside and outside greenhouses respectively, (%); $k_{t.og.}$ – coefficient of heat transfer of the

greenhouse enclosure, (Wt/K); V – geometric volume of greenhouse, (m^3); V_t, V_z – the volume of air heated and humidified accordingly, (m); ρ – air density, (1,2 kg/m^3); C_p – heat capacity of air, (1,005 kJ$\cdot kg^{-1} \cdot K^{-1}$), Q_n – the power of the heating system of the greenhouse, (Wt); Q_t – fogging system performance, (g/sec); S_p – solar radiation absorbed by the greenhouse, (Wt); λ – heat of vapor formation, (2256 kJ/kg); v_v – air exchange provided by the ventilation system, (m^3/sec). $E\left[S_н(t), \varphi_{внутр}(t)\right]$ – eutotransplantation of plants in the function of absorbed solar radiation and humidity in the greenhouse, (g water/sec), α, β – scale factors.

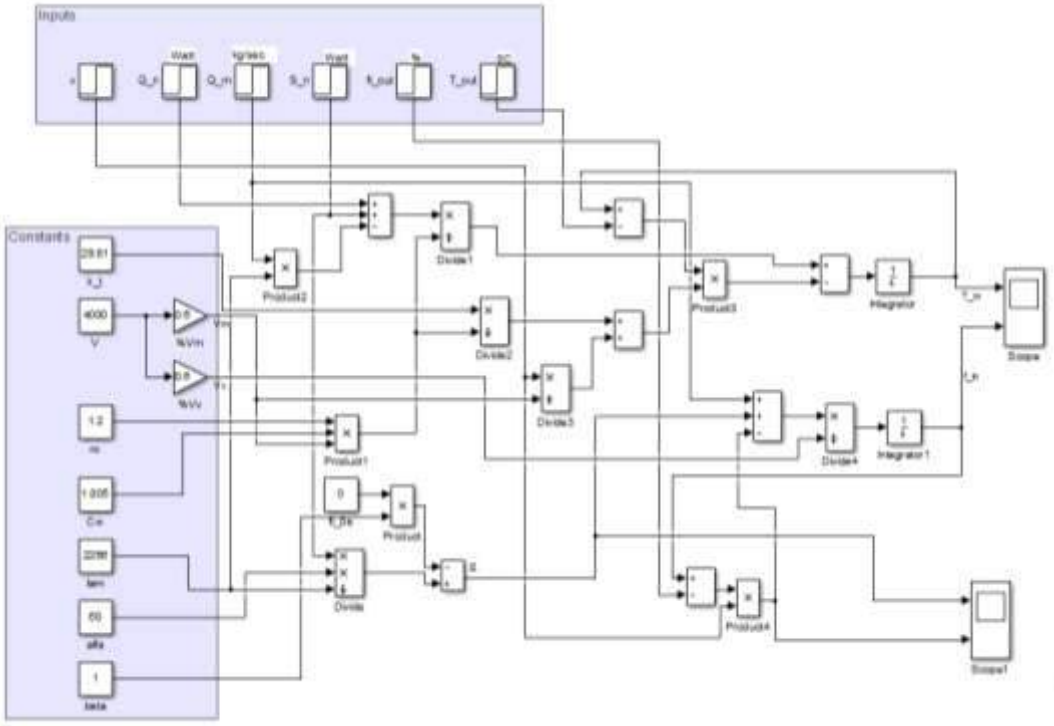

Fig. 2. Structure of the mathematical model

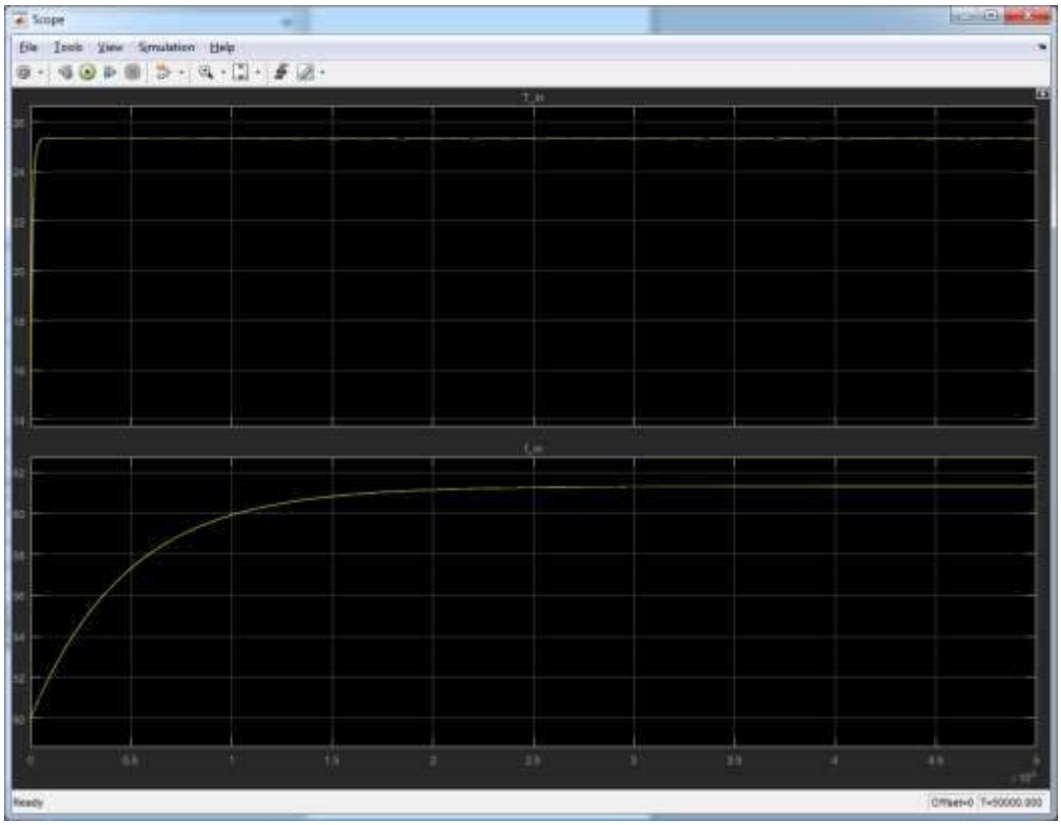

Fig. 3. Air temperature and humidity changes

Conclusions. As a result of the analysis of curves, the following conclusions were drawn:

1. The process of maintaining a given humidity of the air is more inertial, that is, the efficiency of the ventilation system is less, which requires additional research to be taken into account.

2. The process of heating the greenhouse complex largely depends on external natural perturbations, which can be taken into account after application of the method of neural network prediction.

References

1. Lysenko, V., Golovinskiy, B., Reshetiuk, V., Shtepa, V., Rudenskiy, A., Golub, B., Shcherbatiuk, V. (2010). “Technical means of computer-integrated control system of energy resources in poultry farm”. Life and Environmental Sciences, 2, 111–118.

2. Lysenko, V., Dudnyk, A. (2011). “Optimal control: status and prospects in the Greenhouse industry”. Scientific Herald of National University of Life and Environmental Sciences of Ukraine, 166, 104–113.

3. Lysenko, V., Shtepa, V., Zayets, N., Dudnyk, A. (2011). “Neural network forecasting of outside temperature time series”, Biological Resources and Nature Management, 3–4, 102–108.

4. Lysenko, V., Golub, B., Shcherbatiuk, V. (2009). “The total energy saving architecture computer integrated automatic control system living conditions of laying hens” Scientific Herald of National University of Life and Environmental Sciences of Ukraine, 139, 27–31.

5. Chang Yang (2014). Development of an automation system for greenhouse seedling production management using radio-frequency-identification and local remote sensing techniques / Chang Yang, Kuang-Wen Hsieh Chao-Yin Tsai, Yu-I. Huang, Yu-Liang Chen, Suming Chen // Engineering in Agriculture, Environment and Food, 7, 1, 52–58.

6. Uday, A. Greenhouse Automation System / Uday A. Waykole,. Dhiraj G. Agrawal // 1st International Conference on Recent Trends in Engineering & Technology, Mar-2012. – Special Issue of International Journal of electronics, Communication & Soft Computing Science & Engineering, ISSN: 2277–9477.

7. Jenny Aitken-Christi (2013). Automation and environmental control in plant tissue culture / Jenny Aitken-Christie, T. Kozai, M.A.L Smith // Springer Science & Business Media, 574.

МЕТОДИКА ПРОЕКТУВАННЯ РЕСУРСОЕФЕКТИВНОЇ СИСТЕМИ КЕРУВАННЯ РЕЖИМАМИ ВИРОЩУВАННЯ ОВОЧІВ У ТЕПЛИЦЯХ

А. О. Дудник

Анотація. *Тепличні комплекси характеризуються наявністю значних енергетичних потоків, що використовуються для забезпечення відповідної технології. Високі ціни на енергоносії (природній газ, електрична енергія) створюють умови для розроблення спеціальних систем, здатних зменшити, а краще мінімізувати, енергетичні витрати.*

Заслуговують на увагу ресурсоефективні алгоритми керування енергетичними потоками на таких об'єктах. Результати попередніх досліджень дали змогу зробити висновок, що додаткова інформація щодо прогнозних значень температури навколишнього середовища, сонячної радіації, інформація про стани біологічного наповнення дозволяє створити базу знань та використати її для формування керуючих впливів на біотехнічні об'єкти з метою мінімізації енергоспоживання, забезпечуючи при цьому виробництво продукції потрібної якості та обсягів.

Вирішення зазначених проблем можливе за допомогою використання сучасних інтелектуальних алгоритмів опрацювання інформації, що надходить від об'єкта керування, та застосування результатів для формування відповідних стратегій керування з метою максимізації прибутку за результатами виробництва.

Запропонована система із застосуванням інтелектуальних інформаційних технологій та програмного забезпечення на основі прогнозованих значень зовнішніх природних збурень та поточних параметрів технологічного процесу забезпечить підтримку прийняття рішень, контроль та моніторинг параметрів біотехнічного об'єкта.

Тому актуальним є використання ресурсоефективних алгоритмів для: прогнозування природних збурень та формування з високою надійністю оптимальних режимів вирощування овочевої продукції з урахуванням станів біологічної складової об'єкта керування та цінової політики на ринку товарної продукції.

Ключові слова: тепличний комплекс, ресурсоефективність, методи проектування систем.

МЕТОДИКА ПРОЕКТИРОВАНИЯ РЕСУРСОЭФФЕКТИВНОЙ СИСТЕМЫ УПРАВЛЕНИЯ РЕЖИМАМИ ВЫРАЩИВАНИЯ ОВОЩЕЙ В ТЕПЛИЦАХ

А. А. Дудник

Аннотация. *Тепличные комплексы характеризуются наличием значительных энергетических потоков, используемых для обеспечения соответствующей технологии. Высокие цены на энергоносители (природный газ, электрическая энергия) создают условия для разработки специальных систем, способных уменьшить, а лучше минимизировать, энергетические затраты.*

Заслуживают внимания ресурсоэффективные алгоритмы управления энергетическими потоками в таких объектах. Результаты предыдущих исследований позволили сделать вывод, что дополнительная информация о прогнозных значениях температуры окружающей среды, солнечной радиации, информация о состоянии биологического наполнения позволяет создать базу знаний и использовать ее для формирования управляющих воздействий на биотехнические объекты с целью минимизации энергопотребления, обеспечивая при этом производство продукции нужного качества и объемов.

Решение указанных проблем возможно путем использования современных интеллектуальных алгоритмов обработки информации, поступающей от объекта управления, и применение результатов для формирования соответствующих стратегий управления с целью максимизации прибыли по результатам производства.

Предложенная система с применением интеллектуальных информационных технологий и программного обеспечения на основе прогнозируемых значений внешних природных возмущений и текущих параметров технологического процесса обеспечит поддержку принятия решений, контроль и мониторинг параметров биотехнического объекта.

Поэтому актуальным является использование ресурсоэффективних алгоритмов для: прогнозирования природных возмущений и формирования с высокой надежностью оптимальных режимов выращивания овощной продукции с учетом состояний биологической составляющей объекта управления и ценовой политики на рынке товарной продукции.

Ключевые слова: тепличный комплекс, ресурсо-эффективность, методы проектирования систем