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THE PROBLEMS OF TECHNOLOGICAL MONITORING IN THE CONTROL OF INDUSTRIAL ENTERPRISE

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Abstract

The problems of technological processes monitoring in the control of industrial enterprises were considered by the example of the sugar industry. The problems and methods of technological information processing and analysis based on modern informational technologies were described. The role of informational and analytical systems of technological monitoring in the structure of the automated control systems was determined.

Keywords: control systems, technological monitoring, Data Mining, informational technology.

The increasing of production efficiency is performed by the increasing of equipment capacity, the intensification of technological processes and the improvement of economical mechanisms at the present stage of development of the industry. All this leads to a complication of solving of many industrial tasks such as task of control of industrial enterprise. Manufacturing enterprise as an control object is a complex, that have all features of compound organizational and technical systems.

From the standpoint of classical control theory, any system is considered as a set of administering and controlled system. This system have a real energy and, what the most important, information communications, is implemented administrating strategies of control based on information about the behaviour of the object, while is ensured the optimal state of such object in accordance with existing conditions and specific targets of functioning [1]. There are existing multifactorial, all sorts of the uncertainties, the unsteadiness, the significant nonlinearities, the conflict interactions, the presence of fluctuations to some extent unpredictable behaviour of an object in the compound organizational and technical systems, so the control systems within the existing structures do not provide adequate control actions that could ensure the necessary efficiency of industrial enterprise at all levels of control hierarchies. Under these conditions, a new paradigm of information control [2] envisages the increasing intelligence decision-making due to the provision of full disclosure of control system to identify critical and adverse situations in control object and their timely removal. This fact allows us to consider the information process of monitoring of technological processes as a part of an information decision making of control.

Technological monitoring is monitoring over the work of the control object by instrumental and sensory measurements of process variables with the subsequent analysis, assessment of the state and behavior of the object, as well as the forecasting of its development, including the identification of trends of system changes. The essence of technological monitoring in automated information control system is the collection, transformation and presentation of information in accordance with the objectives and requirements of control bodies [3].

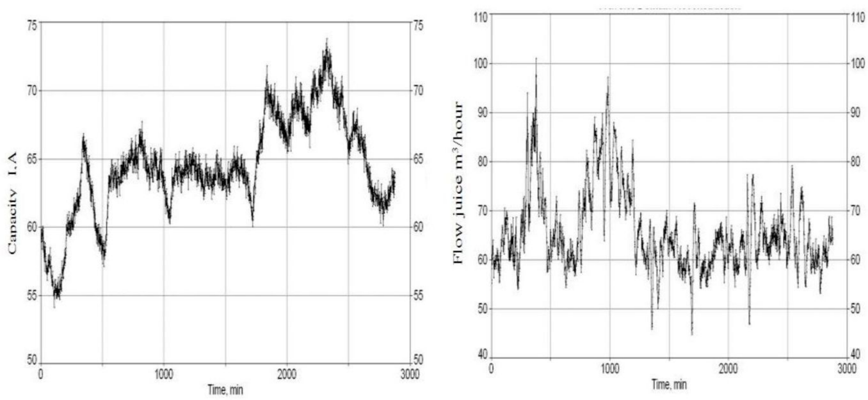
Consider the methodology of construction of technological monitoring system on example of food enterprises.

In terms of control problems food production enterprises are related to complicated organizational and technical systems. One of the characteristics of such control objects is considerable uncertainty in the evaluation of technological parameters such as indicators of quality of raw materials, semi-finished and finished products. Detection of situational behaviour of technological processes through significant signal interference and noise of random character is also an important problem. The presence of composite nonlinear dynamic interconnections in objects of food industry generates phenomena of intermittency as alternating chaotic (turbulent) regimes with regular (laminar) and with the formation of dissipative time-space structures. An important factor is the analysis of criterial and resources conflicts, detection of reasons of their origin and solutions. These factors complicate the task of technological forecasting, analysis of work situations, production control, resource allocation in the production of foodstuffs, making operational economical solutions for control stimulating non-coercive nature.

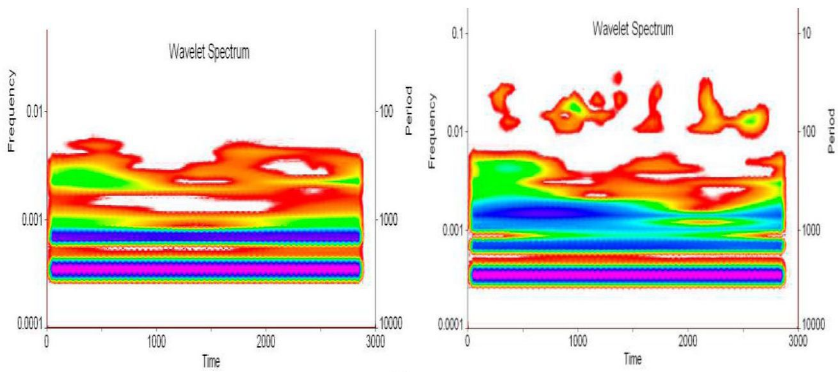
Solution of these problems is provided by comprehensive observation of the control object, analysis of technology information, forecasting the development of technological processes of different depth, including trends of forecasting of system modifications due to intellectual information-measuring systems of technological monitoring.

System of technological monitoring was developed for food enterprises based on modern information technologies. The main applied functions of this system are: the analysis of input technological information, which includes task of correction of false measurement (abnormal) results of different nature using neural networks; filtration of measured data using wavelet transformation, recovery gaps in the data based on precedent and fractal analysis; classification of technological regimes and production situations by methods of pattern analysis and Kohonen's maps; technological forecasting powered by DATA MINING technologies and flicker-noise spectroscopy; constructing mathematical models of optimal control of technological processes due to original methods of structural and parametric identification and fuzzy approximation; analysis of the technological conflicts and recommendations to their solutions.

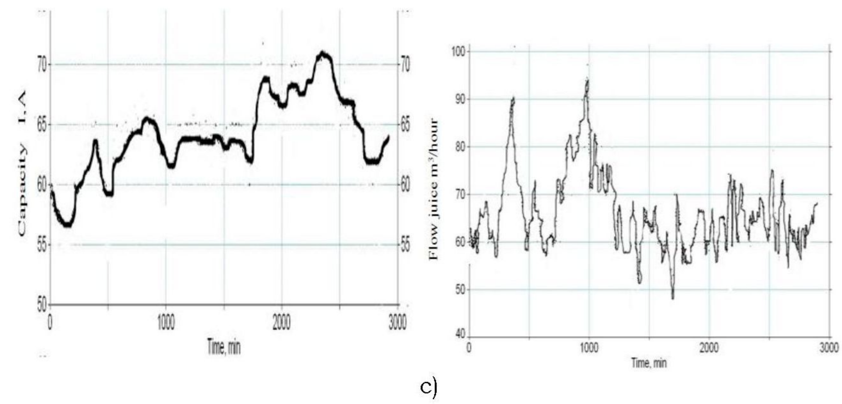
Let's consider some received results. The wavelet-transform of technological variables signals by Morlet wavelets [4] (fig. 1, 2) were applied to remove noise from the useful signal (the task of filtering information) determining the characteristic's behavior (the phenomena of intermittency of objects, patterns).



a)



b)



c)

Fig. 1. Load current signal to the actuator diffuser, flow diffusion juice a) signal with obstacles, b) spektograma Morlet's wavelet, c) the filtered signal.

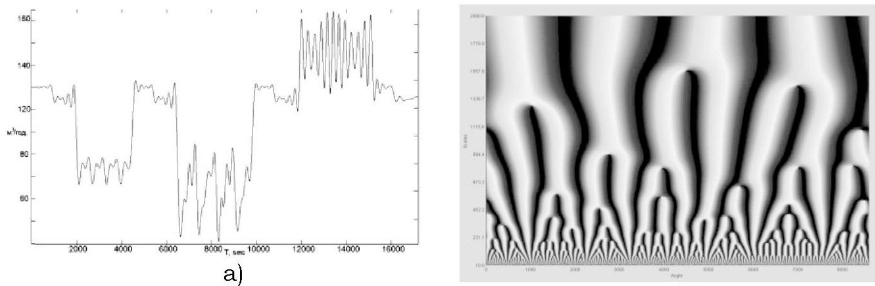


Fig. 2. The wavelet –transform of signal of flow diffusion juice
a) signal of intermittency, b) spektograma Morlet wavelet

The Gilmor's graphic test [5] was applied in order to identify specific differences in the behavior of an object such as the presence of domains channels and jokers (wildcard character) and their classification. Using recursive analysis allowed the band to explore attractive dynamic system and evaluate the qualitative and quantitative chaos (fig. 3).

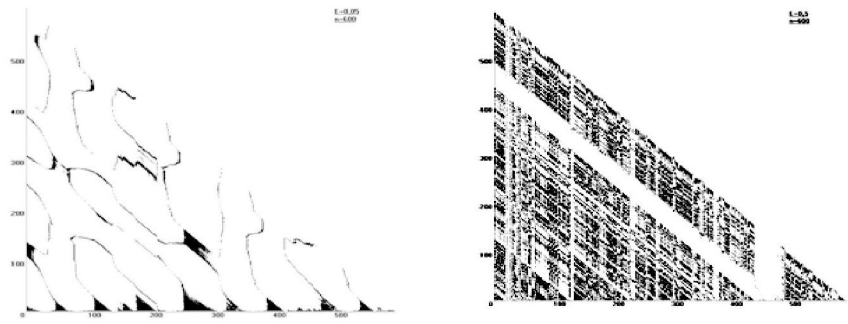


Fig. 3. The Gilmor's graphic test chaos: a) pH juice; b) flow diffusion juice

Recurrent diagram (fig. 4) is described by the relation [6]:

$$R_{i,j}^{m,\varepsilon} = \Theta(\varepsilon_i - \|x_i - x_j\|), \quad (1)$$

where $\{x_i\} = [x_1, x_2, ..., x_N] \in R^m$, $i, j = 1,2,...,N$, N - the number of the state of the observed process ε_i - the size of the neighbourhood of the point x_i of the moment i - $\|x_i - x_j\|$ the distance between the points $\Theta(\cdot)$ - Heaviside function.

The texture makes it possible to estimate the distance between the states of the diagram distances, that displayed on a certain color palette (Fig. 4):

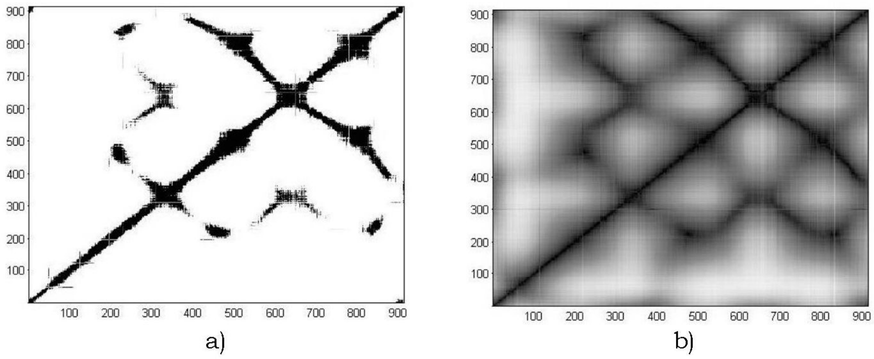
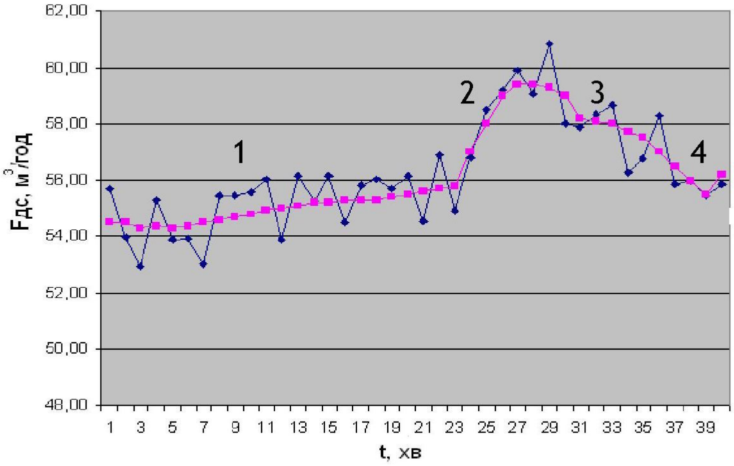


Fig. 4. Recurrent diagram (a) and texstur (b) pH 1-st saturation

$$D^m_{i,j} = \left\| x_i - x_j \right\| \quad (2)$$

Forecasting system carried out on the basis of trends time series mining process variables [7] (fig. 5).



1 - a slight increase
2 - rapid decrease
3 - trends change (increase/ decrease)
4 - a moderate decrease

Fig. 5. Forecasting system changes of flow diffusion juice

An algorithm for control the compound technological complex based on the scenario approach by using the information of monitoring system was developed (fig. 6).

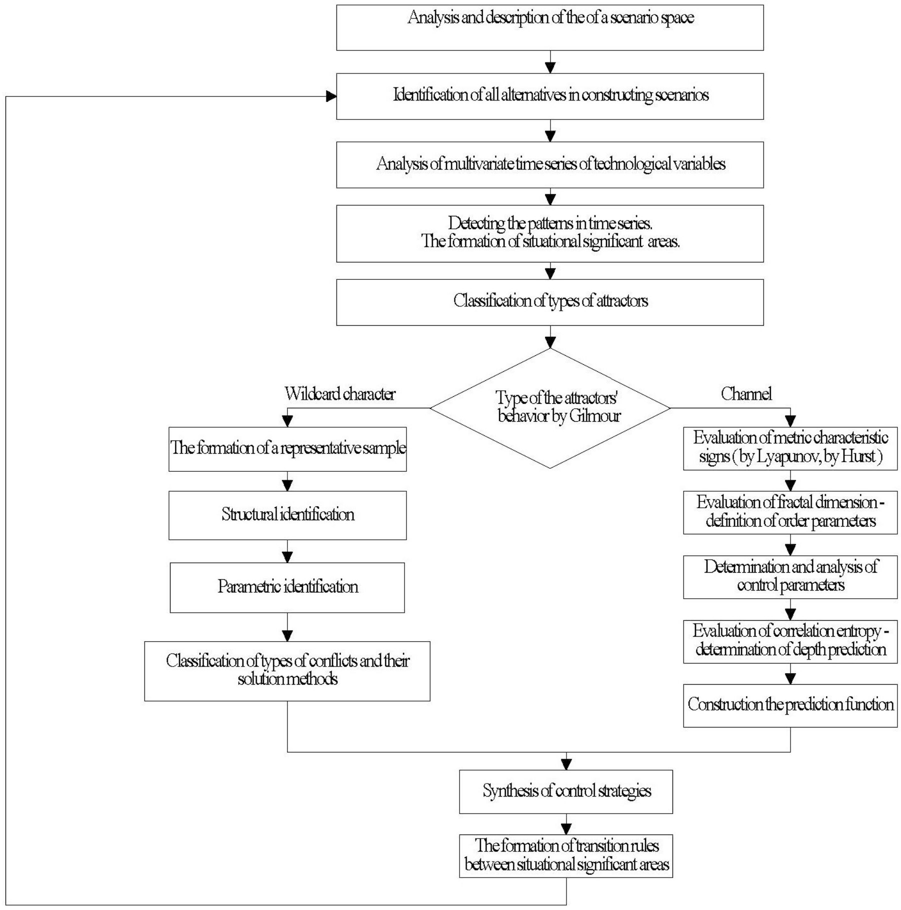


Fig. 6. An algorithm for control the complex technological complex based on the scenario approach.

The system is integrated into the automated systems of technological processes due to information and computer networks (fig. 7).

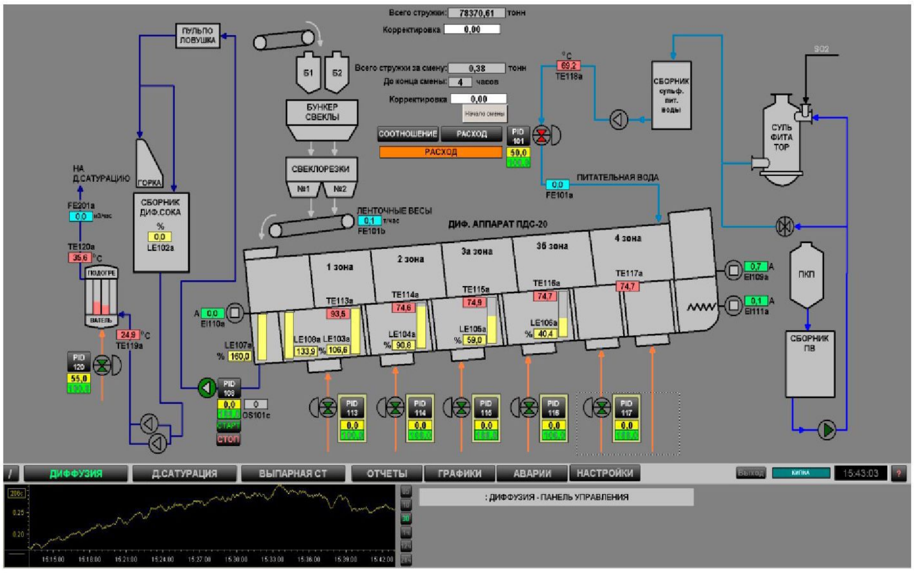


Fig. 7. The user interface of automated process of control system

As the production tests show, the developed technological monitoring system provides improvement of product quality, increases productivity manufacturing equipment and contributes to resource conservation.

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