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POSSIBILITY TO USE CAD IN THE STUDIES OF NEW SOLUTIONS OF WASTEWATER DISCHARGE IN ENVIRONMENTAL ENGINEERING

Dynamic development of the market for the disposal of wastewater utilization and management, forced largely by steadily tightened legal requirements of environmental protection and energy efficiency, causes the necessity to use new, meeting certain requirements computer tools for their complete implementation. It is facilitated by the dynamic development of such tools, which is the CAD software. The paper discusses the example of selected CAD software to improve and ensure the effective designing of wastewater discharge collecting systems in the areas of distributed architecture.

Keywords: *CAD software, modelling, wastewater discharge, environmental engineering.*

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МОЖЛИВІСТЬ ВИКОРИСТАННЯ САПР ПРИ ДОСЛІДЖЕНІ НОВИХ РІШЕНЬ ДЛЯ СКИДАННЯ СТІЧНИХ ВОД У ГАЛУЗІ ПРИРОДООХОРОННОЇ ІНЖЕНЕРНОЇ

Динамічний розвиток ринку видалення та управління утилізацією стічних вод, спричинений, головним чином, постійно посилюваними вимогами законодавства щодо охорони навколишнього середовища та енергоефективності, для їх якнайповнішого задоволення викликає необхідність використовувати нові, відповідні певним вимогам комп'ютерні інструменти. Цьому сприяє динамічний розвиток таких інструментів, як програмне забезпечення САПР. У статті розглядається приклад окремого програмного забезпечення САПР для поліпшення і забезпечення ефективного проектування колекторних систем скидання стічних вод в областях розподіленої архітектури.

Ключевые слова: САПР, моделирование, сброс сточных вод, инженерной экологии.

INTRODUCTION

The problem with wastewater discharge is a social problem. It is connected with the human problem, where many houses, especially in rural areas, do not have a current access to sewer systems. Only every fourth household in the rural areas of, so called, distributed architecture have an access to the wastewater system and wastewater treatment plant. In non-urbanised areas, for example in Poland, in recent years 33,4 thousand km of wastewater collecting systems have been built. 87,6 % of rural is without wastewater systems, 5,1% has partial wastewater system, while only 7,3 % is completely canalized. Each day many urban settlements grow which are also not urbanized and have no wastewater system. That is why the issue of wastewater systems in non-urbanized areas is a complex process.

Installing of traditional collecting systems in rural areas is often unjustified on economic reasons, therefore, discussion of alternative solutions is very important. Operating costs of wastewater entering into the agglomeration network and its treatment plant can stand a considerable degree of variation in individual municipalities. Many factors have an impact on this fact. It is connected, inter alia, with the land, that is why each project should be considered individually, taking into account not only technical aspects, but also economic and ecological [2].

Dynamic development of the market for the disposal of wastewater utilization and management, forced largely by steadily tightened legal requirements of environmental protection and energy efficiency, causes the necessity to expand and use computer tools that may be used in designing of biological wastewater treatment plants.

PROBLEMS AND SPECIFICITY OF ISSUES REGARDING PRESSURE WASTEWATER DISCHARGE

To effectively manage the processes associated with biological wastewater treatment plants functioning, it is necessary to use a range of technological solutions that combined together create a synergy giving practical benefits contributing to:

- optimization of biological process of wastewater treatment,
- optimization of energy use,
- economic development of the region [4].

When designing low-pressure wastewater systems, it is assumed that the systems are tight and sludge balance does not include infiltrating and accidental waters. In small settlements, sludge balance does not include precipitation wastewater, but only a household waste and the industrial ones. Amount of household waste can be estimated on the basis of water meters readings (actual amount of water taken from water supply system) or on the basis of calculated water demand. On the other hand, when calculating the amount of domestic waste, water intended for irrigation, spraying of crops, and for livestock is not included. Gravity sewer systems contain various technical devices that are designed for flow calculation Q [3].

Taken design and research activities are based on research reverse method and include analysis of impact of selected input parameters on the process of liquid flow in relation to diverse external environment. Assumed research methods have been focused on the use of appropriate computer software, so that it is possible to study the

liquid flow phenomena. This approach provides results with a high level of reliability. Created representative models of the rotor allows to recreate the working conditions of the rotor, which are then used as input elements in process of numerical analysis of liquid flow. Cooperated object models are connected by defined conditions of cooperation by specifying possibilities of their movements related to six degrees of freedom. Applying the reverse method with respect to the computer studies required the analysis of tested system for parametric quantities defined with a given step.

In particular, it is connected with the selection of pumps installation in adjacent wastewater pumping stations working at random. At peak hour of wastewater flow, pumps switch on average once or twice.

CAD software is now widely used tool for engineering. Development of vector graphics use ran, and still runs in parallel with the development of computer technology. Tasks placed for it, inter alia, are connected with designing of complex elements of gravity sewer system together with their modelling and evaluation of effectiveness. One of the basic elements is, so called, rotor, which is an element in the basic segment of device to biological wastewater treatment, developed according to the authors' idea.

EXAMPLE OF APPLICATION OF PARAMETRIC CAD DESIGN TO WASTEWATER DISCHARGE SYSTEMS

Precise design of rotor parameters, basic element in designing the biological wastewater treatment plant, allows for reducing financial costs in prototyping process, and is crucial for the development of further design works and construction. The analysis of the research can give an answer to the question how sensitive is the model to changes of selected input parameters and how changes of initial conditions affect operating characteristic of device. Parametric designing of the tool gives the opportunity to receive information in the field of technological designing and preventing, at the stage of designing, errors occurrence in the processes of device creating [5,6].

Device construction in the form of solid model can be the basis not only for the creation of two-dimensional technical documentation, but also a starting point for engineering calculations. An exemplary model project of device to biological wastewater treatment is shown in Figure 1and in Figure 2.

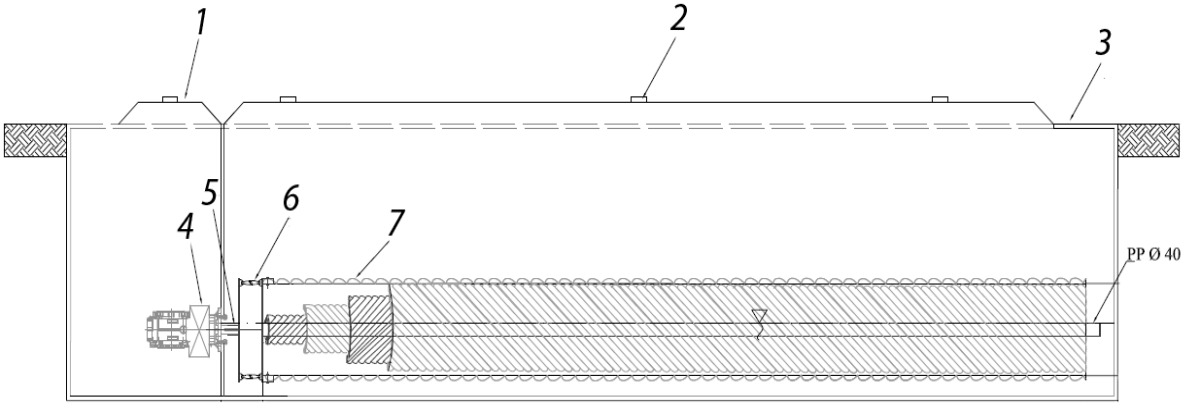
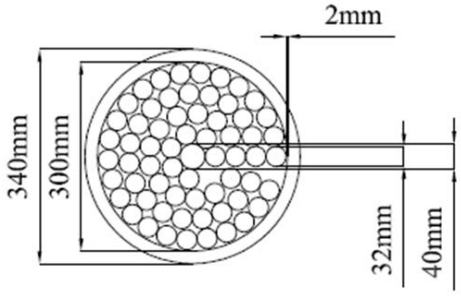


Figure 1. Device for biological wastewater treatment.
1-Cover of the driving mechanism, 2- Rotor cover, 3- Stainless steel tank, 4- Flange gear motor, 5- Drive shaft, 6- Fixing clamp, 7- Rotor

Computer modelling functions also as a prognostic and allows for the prediction of number of test results that are difficult to obtain with alternative research methods. Project activities computationally supported are connected with simulation modelling, which is defined as a numerical technique designed to conduct research processes on specially prepared models. The increasing use of modelling systems in 3D space facilitates and accelerates the process of preparing the production and generation of necessary data, and implementation of innovative technologies. Modelling sanitary devices is considered as theoretical and design action that is why it should be experimentally verified and supplemented by practical knowledge [1].

Typical, computer-aided design process of a new object, e.g. shown in Fig. 1 can be carried out as follows:

- agreeing overall concept of the project with team,
- performing a digital model of main element of



4 layer – 25 tubs Ø 32 mm
3 layer – 19 tubs Ø 32 mm
2 layer – 13 tubs Ø 32 mm
1 layer – 6 tubs Ø 32 mm

Figure 2 The cross-section of the rotor.

the project,

- performing a digital mock-up of the product – modelling missing parts,
- carrying out calculations of the strength of selected items, validating operation (analysis of the collisions), selection of the materials on individual components and the assessment of the visual – at this stage, composition may be presented in the form of multimedia presentation (e.g. as jt, WAF, DXF or avi format) or 3D model can be made using rapid prototyping,
- performing the prototype,
- performing documentation required by law (e.g. instructions for use, risk analysis, research reports, etc.),
- making possible amendments and changes in the project, estimating costs of implementation,
- drawing a BOM (Bill of Materials),
- making drawings of individual parts or development of the instruction for CNC machine tools,
- performing installation instructions (including preparation of exploded views,
- making the final multimedia presentation for marketing purposes [7].

Methodology of scientific research using CAD software and Flow Simulation allows for the interpretation of the behaviour of tested model in many functions:

- prognostic function – allows for prediction of the existence of a number of research results using graphical models in computer simulations. Predicting future states of tested models and their verification as to the validity of accepted changes range,
- measuring function – allows to analyse the behaviour of experimental system in relation to the selected boundary values for prototype construction solutions. In this way a reliable picture of calculations for the analysed process of liquid flow can be obtained,
- criterion function – results of computer research are empirically verified. Computer analysis of prototype model gives the results on the high level of reliability. Such a research tool may be used to check previously defined design assumptions,
- demo-function – facilitates understanding of the mechanism of analysed computational model of a given rotor and allows for a simulation in the conditions similar to reality. Model system is treated as a virtual reflection of real situation of test bench. Model systems of numerical analysis of examined objects are never fully reflected stated with respect to its real equivalent due to dynamically changing reactions, interactions and enforcement,
- explaining function – difficulty in observing certain research facts allows for model explanation of changes parameters of devices, e.g. inside the rotor structure [6].

Repeatability of computer analysis allows for multiple receive of physical quantities' sets measurements characterizing examined phenomenon of liquid flow, for various input parameters. Their further interpretation and verification is connected with research results of measured process parameters. Assumed model system largely maps original test bench, but to increase its efficiency its detailing should be carried out. This applies particularly to works for getting greatest functional similarity of actual research team [8].

CONCLUSION

Application of parametric designing related to the use of CAD software, especially in conducting new studies on the liquid flow in the devices for biological wastewater treatment, is at the moment one of the most modern solutions not only in Poland, but also in the world. In the example presented in the article, there has been obtained the effective selection of geometric parameters using CAD to the new solutions of wastewater transport. Undoubtedly, this has contributed to a significant reduction performance costs and testing in the natural environment.

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