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РОЗРОБЛЕННЯ ПРОГРАМНОГО ЗАБЕЗПЕЧЕННЯ ДЛЯ АВТОМАТИЗОВАНОГО ПРОЄКТУВАННЯ ТРИВИМІРНИХ МОДЕЛЕЙ КОНВЕКТИВНИХ СУШИЛЬНИХ КАМЕР

Анотація. У роботі представлено розробку програмного забезпечення для автоматизації процесу проєктування тривимірних моделей штабелів деревини, призначених для сушіння в конвективних сушильних камерах. Створена програма на C# дозволяє користувачеві задавати параметри штабелю, зокрема кількість та розміри дерев'яних дошок, що піддаються сушінню. На основі введених даних, програма генерує 3D моделі штабелів за допомогою макросів у SolidWorks, що забезпечує швидке та точне розміщення цих моделей у тривимірному просторі сушильної камери. Автоматизація цього процесу значно спрощує підготовчі етапи проєктування та дозволяє зменшити кількість ручних операцій. В подальших дослідженнях передбачається використання розроблених 3D моделей для аналізу теплових і гідродинамічних процесів сушіння в середовищі SolidWorks Flow Simulation.

Ключові слова: Windows Form; C#; макроси SolidWorks; деревина; процес сушіння.

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DEVELOPMENT OF SOFTWARE FOR AUTOMATED DESIGN OF THREE-DIMENSIONAL MODELS OF CONVECTIVE DRYING CHAMBERS

Abstract. The paper presents the development of software for automating the design process of three-dimensional models of wood stacks intended for drying in convective drying chambers. The created C# program allows the user to set the parameters of the stack, including the number and size of wooden boards to be dried. Based on the entered data, the program generates 3D models of the stacks using macros in SolidWorks, which ensures fast and accurate placement of these models in the three-dimensional space of the drying chamber. Automating this process greatly simplifies the preparatory stages of design and reduces the number of manual operations. Further research involves the use of the developed 3D models to analyze the thermal and hydrodynamic drying processes in the SolidWorks Flow Simulation environment.

Keywords: Windows Form; C#; SolidWorks macros; wood; drying process.

Introduction. Automation of 3D model design is an important area of development for modern engineering solutions, especially in industries such as wood drying [1], where the accuracy of material placement and the efficiency of thermal processes play a key role. Convective drying chambers are complex engineering systems where heat and mass transfer processes take place, requiring careful modeling to achieve optimal drying conditions. Traditional methods of manual modeling of such systems are time-consuming, have a high risk of errors, and limit the speed of developing new solutions.

In response to these challenges, software has been developed that automates the process of designing three-dimensional models of wood stacks for drying chambers. Using macros in SolidWorks allows you to automatically generate 3D models based on the entered parameters, which greatly simplifies the design process and minimizes manual work. This solution opens up opportunities for further analysis of wood drying processes using SolidWorks Flow Simulation, which allows for accurate prediction of heat and mass transfer processes and optimization of drying chamber operation.

The **aim of the study** is to develop an effective software tool for automating the design of wood stacks in convective drying chambers, which will provide a high

level of modeling accuracy and allow further research on drying processes using computer modeling methods.

Overview of existing solutions. In modern wood drying chamber design practice, various software tools are widely used to model and optimize heat and mass transfer processes. In particular, CAD systems such as AutoCAD, SolidWorks, and their analogues are popular, allowing for the creation of three-dimensional chamber models and preliminary analysis of material placement. However, most of these solutions involve a significant amount of manual intervention when building and customizing models, which increases the likelihood of human error and time consumption [2].

One of the most urgent tasks in the industry is to automate these processes. Among the well-known solutions are software products that integrate with CAD systems to simplify certain design steps, such as geometry optimization or drying process analysis. However, many of these solutions focus on individual aspects of the process, without providing a comprehensive approach to automating the design of 3D models of wood stacks in the context of a drying chamber.

There are also specialized software tools for modeling drying processes, such as CFD (computational fluid dynamics) programs that allow you to investigate the effect of various parameters on the drying process [3]. However, these programs are mostly focused on analyzing off-the-shelf models and do not include functions to automate the process of creating them. This creates the need for a more integrated approach that would cover both the design phase and further research of drying processes.

Thus, existing solutions demonstrate significant progress in the field of engineering modeling, but there is still a need to develop more flexible and integrated tools that would automate the entire process - from entering material parameters to creating a ready-made 3D model for further CFD studies.

Software development. In the process of developing software for the automated design of three-dimensional models of wood stacks, we used a desktop application created in the C# programming language using Windows Forms. This approach allows for the implementation of a graphical user interface (GUI), which provides ease of interaction with the program and flexibility in setting the parameters of wood stacks for further modeling.

The program consists of a form (see Fig. 1), where the user can enter the basic parameters of wood stacks, including the number of boards, their dimensions (length, width, thickness), and wood species.

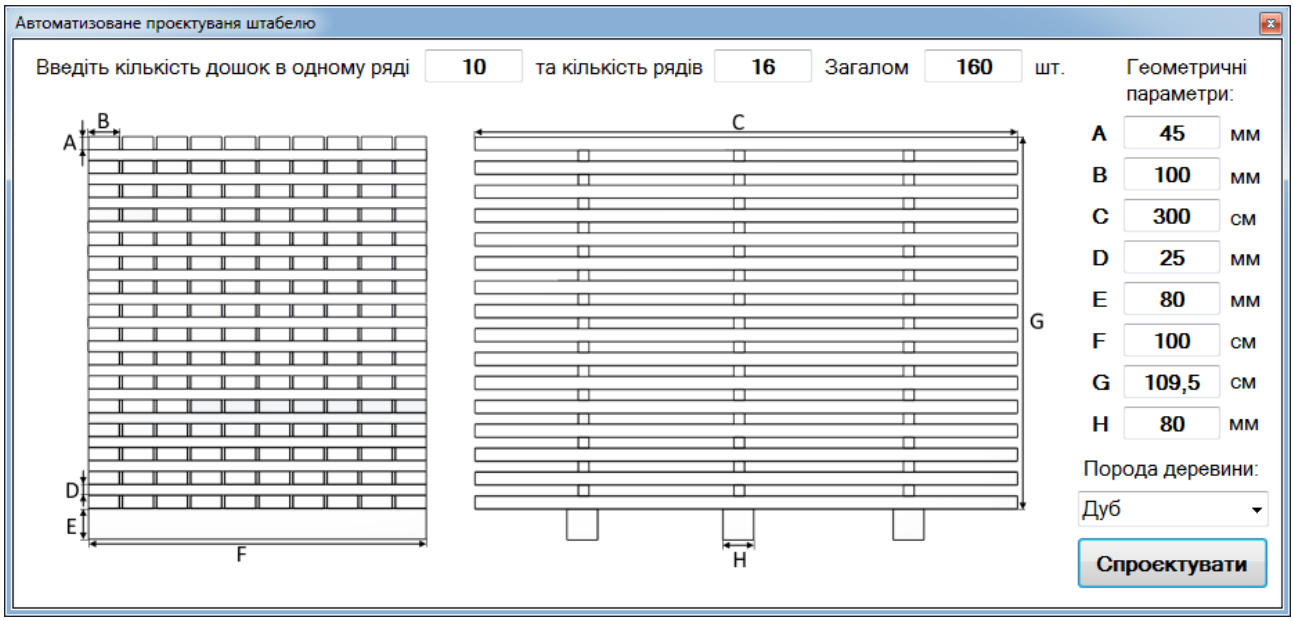

Fig. 1. Form of automated stack design

After entering the data, the program automatically transfers these parameters to SolidWorks through macros, which allows generating 3D models of the stacks and placing them in a pre-prepared 3D model of the convective drying chamber (see Fig. 2).

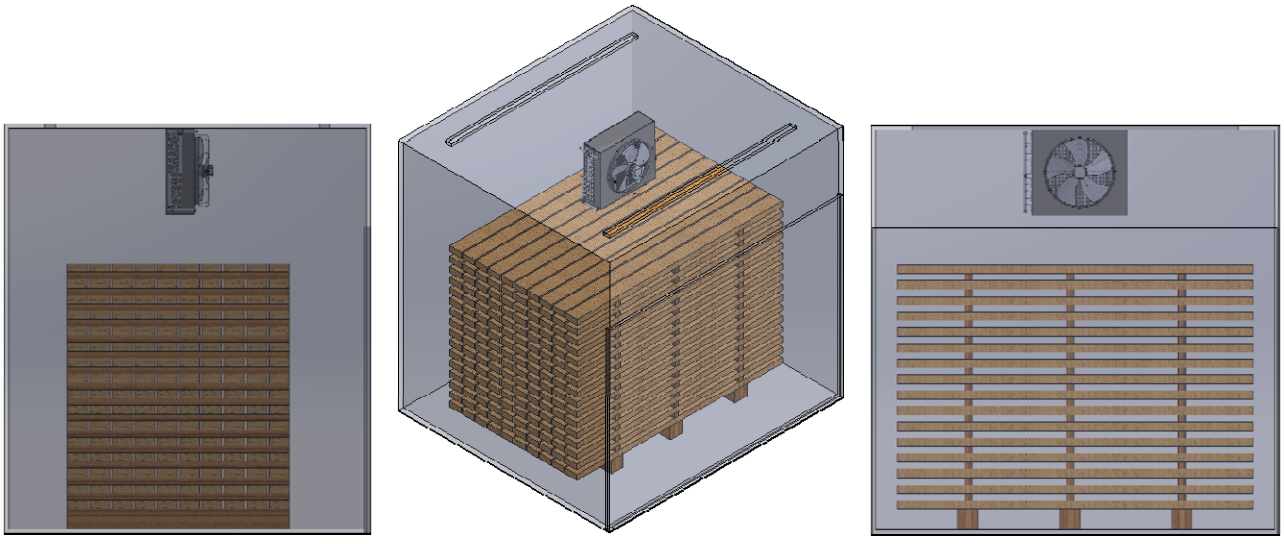

Fig. 2. View of 3D model of the convective drying chamber

In the 3D model of the drying chamber created, was used an axial water-heated fan. It ensures efficient air distribution throughout the chamber, which contributes to a uniform wood drying process. The use of water heating allows for more precise

control of the temperature in the chamber, which is important for ensuring optimal drying conditions. In addition, this system is energy efficient and reduces operating costs by using less energy-intensive heat sources. The used axial fan (see Fig.3) is reliable and durable, making it easy to operate and minimizing maintenance costs.

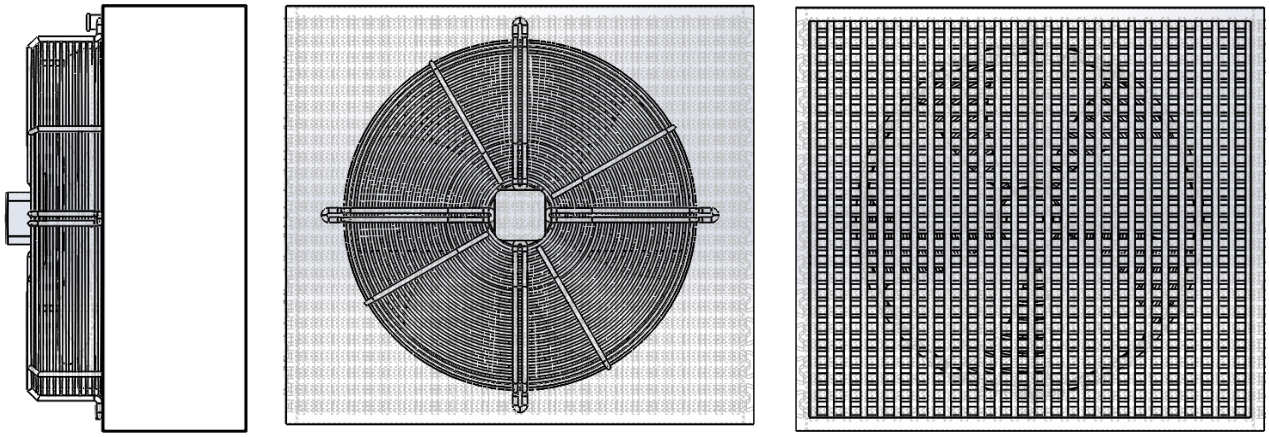

Fig. 3. View of 3D model of axial water-heated fan

The development uses a classical approach to creating Windows applications, which ensures a high level of performance and integration with other software products, including SolidWorks. The choice of Windows Forms made it possible to simplify the development of the interface as much as possible and ensure intuitive user interaction with the program. Thanks to the automation of the process through macros, the program significantly reduces the number of manual operations, which allows you to quickly get ready-made 3D models for further use in engineering research.

The application is built in such a way that it can be easily scaled to add new features, such as support for other types of materials or the ability to configure additional drying parameters. In the next stages, it is planned to add support for exporting the results for further analysis in SolidWorks Flow Simulation, which will allow to study heat and mass transfer processes within the drying chamber model.

Automation and efficiency of design. Automating the design of 3D models of wood stacks in convection dryers significantly increases the efficiency of the process and reduces the time required to create accurate engineering models. The traditional design method involves many manual operations, including building each board in the stack and placing it accurately in the drying chamber model, which is time-consuming

and increases the risk of errors [4]. Using the developed software to automate this process allows you to eliminate most of the routine work and focus on analyzing the results.

The program provides fast generation of 3D models based on user-entered parameters, such as the number of boards, their dimensions, and location in the drying chamber. With the help of macros, SolidWorks automatically creates and places stacks in the prepared 3D model of the chamber. This reduces the risk of human error and significantly reduces the time required to obtain a finished model.

The effectiveness of the automated approach compared to traditional methods is confirmed by a significant reduction in time spent on each stage of the design process. The created system reduces the number of repetitive operations and automates the model generation process, which not only improves accuracy but also facilitates faster implementation of changes and adaptations in the models, if necessary.

The use of automation also helps to increase the productivity of engineering teams, as it allows them to quickly test different drying scenarios by changing model parameters and adapt designs to specific conditions without significant time investment. This opens up new opportunities for operational analysis and optimization of wood drying processes based on three-dimensional models, as well as for the further use of these models in CFD simulations to study heat and mass transfer in drying chambers.

Opportunities for further research. The developed software for automating the design of three-dimensional models of wood stacks opens up significant opportunities for further research in the field of heat and mass transfer processes in drying chambers. One of the areas of future work is the integration of the created 3D models with CFD (Computational Fluid Dynamics) analysis, which will allow for a detailed study of air movement and heat distribution in the drying chamber. Thanks to SolidWorks Flow Simulation, accurate simulations can be performed that take into account the aerodynamic features of the chamber and the structure of the stacks.

Another promising area of research is to adapt the software to work with other materials that are subjected to drying, such as agricultural products or food. This will expand the application of the developed program in various industries and allow it to be used to design drying chambers with different characteristics.

It is also possible to implement algorithms for optimizing drying parameters based on the analysis of the simulation results. This will allow not only to model the process but also to automatically find the most efficient drying parameters, which can significantly increase the productivity of production processes.

Conclusions. The development of software for the computer-aided design of three-dimensional models of wood stacks can significantly improve the efficiency and accuracy of designing convective drying chambers. The use of SolidWorks macros to automate model creation eliminates the need for routine manual operations, which reduces design time and reduces the risk of errors.

Design automation facilitates faster adaptation of models to changing parameters and allows for quick results for further research on heat and mass transfer in drying chambers. Prospects for further research include integration with CFD simulations for detailed analysis of drying processes, as well as expanding the software's capabilities for other materials and automatic optimization of drying conditions.

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