

МАТЕМАТИЧНЕ МОДЕЛЮВАННЯ В ПРИРОДНИЧИХ НАУКАХ ТА ІНФОРМАЦІЙНІ ТЕХНОЛОГІЇ



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ABOUT THE FEATURES OF COMPUTER MODELING FOR PIPE PRODUCTION PROCESSES

Метою даного дослідження є визначення концепцій та методів проведення ефективного комп'ютерного моделювання, розробка гнучких комп'ютерних програм для вирішення проблем виробництва труб.

Розглянуто інформаційно-комп'ютерний аспект системних досліджень при розробці моделей виробництва труб. У той же час, інформаційно-довідкова інформація про предмет моделювання, реалізована у вигляді різних баз даних та знань, експертні системи, що використовують новітні засоби інформатики, надають значну допомогу на початкових етапах побудови моделей. Розглянуто інформаційно-довідковий аспект класифікації технологічних процесів виробництва труб для використання дослідником у пошуку необхідної інформації, корисної у комп'ютерному моделюванні.

Ключові слова: напруження; моделювання; алгоритм; концепція.

The purpose of this study is to determine the concepts and methods for conducting effective computer modeling, developing flexible computer programs in relation to the problems of pipe production.

The information-computer aspect of system research in the development of pipe production models is considered. At the same time, out information and reference information about the subject of modeling, implemented in the form of various databases and knowledge, expert systems using the latest informatics tools, provides significant assistance at the initial stages of building models. The information and reference aspect of the classification of technological processes of pipe production for use by a researcher in the search of the necessary information useful in computer modeling is considered.

Keywords: stress; modeling; algorithm; concept.

Formulation of the problem

In recent years, more and more attention has been paid to the modeling of various technological processes, including the processes of pipe production. This is relative in to the fact that in a market economy, the main task of production is to getting maximum profit at minimal cost, and one of the numerous expenses points is testing new products and launching new equipment.

Research and experiments in real pipe production have their disadvantages [1]:

- high energy costs and the risk of producing poor quality products, which will most likely have to be melted down;

- inability to change process parameters over wide ranges;
- the probability of an accident and equipment breakdowns.

Therefore, improving the technological processes of pipe production, as well as obtaining a new assortment of pipes requires additional costs.

Analysis of recent research and publications

However, with the apparent progress of computer simulation in various fields and the availability of a large number of simulation tools, ranging from universal mathematical packages [2,3], statistical processing systems [4,5], simulation modeling packages [6,7] and ending with specialized packages of modeling pressure-treating metals [8—10], during modelling processes in pipe production researches don't use them widely. In addition, despite the large accumulated potential of many research teams [10—12], it is unsatisfactory to present mathematical models in the form of modern competitive software packages with a developed graphical interface to apply in production. Developers of computer models do not actively use modern means of development, environment and language of object-oriented design technologies.

Formulation of the research objectives

Currently, the requirements for the reliability of the experimental research results are increasing, however the high cost of materials or new equipment does not allow a researcher — a specialist in the field of pipe production to fully carry out experimental justifications of new technologies or the intensification of existing traditional ones. At the same time, computing power of computer technology increases with a significant decrease in its price and an increase in the number of programs, tools intended for modeling in the field of pipe production.

The purpose of this work is to determine concepts and methods for conducting effective computer modelling and developing flexible computer programs for pipe production problems.

Presenting of main material

The logical solution to this problem is the widespread use of methodology of computer modeling of objects and processes of pipe production, in which researchers can "reproduce" different process scenarios, investigate the properties of metal in a deformation zone to find rational processing modes and predict product quality.

The gist of such a methodology is to replace the original object with its "image" — the model and further study of the model using computer-implemented algorithms.

Working not with the object or technological process itself, but with its model enables relatively quickly and without significant expense to investigate its properties and behavior in any imaginable situations. At the same time, computer and simulation experiments with models objects allow, based on the modern computing power methods and technical tools of informatics, to thoroughly and deeply to study objects in a sufficiently complete, inaccessible to purely theoretical methods of volume.

At the first stage, an "equivalent" of the object is constructed, which reflects in mathematical form of its most important properties — the laws to which it obeys, the bonds inherent in its constituent parts, etc. The synthesis of an object model is carried out with the use of system analysis apparatus and object decomposition.

At the second stage, an algorithm is being developed to implement the model on a computer in a form convenient for applying numerical methods, and determination of a sequence of computational and logical operations that need to be done to find the desired quantities with a given accuracy. The computational algorithms should not distort the basic properties of the model, and consequently, the original object, as well as be economical and adaptable to the features of the tasks and the technical means used.

At the third stage, programs are created that "translate" the model and algorithm into a language accessible to the computer and to which requirements of economy and adaptability are presented. They are called the "electronic" equivalent of a studied object, suitable for direct testing on a "pilot plant" — a computer. Currently, there are large number of programming languages, tools and design tools for computer system for modelling purposes, in particular object-oriented programming.

Creating a computer model in the form of appropriate software, the researcher gets a universal, flexible and inexpensive tool, which is first tested in "trial" computing experiments. The coinci-

dence of the numerical values of the 10 characteristics of the object and model at the characteristic points of the factor space is checked. After the requirements of the model adequacy of the original object are satisfied, various and detailed experiments are conducted to give all the necessary qualitative and quantitative characteristics of the object. As necessary, the modeling process is accompanied by the improvement and clarification of all elements of the model.

For modeling in the program, it is necessary to enter the rheological properties of the material [13]:

- curves of plastic flow of material at different temperatures and deformation rates;
- physical characteristics of the material, such as thermal conductivity, thermal diffusivity, density, etc.;
- critical conversion points at different cooling rates (thermokinetic diagrams).

The basis of computer modeling in pipe production is the use of modern software. The following systems of three-dimensional design are used for design development of technological models processes and formation of drawings: Pro / Engineer, Solid Edge, SolidWorks, "Компас 3D", AutoCAD, ZWCAD and others.

At the same time, specialized software complexes such as QFORM, Forge 3, DEFORM, ANSYS, PAM-STAMP, AutoForm, etc., are becoming more widely used to model the processes of pipe production and predict metal behavior under the action of deforming loads and deformation conditions.

Tabl. 1 shows a list of software that allows you to calculate the parameters of pipe production processes.

Table 1. Computer programs and their developers

Program	Developer
QForm	«КванторФорм»
Deform	ScientificFormingTechnologiesCorporation
AutoForm	MetalFormingSystems, Inc
AutoForm	AutoForm
Ansys	ANSYS, Inc
LS-Dyna	Livermore Software Technology Corporation (LSTC)
Forge	Transvalor
SuperForge	Superforge

The result of the solution is displayed in the form of a picture in which different areas with different deformation or temperature colors are marked [14].

The main reasons for the creation and active use in the pipe production of these computer programs are:

- the need to reduce the development time of technological processes, the time of designing equipment and conducting research works when implementing processes in production;

- obligatory reduction of the cost of false technological and design solutions before the beginning of industrial experiments, increase of reliability of the developed technical activities, including technological processes of pipe production;

- active development of computer equipment and technology with the simultaneous course of the education system course for training users with personal computers makes it possible to involve software modeling of pipe production processes for enterprises and organizations of different levels.

Applying modern CAD / CAM systems makes it possible to achieve significant optimization of design processes. The following systems of three-dimensional design are used for the design development of technological processes models and the drawing of drawings.

1. SolidWorks — CAD software complex for automation of the industrial enterprise at the stages of design and technological preparation of production, which provides the development of products of any complexity and purpose and works in the Microsoft Windows environment.

2. AutoCAD is a two- and three-dimensional computer aided design and drawing system developed by Autodesk. AutoCAD and specialized applications based on it have been widely used in engineering, construction, architecture and other industries. The current version of the program (AutoCAD 2014) includes a complete set of tools for complex 3D modeling (solid, surface and polygonal modeling is supported). AutoCAD allows you to get high-quality visualization model rendering using the mental ray rendering system. The program also implements 3D printing management (modelling results can be sent to a 3D printer) and point cloud support (allows you to work with 3D scanning results). However, it should be noted that the lack of three-dimensional parameterization does not allow AutoCAD to compete directly with middle-class engineering CAD system such as Inventor, SolidWorks, etc. AutoCAD 2012 includes Inventor Fusion, which implements direct modelling technology.

3. ANSYS — universal finite element analysis software is quite popular with experts in the field of automatic engineering calculations (CAE, Computer-Aided Engineering).

4. In the United States, Scientific Forming Technologies Corporation (SFTC) has developed a specialized software engineering complex DEFORM, designed for the analysis of metalworking processes, heat treatment and machining, which allows you to check, refine and optimize technological processes directly at the computer, not in during experiments on production by trial and error. Due to this, the time of production is significantly reduced, its quality is increased and the cost is reduced.

5. Unigraphics NX is a leading CAD / CAM / CAE system built on the best technologies designed to create products of any complexity. The main task of the system ultimately is to reduce the cost of the product, improve its quality and reduce the time to market. This enables companies to pay back the investment spent on the purchase and implementation of Unigraphics in the short term. An important advantage of the system is that it is the only CAD / CAM / CAE top-level system on the market that has a Russian interface and documentation in Russian.

6. QForm 7- is a new software product that meets the most up-to-date requirements in the modeling of metalworking processes. The creation of the new version used many years of experience in the development of the program, as well as took into account the current requirements and trends of market development. As a result, the new program has collected the most advanced modeling techniques, became more convenient and acquired the flexibility needed to further develop modern software. The program has acquired a new architecture, data structure and interface. The changes made it possible to significantly expand the range of tasks to be solved and make the program faster and easier. The interface part and the program kernel work independently. Information is exchanged between them using files that store the output and the simulation results.

The new data structure was specifically designed to manage large arrays of data that are characteristic of finite element modeling. Now access to the data has become faster and more convenient, with all the steps of the simulation being recorded, and the calculation of a large number of additional parameters is carried out in the post-processor mode after the end of the simulation. View results are much faster and can be done right during the calculation. The Source Preparation Wizard and the Source Editor have convenient access to the QForm database. Data management and view results are separated from the core of the program. This allows you to use your computer's memory more efficiently, and you can view all the results right during the calculation.

The calculation of Langrangian lines, traced points and other additional functions is carried out in the postprocessor. The postprocessor also allows you to calculate some user-specified functions and provides export of results to other programs. The 2D and 3D models are fully integrated and now use a common interface that uses the same commands. This means that both models have the same capabilities except those specific features that are used only for 2D or 3D modeling only.

The use of the above programs has expanded the capabilities of computer simulation in pipe production and has formed a whole class of new tasks:

- associated thermal task of the workpiece with tools;
- connected mechanical problem of viscous-plastic workpiece;
- modeling of several deformable blanks;
- modeling of component 3D tools with pre-stressed tool;
- elastic — plastic deformation of the workpieces, residual stresses in the workpiece.

All this has led to the extension of modeling methods:

- explicit and implicit time integration schemes;

is a new method of generating a finite element grid.

Conclusions and prospects for further research

As a result of the performed research, the goal was achieved and the following results were obtained.

1. The analysis of the systematic approach in the development of models describing different processes and objects in pipe production is carried out. It is shown that in order to create flexible, competitive models, suitable for further implementation in the form of computer software, in the development it is necessary to approach from systematic positions by performing a sequence of stages of model construction: "system-wide model — system model — constructive model".

2. The information-computer aspect of system studies in the development of pipe production models is considered. At the same time, essential information on the subject of modeling is provided in the initial stages of model construction by providing various databases and knowledge, expert systems using the latest tools of informatics.

3. The analysis of widespread use of computer modeling in pipe production is carried out — development of class libraries that describe many types of objects or processes. This component approach reduces the time and cost of developing computer models. The most promising for this purpose is the use of software packages such as QFORM and DEFORM, which have proven themselves well in solving such problems.

4. The information and reference aspect of the classification of technological processes of pipe production is considered, for the researcher to use in finding the necessary information useful in computer simulation. Some issues of use of modern means of informatics are discussed.

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ПРО ОСОБЛИВОСТІ КОМП'ЮТЕРНОГО МОДЕЛЮВАННЯ ПРОЦЕСІВ ВИРОБНИЦТВА ТРУБ

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Реферат

Метою даного дослідження є визначення концепцій та методів проведення ефективного комп'ютерного моделювання, розробка гнучких комп'ютерних програм для вирішення проблем виробництва труб.

Здійснено аналіз системного підходу при розробці моделей, що описують різні процеси та об'єкти у виробництві труб. Показано, що для створення гнучких, конкурентоспроможних моделей, придатних для подальшої реалізації у вигляді комп'ютерного програмного забезпечення, при розробці необхідно підходити з систематичних позицій, виконуючи послідовність етапів побудови моделі: «загальносистемна модель - модель системи - конструктивна модель». Розглянуто інформаційно-комп'ютерний аспект системних досліджень при розробці моделей виробництва труб. У той же час істотна інформація щодо предмета моделювання надається на початкових етапах побудови моделі шляхом надання різних баз даних та знань, експертних систем із використанням новітніх інструментів інформатики. Проводиться аналіз широкого вико-

ристання комп'ютерного моделювання у виробництві труб — розробка бібліотек класів, що описують багато типів об'єктів чи процесів. Цей компонентний підхід скорочує час і витрати на розробку комп'ютерних моделей. Найбільш перспективним для цієї мети є використання програмних пакетів, таких як QFORM та DEFORM, які добре зарекомендували себе у вирішенні подібних проблем. Розглянуто інформаційно-довідковий аспект класифікації технологічних процесів виробництва труб, який дослідник має використовувати для пошуку необхідної інформації, корисної у комп'ютерному моделюванні. Обговорюються деякі питання використання сучасних засобів інформатики.

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