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The biotech complexes control in conditions of situational uncertainty

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Abstract: *The biotech complexes control in conditions of situational uncertainty*. An approaches to the development of automated control systems of biotech complexes that operate in conditions of uncertainty are given. The main provisions, based on the study of nonlinear dynamic characteristics of biotechnological processes are shown. Particular attention is paid to main control criteria.

Key words: uncertainty phase space, biotechnology complex, management scenario.

INTRODUCTION

One of the main components of the intensification of production processes is the implementation of advanced computer technology. Considering the great resources and broad hardware computing, the problem of creating new methodological, algorithmic and software automation on the achievements of the theory and practice of management, stands to the fore. Development of integrated control systems of technological process requires fundamentally new approaches in accordance with the concept of representation as a complex organizational and technical system. Moreover, taking into account the maximum extent of specific features of complex technological objects will naturally organize and provide teleonomic behavior: low-power, but topologically consistent control of the resonant character lead to the disclosure potentially rich resources hidden in organizational and technological structures.

The Department of Automation of the National University of Food Technology of Ukraine conducted research on the development of integrated management systems of technological systems of food production. The main focus is on biotech complexes alcohol, brewing, baking industry, the production of yeast and sugar.

Scientific bases and methods for control of complex biotechnological processes food industries using modern theories of self-organizing, adaptive management, regular and chaotic dynamics of nonlinear systems, decision making under uncertainty and risk are implemented. Scientific and practical research results are based on consideration of the features of biotechnological processes of food industry as a complex nonlinear dynamic objects, and their mathematical modeling taking into account the effects of self-organization of spatial and temporal structures, chaotic behavior and others. Scenario construc-

tion management, design structures and systems of biotechnological processes.

In recent years, the Department of automation conducts the complex of works on a computer-aided management of biotech systems under uncertainty. This system involves decomposition of control problems and solutions with specific subsystems, while necessarily taking into account the determination in accordance with the goals and taking into account uncertainties arising in various industrial situations, including abnormal and emergency.

MAIN APPROACHES AND RESULTS

The solving of this problem is based on the results of development of automated control systems of biotech complex (BTC) and methods of intelligent data processing. The technological processes of food production are allocated to one class of objects with their characteristics, criteria, assessment of functioning, models and specific properties of self-organization and adaptation to changing environments. Such factors as the reduction of degrees of freedom, self-organization, biding in a particular state and the possibility of evolution are taken into account during the explorations of technological processes. Patterns of self-organization in a chaotic spontaneous structure shown in the description of the topology of attractor regions as centers of dissipative structure management processes.

The system is implemented on the principles of multi-branched architecture, based on current trends in building intelligent systems [Rotstein 1999]. Development of the structure of this type provides the following methods of functional subsystems, namely incorporation of temporal characteristics – phase control and an approach that takes into account functional features. Such criteria as determining the optimal number of information links between the subsystems and increase efficiency is using in this case. The solving of the problem of functional subsystems for the temporal feature provides a separate allocation of tasks planning and operational management. Marked subsystems, their characteristics and the basic relationships are based on the objectives, criteria and restrictions on existing resource management. These criteria are effectiveness, flexibility, dynamics. The functionality of the structure should provide a minimum response time to situations of varying complexity. In this case, the main strategic approach is the formation accurate information on vertical transmission of automatic control and manual input places (if there are no appropriate measuring tools).

The most important factor in the strategy of considering situational uncertainty is to include mechanisms for synthesis of control scenarios parameters BTK.

Conducted computer simulation of processes allowed to determine the qualitative behavior of the control objects (attractors change depending on the control parameters) and to identify ways to improve management processes for a wide class of processes, for example, the use of resonant excitation of the chaos, develop scenarios of management, intelligent subsystems decisions, and so on. Consideration of such behavior of the basic processes BTC allows to construct a set of strategic management scenarios.

The following is considered as a system model that describes the processes of change parameters and conditions of the BTC, discrete fixing principle in terms of the developer of automated control points of the transition to a new level and operation modes. In developing such intellectual subsystem should distinguish between scenarios and scenarios of the behavior of the object. First formed, depending on management objectives and rules of selection control actions, while the second focuses on descriptive research facility management. The major difference is that in the scenario of present person who makes decisions, taking an active part in achieving management objectives.

The formation scenario of BTC is based on the subjective – objective scheme [Kononov 2002, Smityuh 2008], which is used in the analysis and decision making, ie, first forming an extended phase space $Z = X \times \times Y$, where X – vector of input, Y – output vector, which is the study of behavior parameters of BTC. The next step divide space into subsets which characterize qualitatively expertly significant properties. This expert way recognize "workspace" $Z \subseteq Z$, which addresses the functioning of the object.

The basis of the expert describe the behavior of processes is the concept of meaningful expert partitioner (MEP) Q_r space Z, expert and significant events (ESE) Q_p, which are in the order specified in the system of regulation which is determined by objective laws of nature (physics passage of the process) [Kononov 2002] . Presenting MEP given set of parameters (characteristics S_P), established center elementary breakdown, which sets the normal parameters of the selected object, form a normal condition of some extended vector convolution phase coordinates (eg, phase space coordinate system changes).

The next step is to enter a script to generate links between elements MEP. The procedure of ESE can be evaluated from different perspectives. There are two extreme possibilities:

- Following an exogenous way (synergetic approach);
- Following through endogenous, based on a detailed description of the transition process (in some cases it may be management processes with the desired goal) underlying attractive approach [Kononov 2007].

Between these points of view is the whole spectrum of the possible models. To construct a scenario formally proposed the use of two time scales:

- The scale Z_t, by which describes the dynamic trajectory of the SO extended phase space Z (usually a continuous time scale);
- The scale R_t of the discrete time by which all events are scenario emerging.

In the formation scenario consistently stand uncertain $a \in N_0$ and random factors $b \in B_0$. Further defined the concept of conditional decisions $R = (a, \mathrm{b}) \in \Gamma_0 = = N_0 \times B_0$, the expected event $(x^{(i)}(t_i), y^{(i)}(t_i), t_i)$ (in time $t_i \in Z_t$, the image of the situation $\mathrm{S}(t)$, the image of the situation $I(t_i)$ in time $t \in Z_t$.

Effective methodological tools in determining the elements of the script behavior BTC can serve as arterial approach to the analysis of the problem [Kantz 2004], whose content is deter-

mined by some special many images (zone of stability of phase portraits) phase space, which describe effective in terms of objective functions defined trajectory system development. The defining of these elements allows for the synthesis of optimal control and optimal trajectory refer to relevant passage processes, such processes rectification as shown in Figure 1.

algorithms {KA}, and the rules of selection algorithms for classification {PK}

$$\{Y\} = \{K_S, K_A, P_K\}, \quad (1)$$

In this subject area as the image taken by the set of states of the BTC, which allow one to identify the situation and select it to a class. In the scenario knowledge of the base management sys-

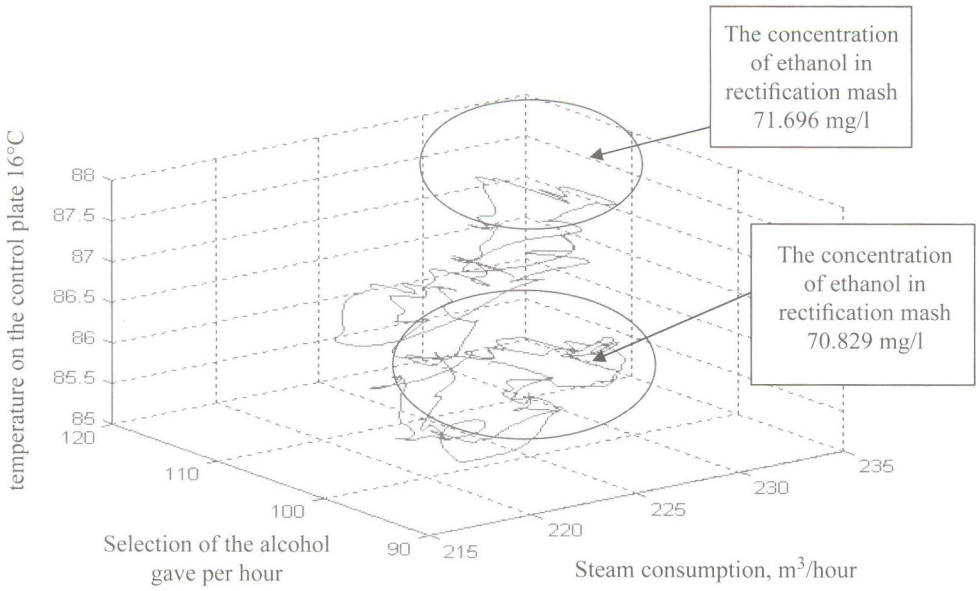

FIGURE 1. Temperature change on the control plate LCD (observation period 24 hours)

Research of attractive areas of basic metabolic processes of phase portraits rectifications and analysis of their characteristic properties revealed significant situationally specific areas in which technological situation $S(t)$ situation as described by the vector of image features that characterize the object, and is determined by some relation on the set of parameters {Y}, characterized by a set of classes of situations {KS}, which are reflected in the script control, the set of classification

tem BTC was proposed such version of knowledge representation. To fulfill the tasks was suggested to use the knowledge representation in the form of scenarios as frame models. Management strategies under uncertainty are based on the strategy of the person who takes decisions and the characteristic properties of processes defined by computer processing of experimental results. In the classification of the purposes of BTC are the following aspects:

- Scenarios in scope of coverage events;
- Local scenarios, which consist of exclusively single subsystem of BTC and the basis for local decision-making system;
- Between-objects scenarios, consisting for the description of interaction and modes of their interaction is the basis for the management of distributed control system BTC.

Building scenarios management is closely connected with theoretical and practical foundations of chaos, and because of the proposed management scenarios are built by their synthesis based on a network approach, this approach will optimize the constructive synthesis of scenarios by structuring the results of modeling processes BTC and meet the challenges of multi-management under uncertainty and risk.

Building a scenario of BTC is based on the concepts of spontaneous chaos in the space of operating conditions. The processes of formation and development of chaos in nonlinear media, which includes processes of rectification are classified depending on the nature of growth attractor dimension in space [Shang and Li 2005]. If the field is complicated by the dynamics along one or more areas, for example, the dimension of growing along the coordinates, then this scenario should be called convection. Obviously, this character of the process should be considered in terms of learning "shear" turbulent hydrodynamic flows in the process of BTC and incorporation of its features.

In the case where the passage appears chaotic behavior of nonlinear fields in localized areas, and gradually subordinates neighbor areas in the final event in the environment established by space – time chaos with uniform, on average, in the space of characteristics, which in turn leads to the establishment of a stationary regime of processes BTK. The substantial theory of space-time chaos can be used primarily in situations where the dynamics of nonlinear fields can be regarded as a dynamic ensemble of interacting stable and metastable structures resulting from the passage of complex processes. As a result of the primary instability in the flow formed ensemble of dynamic elements – vortices associated with each other due to perturbations, which extend down the stream. Individual dynamics of such vortices can be quite varied. In particular, vortices may occur periodically and quasiperiodic oscillations, it is typical seen from simulation results. If the vortices interact with each other, the vibrations can become complicated, until one of them will become chaotic – formed a strange attractor. With some simplifications can show that the development of chaos along the stream is done by a finite number of bifurcations (flow alterations) that is unfolding by changing the control variable, and in space – along the chain structures.

A total of BTC each technological operation performs a separate structure that is represented by a certain set of elements and optimizing functionals. In forming the optimal control algorithm takes into account that each situation that is the object requires a separate solution. All these operations form a feature, and their aggregate form algorithm for solving the problem of BTC under uncertainty.

Context of solving this problem consists of management tasks agreed selec-

tion control actions depending on production situations, direct indicators of objective functions.

Feasibility of integration is smart in the process of automated management BTC. This will eliminate the disadvantages of automated systems that work with objects that are characterized by uncertainty and increase efficiency and reliability management, reduce the time to search for effective solutions provide independent search strategy behavior on subjective judgments operator in a production situation.

CONCLUSIONS

The possibility of using a scenario approach to address the actual problem – the creation of automated control system BTC, operating under uncertainty. As a result of research, new provisions which form the basis of efficient systems of technological systems and processes of food production using modern computer technology, which provides resource and energy efficient operation of technology systems.

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Streszczenie: *Sterowanie systemami biotechnicznymi w warunkach niepewności.* W pracy przedstawiono przykład podejścia do rozwoju automatycznych systemów sterowania złożonymi systemami biotechnicznymi, działającymi w warunkach niepewności. Zostały zaprezentowane główne uwarunkowania funkcjonowania procesów biotechnologicznych o dynamicznej charakterystyce nieliniowej. Szczególną uwagę zwrócono na główne kryteria sterowania.

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