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COMPUTER-AIDED DESIGN OF CALENDER ROLL

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Abstract. *The results of automated calender roll design in AutoCAD are presented through the creation, with the help of specialized software, of detailed drawings of the part and its 3D models. The development employs AutoLISP functional language and Dialog Control Language (DCL) window management functions, providing an interactive mode for prompt data input with automatic recording, subsequent compliance analysis, error detection, and recommendation provision. The obtained results can be utilized to optimize design processes, enhance their accuracy and quality, and swiftly implement innovative technical solutions.*

Key words: *calender roll, calender, calendering process, 3D model, AutoCAD, AutoLISP.*

Introduction.

Calendering is a crucial process in materials processing across various industries, including chemical, metallurgical, textile, rubber, and others [1, 2]. This process allows to change the thickness and shape of materials by rolling them through two or more rolls of a calender machine.

In this case, the roll plays a crucial role in ensuring the quality and efficiency of calendering. The design and parameters of the rolls should take into account the force and temperature factors acting directly on the roll, the characteristics of the materials being processed and the technical requirements for the final product. Ensuring optimal characteristics and parameters of the roll allows to increase productivity, reduce costs, improve quality and ensure the safety of the calendering process [3, 4]. In this regard, there is a need to develop methods that allow for the operational execution of drawings of calender rolls in accordance with the specified geometric dimensions and parameters. In addition, there is a need to improve and modernize their design by changing the dimensions to increase the reliability of operation, which significantly affects the service life of the calender.

Therefore, the development of a system for automated roll design plays an important role in the continuous effort to improve the efficiency and quality of the calendering process [5]. This problem is becoming increasingly relevant as the industries in which the calendering process is used are constantly evolving. An automated system will not only allow for increased accuracy and efficiency of work, but will also significantly reduce the time required for project development and implementation into production. As a result, the use of an automated calender roll design system will contribute to a significant improvement in the quality and accuracy of roll design, which meets modern technological standards.

Aim.

The aim of this work is to develop software for automated calender roll design, which will simplify the design process while ensuring high project quality, significantly reducing the time required for development and execution of engineering and technical documentation.

Materials and methods.

In the development of the software was used AutoCAD, which is currently the world's and Ukraine's most widely used engineering system for design automation [6]. AutoCAD is a powerful tool that is both user-friendly and efficient for developing complex projects.

The software for the automated system is based on usage of the AutoLISP functional language and DCL dialog box management functions, which allow users to use an interactive data entry mode and significantly speed up the project execution process, design and development, and improve the accuracy of work. DCL dialog box management functions allow you to create user interfaces, making the data entry process more convenient and intuitive [7, 8]. This ensures the prompt assignment of the necessary information and the receipt of results in real time, contributing to the efficiency and quality of design. It also allows to perform various analyzes and definitions, which contribute to a deeper understanding of the results obtained and help in making informed decisions.

Results and discussion.

The developed software is a complex structure with window designed for quick and easy input or modification of product parameters, which significantly simplifies the design and modification process. It allows to create drawings in 2D and 3D formats. All necessary actions for entering and changing data can be performed in interactive mode using the dialog box shown at Figure. 1.

For ease of interactive use, the dialog box contains a schematic representation of the roll with variable designations. The window is divided into a number of sections, each of which has its own purpose for entering new values and adjusting previously entered values. The following options are also provided when executing the project:

1. "Scale" - to specify the drawing scale;
2. "Test" key - to set all dimensions to typical values;
3. "File Selection" key - to use data from previous projects;
4. "Check" key - to check the entered data;
5. "2D" key - to create a 2D drawing of the calender roll;
6. "3D" key - to create a 3D model of the calender roll;
7. "Cancel" key - to exit the dialog box and cancel the program.

The result of the drawing and 3D construction with entered basic data of the calender roll are shown at Figure. 2.

The software data processing, which is performed in AutoLISP, allows realization of various analyzes and calculations. Therefore, after entering the values, the input data is checked for consistency of dimensions. Afterwards detected errors are indicated and given recommendations on how to correct them.

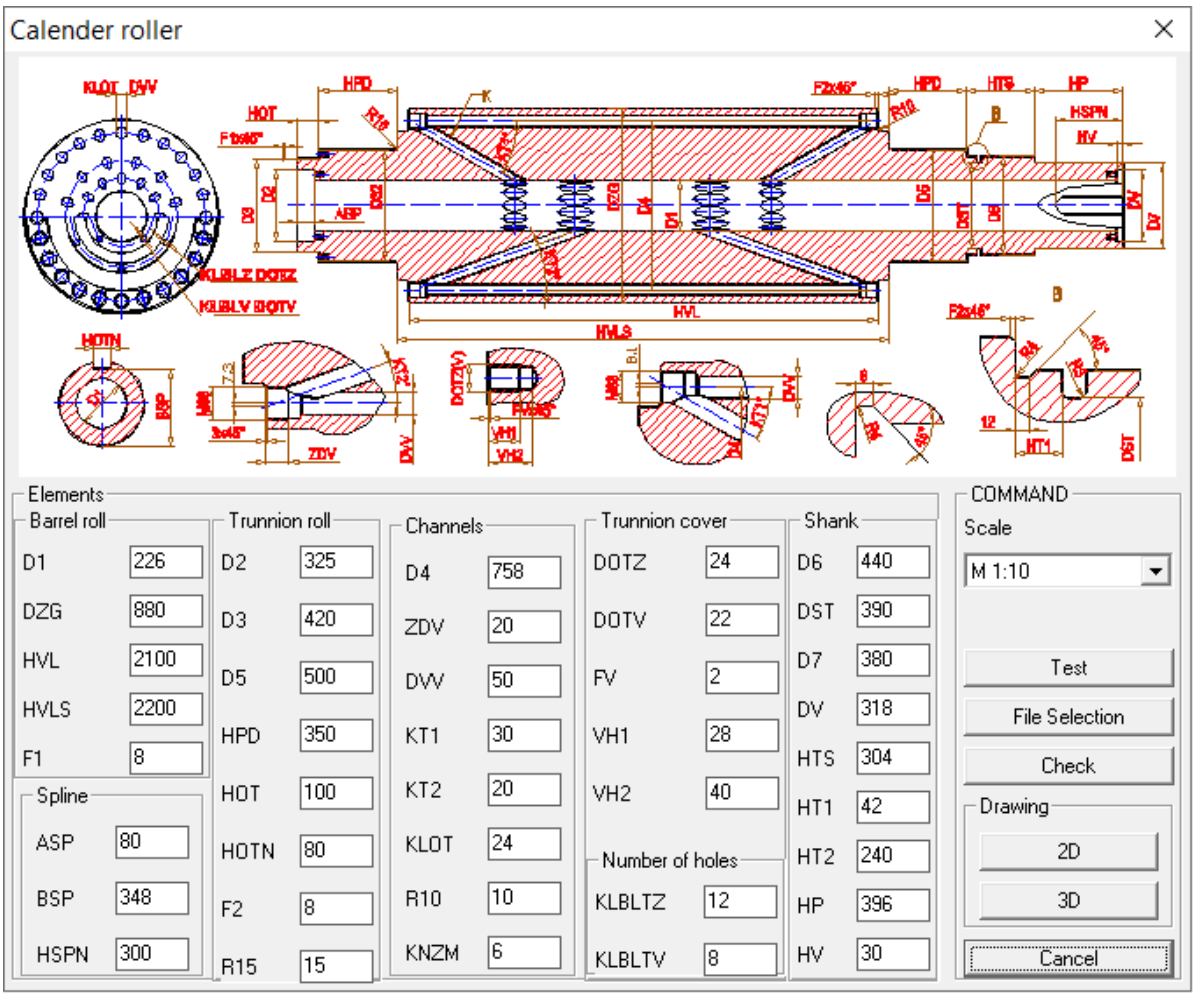
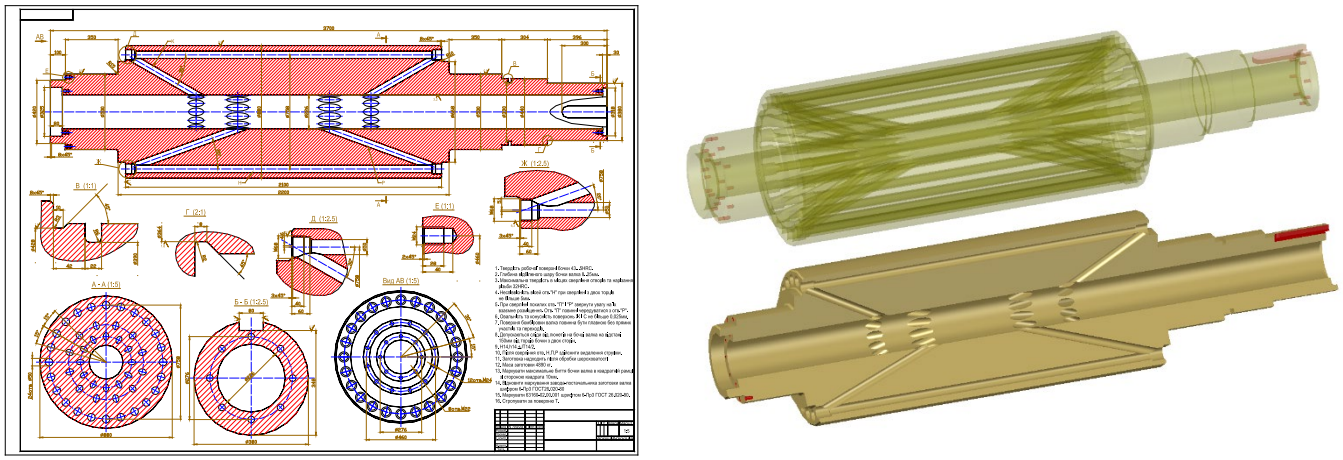


Figure 1 - Dialog box for entering data

Authoring



a) Calander roll drawing *b) 3D model (with sectional view)*

Figure 2 - Drawing and 3D model creation for a typical model of calender roll

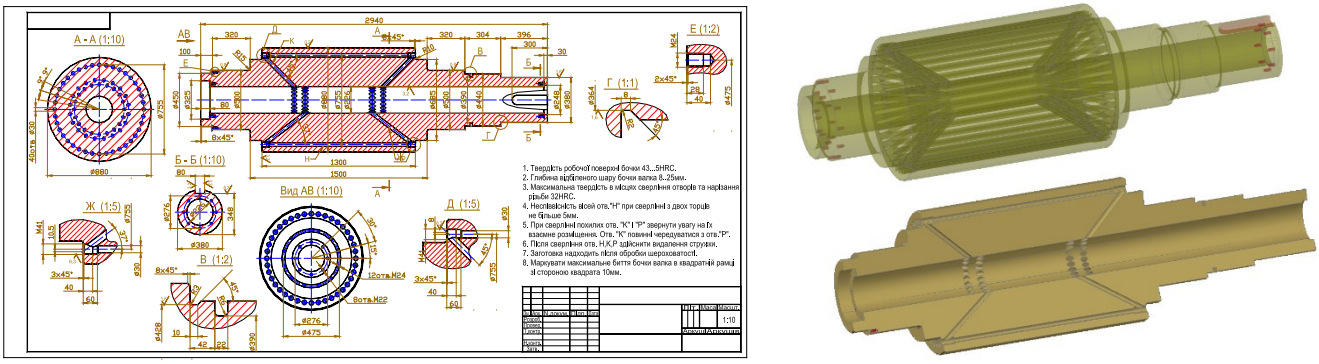
Authoring

After the parameters are entered into the dialog box, the system automatically calculates the required geometric dimensions, creates a drawing of the calender roll with the display of the corresponding sections and callouts (Figure. 2a), or generates a 3D SOLID model. The 3D model of the roll (Figure. 2b) is shown with 50% transparency, which improves the visualization of the internal structure of the coolant

channels. For a detailed view, in the figure is also presented the roll with a section. The design engineer can use visual control to analyze the created 3D model and, if necessary, make changes to the design.

Usage of a graphical database in AutoCAD provides the ability to analyze and process text and numerical data related to the project. This contributes to the effective management and storage of arrays of information. Therefore, after drawing creation, all used variables are automatically saved to the project file with the possibility of further use.

Figure. 3 shows the results of drawing execution with changed basic dimensions of the base part. These include the length of the roll, the angles, the number and diameters of the coolant channels, which are important for the functionality and efficiency of the product.



a) Calander roll drawing *b) 3D model (with sectional view)*

Figure 3 - Drawing and 3D model creation with changed basic dimensions

Authoring

It should be noted that the creation of a 3D model (of the SOLID type according to the AutoCAD classification) provides not only visual control but also makes it possible to use it in strength calculations using such programs as SOLIDWORKS, ANSYS, VESNA [6], and to simulate the movement of the coolant in the channels using such programs as CFX, FLUENT and the like. In this case, the possibility of AutoCAD is used to transform 3D models into the <>.sat format, which is used in the specified programs to specify the shape and derivative data.

Summary and conclusions.

The developed program is aimed at improving the methods of automated design, providing the ability to create 2D drawings and 3D models of SOLID type for calender rolls. The software integrates functions written in AutoLISP for the AutoCAD software environment, which allows to use the interactive mode for data entry and perform checks of the values of the entered variables.

The usage of this program significantly accelerates the process of creating design and engineering documentation, improving its quality during the development of new or modernization of existing rolls. This contributes to increased productivity, accuracy and quality of projects, and also opens up new opportunities for optimizing design processes and the rapid implementation of innovative technical solutions

References:

1. I. O. Mikulionok, Modelyuvannya obladnannya texnologichny`x linij dlya pereroblennya plastmas i gumovy`x sumishej na bazi valkovy`x mashy`n [Elektronny`j resurs]: monografiya. – 2-ge vy`d., vy`pr. Ky`yiv.: NTUU «KPI», 2015. – 244 c.

2. Sivetskii, V. I., Shcherbyna, V. Yu., & Gondliakh, O. V. (2022). Inzhy`niry`ng innovacijny`x texnologij ta obladnannya. Liniyi dlya vy`gotovlennya ly`stovy`x i profil`ny`x polimerny`x vy`robiv [Elektronny`j resurs] – Ky`yiv: KPI im. Igorya Sikors`kogo. Ky`yiv, 2022. – 113 s. URL: https://ela.kpi.ua/handle/123456789/45732

3. Suberlyak O. V. Teorety`chni osnovy` ximiyi ta texnologiyi polimeriv: navch. posib. / O.V. Suberlyak, V.J. Skoroxoda, N.B. Semenyuk. – L`viv: vy`d-vo L`vivs`koyi politexniky`, 2014. 336 s

4. Shcherbyna, V. Yu., Sivetskii, V. I., & Gondliakh, O. V. (2022). Mexanichni procesy` i obladnannya vy`robny`cztva polimerny`x ta budivel`ny`x materialiv i vy`robiv. Pidgotovka sy`rovy`nny`x materialiv i ustatkuvannya dlya zmishuvannya ta formuvannya [Elektronny`j resurs] / KPI im. Igorya Sikors`kogo. Ky`yiv, 2022. 131s. URL: https://ela.kpi.ua/handle/123456789/45734

5. Shcherbyna, V. Yu., Shvachko, D. G., & Hurieva, L. N. (2024). Texnologiya vy`robny`cztva materialiv i vy`robiv budivel`nogo pry`znachennya [Elektronny`j resurs] / KPI im. Igorya Sikors`kogo. Ky`yiv, 2024. – 188s. URL: https://ela.kpi.ua/handle/123456789/66516

6. Shcherbyna, V. Yu., Sakharov, O. S., Gondliakh, O. V., & Sivetskii, V. I. (2014). SAPR. Programuvannya na funkcional`nij movi AutoLISP pry` proektuvanni texnologichnogo obladnannya [Elektronny`j resurs] Ky`yiv: NTUU «KPI», 2014. 156 s. https://cpsm.kpi.ua/publikatsiji/knigi/731

7. Shcherbyna, V. Yu., SAPR. Programuvannya na funkcional`nij movi AutoLISP pry` proektuvanni texnologichnogo obladnannya [Elektronny`j resurs] Ky`yiv: NTUU «KPI», 2014. 156 s. https://cpsm.kpi.ua/publikatsiji/knigi/731

8. Shcherbyna, V. Yu., & Chemerys, A. O. (2018). Konstruktors`ke proektuvannya obladnannya. Kursovy`j proekt [Elektronny`j resurs] KPI im. Igorya Sikors`kogo. Ky`yiv: KPI im. Igorya Sikors`kogo, 2018. 38 s. http://ela.kpi.ua/handle/123456789/25664

Анотація. *Представлено результати автоматизованого проєктування валка каландру в системі AutoCAD, шляхом створення, за допомогою спеціальної програми, креслень деталі ті її 3D-моделі. В розробці застосовано функціональну мову AutoLISP та функції управління діалоговими вікнами DCL, що забезпечують інтерактивний режим оперативного введення даних з їх автоматичним записом, подальшим аналізом відповідності та виявленням помилок з наданням рекомендацій. Отримані результати можуть бути використані для оптимізації проектувальних процесів, підвищення їх точності та якості, і швидкого впровадження інноваційних технічних рішень.*

Ключові слова: *валок каландра, каландр, каландрування, 3D модель, AutoCAD, AutoLISP.*

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