INTELLIGENT SYNERGISTIC CONTROL OF THE TECHNOLOGICAL COMPLEX FOR THE SUGAR FACTORY

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Abstract

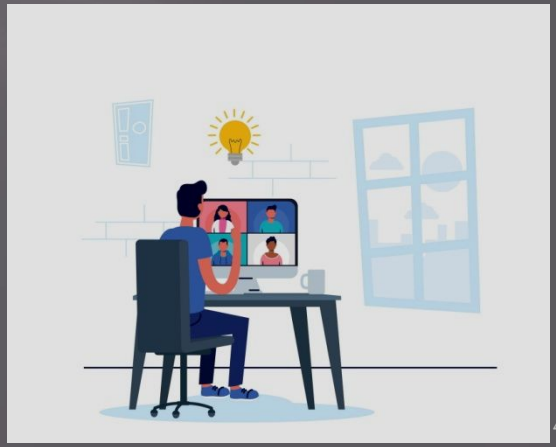
- The problem of automated control of the technological complex of a sugar factory in the conditions of the formation of dissipative spatio-temporal structures of a chaotic nature in the process of its operation is considered.
- The proposed synergistic approach, based on taking into account the phenomena of self-organization of a complex object of control
- Building an intelligent subsystem in the system of automatic management.
- Using the method of analytical construction of aggregated regulators.
- The structural diagram of the control system for sugar preparation processes is presented and the functions of individual blocks are defined.

Introduction

- To increase the efficiency of managing complex systems, uses methods of synergetics.
- Synergetics is an integrated science that studies the processes of self-organization and covers almost all modern knowledge about phenomena of different nature. The basis of synergetics is nonlinear dynamics and thermodynamics of irreversible processes.
- The novelty of the synergetic approach to control is the transition from unpredictable behavior of the system by dissipative to directional motion along the desired invariant varieties - attractors, to which other variables of the dynamic system are adapted.
- Therefore, the purpose of the synthesized system is to achieve the corresponding desired attractor, i.e. the asymptotic stability of the final state.

Materials and methods of research

- The synergistic principle of managing complex systems allows you to change the structure of the system or to move to another level of self-organization by changing the order parameters.
- Determined by an adaptive controller.
- Methods of managing :
- 1. Control by changing the order parameters.
- 2. Control by changing the initial conditions.
- The synergistic method of controlling complex dynamic systems is the principle of resonant information influence on the order parameters, within which the system is sensitive and its internal features are preserved.



The results of research

- The example of the technological process of preliminary defecation.
- The mathematical model of the process of preliminary defecation has the form:

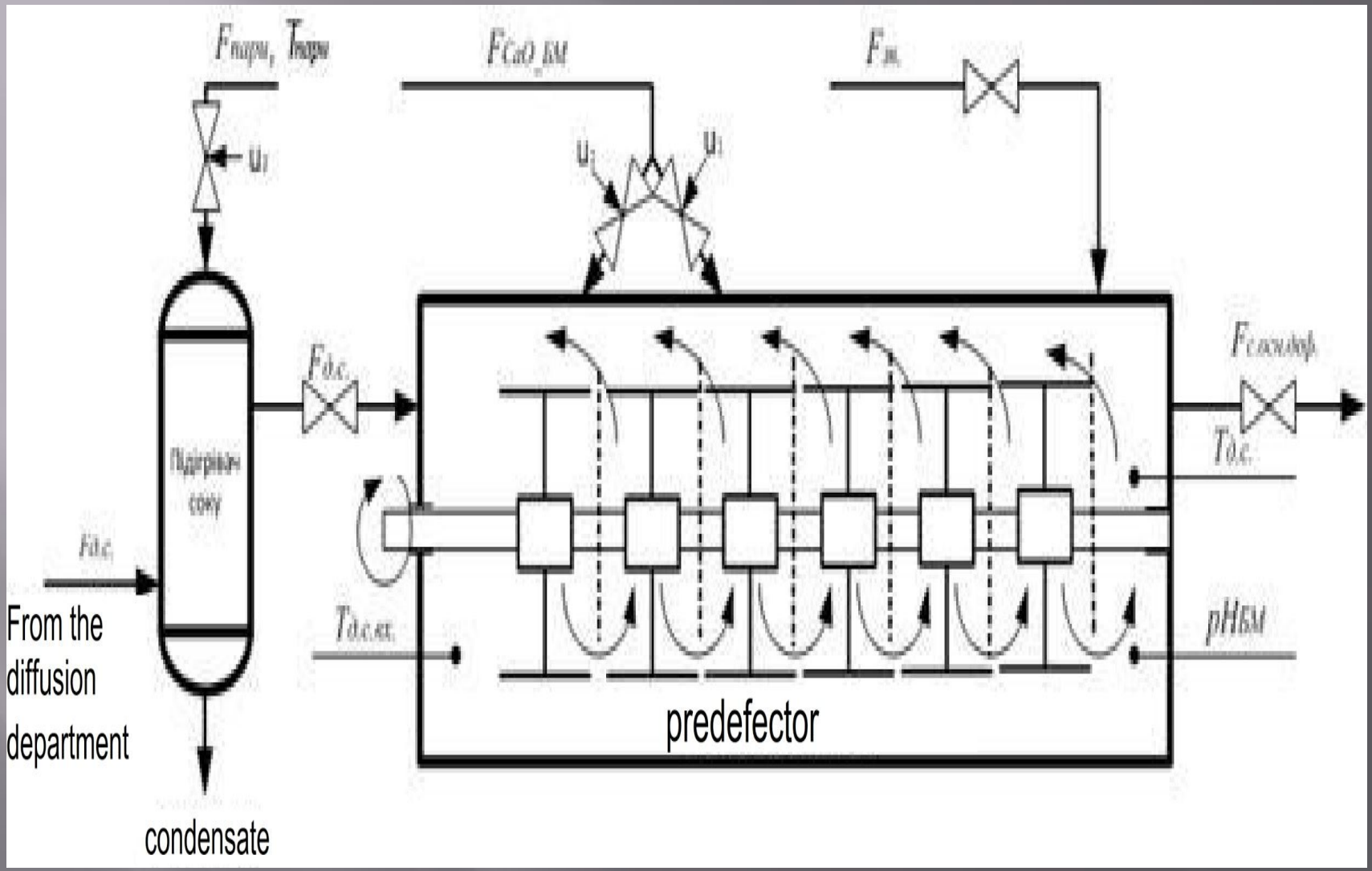
$$\frac{dC_{CaO\_БМ}}{d\tau} = \frac{F_{CaO\_БМ} \cdot C_{CaO}^{вх.}}{V} - k_1 \cdot C_{CaO} \cdot C_{с.р.} - \frac{F_{д.с.} + F_{зв.}}{V} \cdot C_{CaO}$$

$$\frac{dC_{с.р.}}{d\tau} = \frac{F_{д.с.} \cdot C_{с.р.}^{вх.} + F_{зв.} \cdot C_{с.р.}^{зв.}}{V} - k_2 \cdot C_{с.р.} \cdot C_{CaO} - \frac{F_{д.с.} + F_{зв.} + F_{CaO\_БМ}}{V} \cdot C_{с.р.}$$

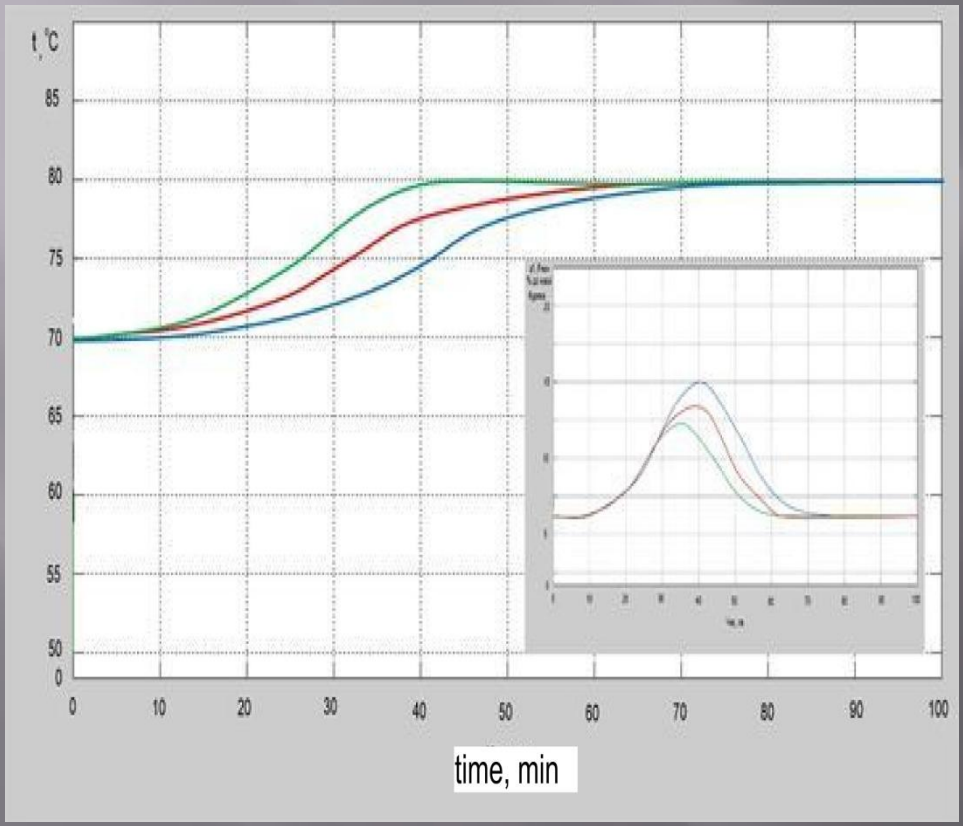
$$\frac{dT_{д.с.}}{d\tau} = \frac{F_{CaO\_БМ} \cdot T_{CaO}^{вх.} + F_{д.с.} \cdot T_{д.с.}^{вх.} + F_{зв.} \cdot T_{зв.}}{V} + [k_1 \cdot F_{CaO\_БМ} - k_2(F_{д.с.} + F_{зв.})] \cdot Q -$$

$$- \frac{k_T \cdot F}{\rho \cdot C_p \cdot V} \cdot (T_{д.с.}^{вх.} - T_{р.}) - \frac{F_{CaO} + F_{д.с.} + F_{зв.}}{V} \cdot T_{д.с.} + \frac{T_{д.с.}^{вх.} - T_{д.с.}}{V} \cdot F_{CaO\_БМ},$$

- The example of the technological process of preliminary defecation.

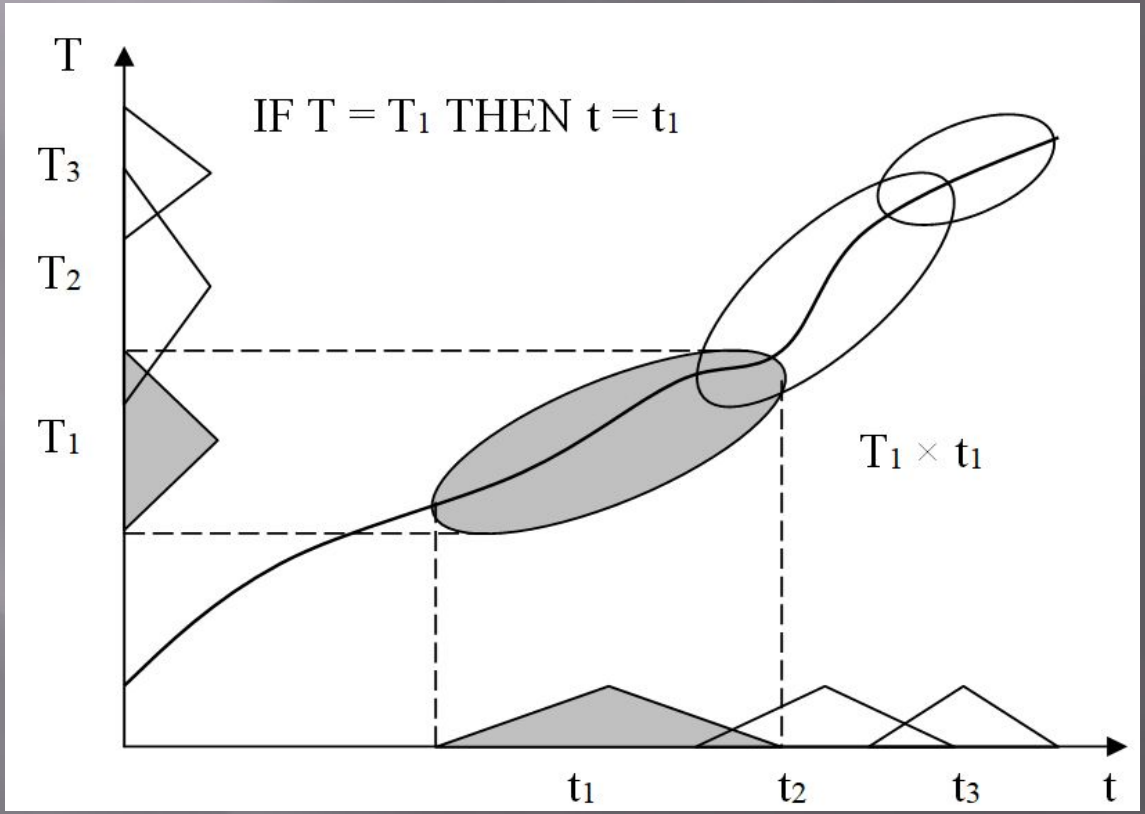


- The setting parameters of the control laws regulate the control time T1, T2. The condition for the stability of the system are the values: T1> 0, T2> 0.
- The quality of management was evaluated by the integral quadratic criterion.
- As a result of the research it was found that the system is resistant to disturbances, and the regulation time depends only on the values of T1, T2.



The process of regulating the temperature of the diffusion juice taking into account the perturbation by pH (ΔpHБМ=+2): a) at T1 = T2 = 200 min; b) at T1 = T2 = 100 min; c) at T1 = T2 = 10 min

- The problem of constructing a fuzzy approximator while limiting the number of approximation points is solved as a task of finding the optimal values of the approximation parameters, namely: choosing the position of the approximation points, choosing the form of the function of the fuzzy linguistic term parameter, and choosing the method of fuzzy logic implementation.



The structure of constructing fuzzy rules for Kosco

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- Ladanyuk A.,Shkolna O., Kyshenko V. Automation of Evaporation Plants Using Energy-Saving Technologies Advances in Intelligent Systems and Computing, Warsaw, Poland, Volume 543, 220-226 (2016).
- Kyshenko V. The problems of technological monitoring in the control of industrial enterprise Pressing issues and priorities in development of the scientific and technological complex. B&M Publishing, San Francisco, California, USA, 62-68 (2013).
- Korobiichuk I., Ladanyuk A., Zaiets N., Vlasenko L. Modern development technologies and investigation of food production technological complex automated systems. ACM International Conference Proceeding Series, 52-57 (2018). Doi: 10.1145/3185066.3185075.
- Korobiichuk I., Lutskaya N., Ladanyuk A., Naku S., Kachniarz M., Nowicki M., Szewczyk R. Synthesis of Optimal Robust Regulator for Food Processing Facilities. Advances in Intelligent Systems and Computing, V. 550, ICA 2017: Automation 2017, pp 58-66 DOI: 10.1007/978-3-319-54042-9_5.
- Kosko B. Fuzzy engineering. Includes bibliographical references and index. – 574 p (1997).
- Korobiichuk I., Ladanyuk A., Shumyhai D., Boyko R., Reshetiuk V., Kamiński M. How to Increase Efficiency of Automatic Control of Complex Plants by Development and Implementation of Coordination Control System. Advances in Intelligent Systems and Computing, V. 543, p 189-195 (2017) DOI: 10.1007/978-3-319-48923-0_23 .
- Mamdani E.H. Application of fuzzy logic to approximate reasoning using linguistic synthesis. IEEE Transactions on Computers,Vol. 26(12), p.p. 1182 – 1191 (1997).
- Ladanyuk A., Kyshenko V., Smityuh Y. The biotech complexes control in conditions of situational. Annals of Warsaw University of Life Sciences. № 60,149-154 (2012).