Budownictwo o Zoptymalizowanym Potencjale Energetycznym **Vol. 7, Nr 2/2018, s. 51-57**
DOI: 10.17512/bozpe.2018.2.06

Olena GUMEN (orcid id: 0000-0003-3992-895X)
Petro YAABLONSKYI (orcid id: 0000-0002-1971-5140)
Nataliia KOLOMIIETS (orcid id: 0000-0003-1928-9716)
National Technical University of Ukraine Igor Sikorsky Kyiv Polytechnic Institute, Ukraine

Nadiia SPODYNIUK (orcid id: 0000-0002-2865-9320
Lviv Polytechnic National University, Ukraine

COMPUTER GRAPHICS TECHNOLOGIES IN TEMPERATURE SPACE RESEARCH OF INDUSTRIAL BUILDING INTERIORS

Taking into account the multi parameter character of the investigated process, the means of multidimensional applied geometry for constructing a graphic model of the temperature space of an industrial building interior was proposed. Constructed with the help of computer technologies, the models allow, on the basis of the physical analysis of a particular regime, the performance of the proposed technical means for increasing the efficiency of the system of infra-red heating and ventilation in industrial premises of various uses to be evaluated. The aim of the study is to offer universal geometric shaped models of processes of thermal and ventilation modes for studying the temperature space of an industrial building interior.

Keywords: **computer graphics technologies, 3D model, industrial buildings, temperature space**

INTRODUCTION

The analysis of recent research and publications in the scientific field concerning studies of the temperature space of industrial building interiors [1-4] shows that in the analysis the process of utilizing heat by a drainage umbilicus [1] and the results of the study in the form of isotherms of the temperature field in the premises, taking into account the work of the local ventilation system, all the possibilities of computer graphics technologies are not sufficiently involved. On the other hand, modern techniques for conducting research, using a geometric visualization apparatus in its entirety and the methodology for analysing and processing the obtained data, allow the parameters of the temperature range of industrial buildings of various applications to be much more efficiently controlled.

The aim of the paper is to develop the means of processing experimental data to establish rational modes of operation of the corresponding technological equipment in industrial buildings by applying the methods of geometric modeling developed in [5-7].

EXPERIMENTAL STUDIES

To research of the temperature space of the industrial building interior, the data obtained from the experimental setup [1] were used. They are represented by isotherms in the secant plane, with measurements of the height of the room *h* and coordinates *x* of the room at a constant value of coordinate *y* (Fig. 1).

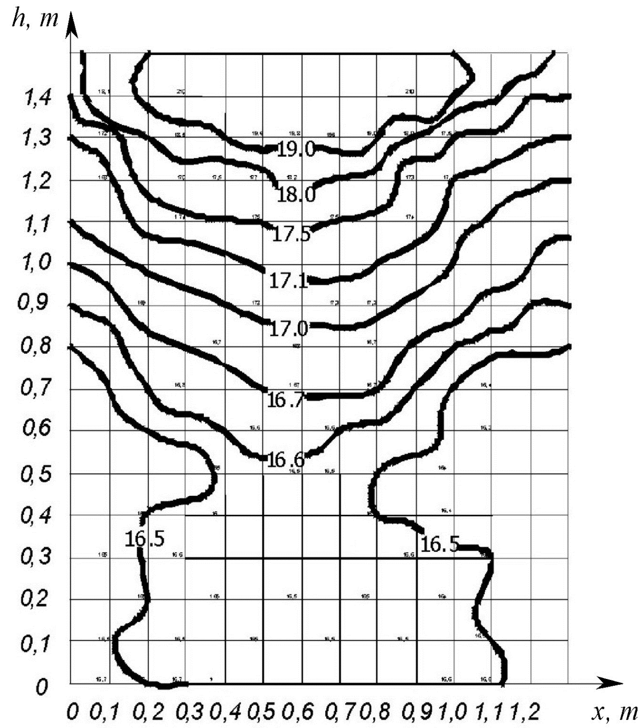

Fig. 1. Investigated section of temperature space of industrial building interior

The temperature values were recorded at fixed points in the working space of an industrial building at constant values of *y* (*y* = const) of a cross-section of the room with the infrared heater turned on. The measurement results are listed in Table 1.

The spatial model is created in accordance with the graph of the temperature field projections in the following order: A rectangular area is created (Fig. 2). Axis *x* and axis *y* are scaled as 4:1, axis *z* can not be scaled. The accuracy class on the axis is determined in millimetres (1:1).

According to the determined coordinates (Table 1), a plot of the temperature field projection is constructed (Fig. 3). According to the specified coordinates (Table 1), a plot of the temperature field projection of the industrial building is constructed (Fig. 3).

Table 1. **Temperature values at fixed points of space with infrared heater turned on**

Temperature value [°C]	Coordinates of fixed points of space *m*										
	16.5	h	0	0.20	0.40	0.60	0.80	0	0.20	0.40	0.60	0.80
		x	0.20	0.20	0.20	0.20	0	1.12	1.06	0.80	0.96	1.13
	16.6	h	0	0.075	0.09	0.08	0.072	0.07	0.06	0.05	0.05	0
		x	0.40	0.45	0.50	0.60	0.65	0.70	0.75	0.80	0.85	0.9
	16.7	h	1.00	0.95	0.80	0.70	0.70	0.82	0.86	0.90	0.94	0.90
		x	0	0.10	0.30	0.50	0.80	0.90	1.00	1.05	1.10	1.20
	17.0	h	1.10	1.00	0.94	0.90	0.85	0.87	0.90	1.00	1.10	1.20
		x	0	0.15	0.30	0.40	0.70	0.80	0.85	0.99	1.08	1.25
	17.1	h	1.30	1.20	1.10	1.03	1.00	0.97	1.00	1.05	1.20	1.30
		x	0	0.12	0.16	0.40	0.47	0.70	0.80	0.90	1.00	1.25
	17.5	h	1.40	1.32	1.17	1.12	1.10	1.10	1.10	1.25	1.30	1.40
		x	0	0.10	0.20	0.30	0.40	0.50	0.70	0.90	1.00	1.20
	18.0	h	1.40	1.30	1.24	1.24	1.23	1.20	1.21	1.30	1.36	1.40
		x	0.40	0.20	0.30	0.40	0.50	0.65	0.80	0.90	1.00	1.12
	19.0	h	1.40	1.30	1.28	1.26	1.27	1.30	1.36	1.35	1.34	1.40
		x	0.17	0.40	0.50	0.60	0.70	0.80	0.85	0.90	0.95	1.00

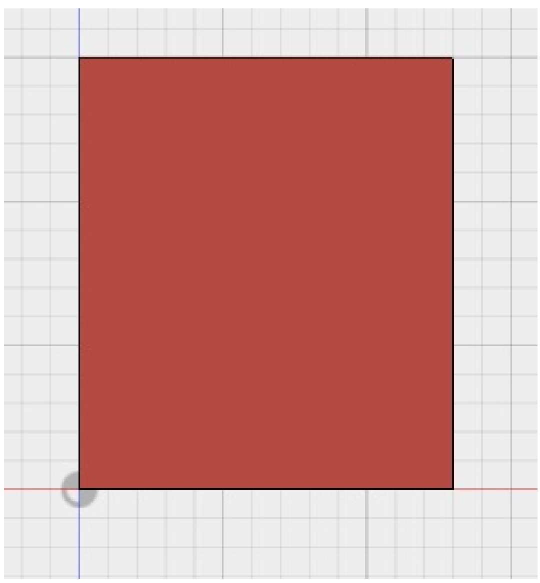

Fig. 2. Setting modelling area

The investigated area is divided into segments - squares of small size. The smaller the size of the squares that form the grid, the more precise the structure will turn out relative to axis *z*. Then, those segments of the temperature field that fall into the region bound by the projection are allocated and belong to the lines of the projection itself (Fig. 4).

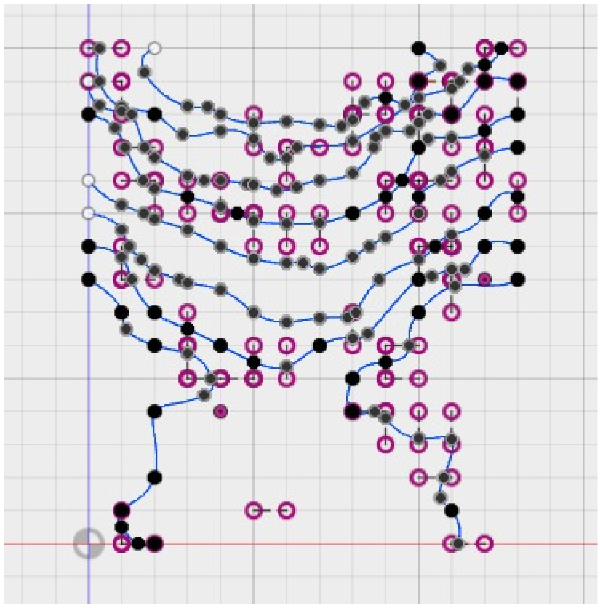

Fig. 3. Construction of projection graph of temperature field

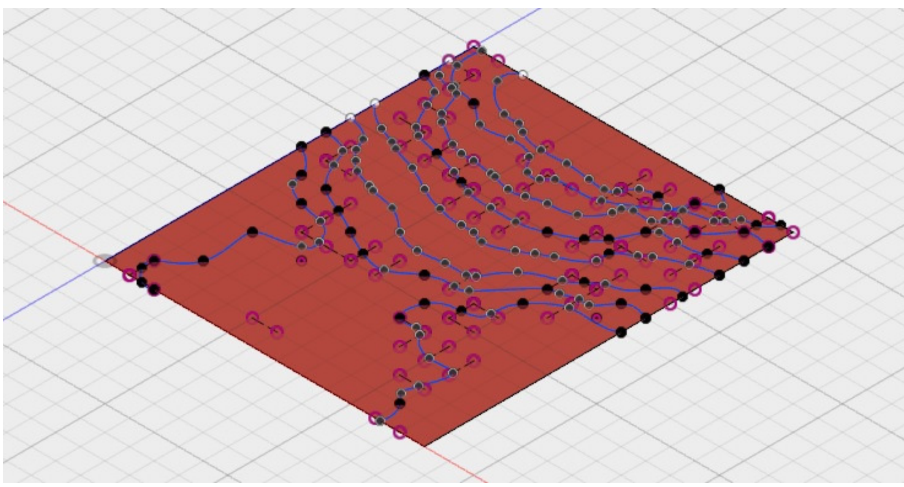

Fig. 4. Highlight of modeling area

Then it is possible to create a spatial model of the selected region using axis *z* (Fig. 5). Such a representation illustrates the interrelation of the investigated parameters, allows systematic analysis and data processing using modern computer graphics technologies.

In the study of the temperature space of industrial building interiors using experimentally obtained isotherms that form the surface of a framework, we can visualize it by means of computer graphics technologies as a frame model (Fig. 6).

In this case, we have the opportunity to see the picture of the process both at individual points, and in a specific section of the temperature space of the building, for example, at a given height of the room.

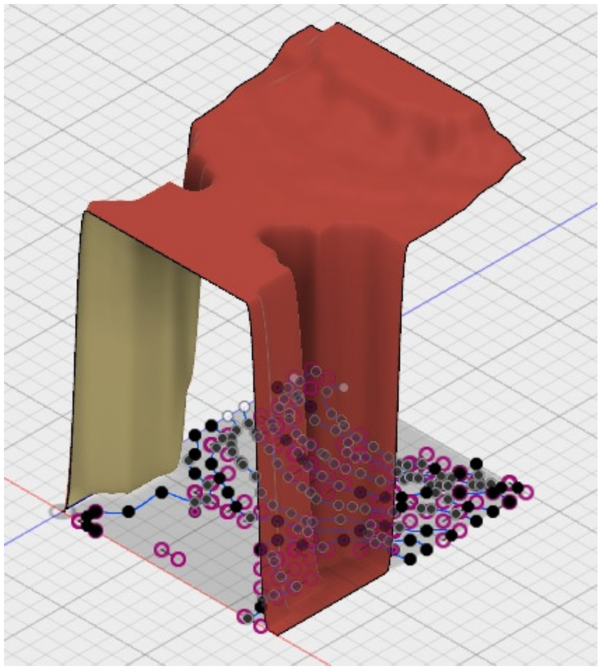

Fig. 5. Visualized 3D model of temperature space

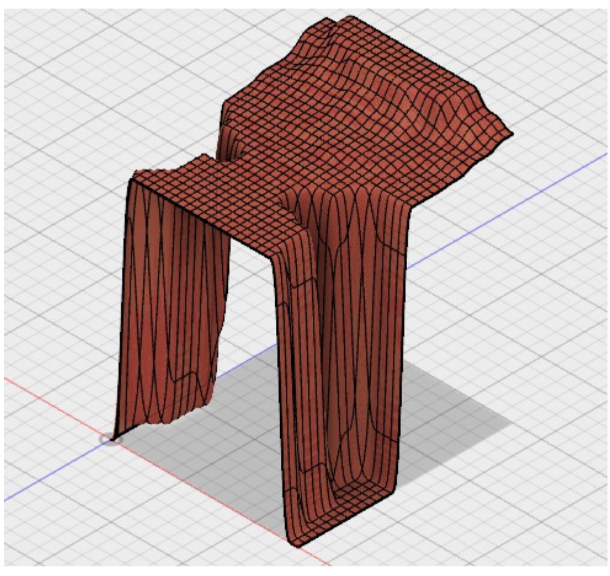

Fig. 6. Investigation of frame model of temperature space of industrial building

This approach, combining the experimental and geometrically simulated computer graphics technology components, allows one to control the technological process and track the characteristic changes in its flow in the problem zones of the study area.

At the same time, it is possible to determine the appropriate parameters at specific points of the industrial buildings, to correct them if necessary, which increases the quality and efficiency of work, provides comfort of the temperature conditions of the premises in accordance with the technological features of its purpose.

CONCLUSIONS

The practical significance of the scientific results obtained in the work consists in developing a new methodical approach to the process of studying the temperature space of industrial buildings on the basis of a combination of physical and geometric modelling using a construction instrument of an applied multidimensional geometry, which can be an instrumental basis for the purposeful study of similar technological processes in industrial premises.

The spatial models constructed with the use of computer graphics technologies allow, based on the physical analysis of a particular regime, the performance of infrared heating and ventilation systems in industrial premises of various uses to be evaluated. The visualized 3D model makes it possible to determine the values of those parameters at arbitrary points of the space of the premises, which are difficult to determine experimentally, as well as to process and analyse them using methods of multidimensional geometric modelling.

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INFORMATYCZNE TECHNOLOGIE GRAFICZNE W BADANIU WARUNKÓW TEMPERATUROWYCH WE WNĘTRZU BUDYNKÓW PRZEMYSŁOWYCH

Biorąc pod uwagę wieloparametryczny charakter badanego procesu, zaproponowano wykorzystanie wielowymiarowej geometrii do stworzenia graficznego modelu przestrzeni temperaturowej wnętrza budynku przemysłowego. Zbudowane na bazie technologii informatycznych modele graficzne pozwalają, na podstawie analizy fizycznej konkretnego procesu, ocenić działanie zastosowanego wyposażenia technicznego budynku. Wykorzystane mogą one być do poprawy efektywności działania systemu ogrzewania pomieszczeń przy zastosowaniu urządzeń wykorzystujących efekt podczerwieni oraz wentylacji pomieszczeń przemysłowych o różnym funkcjonalnym przeznaczeniu. Celem badań jest zaproponowanie uniwersalnych geometrycznych modeli procesów cieplnych i wentylacyjnych do badania przestrzeni temperaturowej budynku przemysłowego.

Słowa kluczowe: **technologie informatyczne, model 3D, budynki przemysłowe, warunki temperaturowe wnętrza budynku**