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FUZZY LOGIC CONTROLLER IN THE MANAGEMENT OF TECHNOLOGICAL PROCESSES OF BACTERIAL OXIDATION

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Annotation
The current stage of progress involves the formation of intelligent systems and technologies that provide clear solutions based on vague rules, vague conclusions and vague controls. However, classical control methods work well only with a fully deterministic control object and a deterministic environment, but for fuzzy information systems and very complex control objects, fuzzy control methods are optimal.

Keywords. Intelligent control systems, fuzzy logic control, controller, regulator, actuator, algorithm, bacterial oxidation, fuzzy set.

INTRODUCTION

In order to increase the level of automation of the intellectual functions of the human manager involved in the management by operating automated control systems of technological processes and production, it is necessary to use modern IT

achievements and advances in the field of intelligent control technologies. At present, fuzzy logic methods, neural networks, genetic algorithms, and many other information technologies are widely used in control systems.

The issues of unclear logical use of the controller (CFL) in control systems are currently quite relevant. The benefits of using methods of unclear logic have been actively discussed over the past few years. The advantages of the implementation of advanced technologies are related to the improvement of the performance of engineering systems and equipment, the increase of productivity in comparison with the systems using classical regulators [1, 2, 3, 4]

In recent years, fuzzy logic-based controls have been used to manage many systems, including systems for managing the technological parameters of production facilities [5, 6, 7, 8, 9, 10, 11, 14, 15, 16, 17, 18, 19, 20].

The analysis of many works [5, 6, 9, 10, 11] showed that the obtained studies are related to the comparison of the results of the use of classical PID regulation with respect to CNL. CNL has been shown to have the best results in many of the indicators and practical applications studied. It is widely used in systems with complex nonlinear characteristics.

The authors of this article propose to consider a modern building with a complex of life support systems, one of which is a system for supporting the parameters of the bacterial oxidation process of gold-containing sulfide ores, as a control object.

It is proposed to perform a study of the control system of a complex object, the operation of which is characterized by many variables. Performing an object study using traditional methods of mathematical analysis has drawbacks, as it can be difficult to derive mathematical models that take into account the whole set of variables, and there are operational limitations when using traditional management methods [2, 3, 4].

Because it is difficult to find a universal mathematical model for the orientation of various types, structures, structures, technologies, and / or objects, the operation of conventional controllers is detrimental to convenience. Intelligent systems can help avoid these problems because there is no need to define a complex process model [2,3]. This fact is a common innovation in the development of automated control systems.

Due to this advantage, controllers based on fuzzy logic have been implemented in the management systems of many industrial enterprises [8, 9, 10, 11, 18, 19, 20]. In recent years, many complex manufacturing processes, including household appliances, have been successfully controlled using unclear logic [7, 8].

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METHODS AND MATERIALS

The Mamdani algorithm, based on a vague logical conclusion, avoided an excessive amount of calculations, which was highly evaluated by experts. This algorithm is now practically applied to fuzzy modeling problems [12, 13].

The approximate variable is a multiple of the form <α, X, A>, where:

α is the name of the fuzzy variable;

X is its scope;

A is a fuzzy set of universe X.

This algorithm describes several sequential steps corresponding to the process diagram of a fuzzy conclusion: rule base formation, phasification, aggregation under conditions, activation according to conclusions, accumulation of conclusions, defusion [1, 2, 3, 4].

Quantitative values are obtained at the input, output variables are formed in the output. In the intermediate stages a fuzzy logic apparatus, fuzzy set theory is used. You can manipulate known digital data while researching, but at the same time use the flexibility provided by fuzzy inference systems. An objective approach is used to implement the algorithm [1, 3, 4]. The source code is written in the Java programming language. Rules (rule) consist of conditions (Condition) conclusions (Conclusion), which in turn are vague statements (Statement).

An approximate sentence contains a linguistic variable (variable) term represented by a fuzzy set (Fuzzy Set). The membership function is defined in an ambiguous set, the value of which can be obtained using the get Value method. This method is defined in the Fuzzy Set Iface interface. The algorithm requires the use of an "activated" fuzzy set, which replaces the fuzzy set membership feature.

To successfully apply control algorithms, they must be simple enough to be implemented and understood. According to recent reports, most Japanese companies still use conventional PID controllers. In addition, algorithms must have the ability to learn, flexibility, robustness, nonlinearity. Algorithms based on unclear logic have these properties, which is why they are now widely used.

Linguistic rules create a fuzzy logical controller that is closely related to knowledge-based technologies. The development of advanced management systems using this technology requires the following steps [1, 3, 4, 5]:

- definition of the input and output of the developed control system;
- assignment of input and output variables for each membership function;
- creating a basis for vague rules;
- selection and implementation of fuzzy conclusion algorithm;
- analysis of the developed system management process.

The range of variation of a variable is divided into sets, each of which contains a function of the variable belonging to each set. Usually, membership functions have a triangular, most common form, although they can usually be any, depending on the meaning of the problem being addressed [1, 3, 4]. There is a generally accepted system for marking fuzzy sets. In order to perform the function of regulating fuzzy variables, operations must be performed on the basis of statements made by the operator in the form of fuzzy rules.

The set of approximate rules and fuzzy variables is used to implement the fuzzy conclusion, the effect on the control object. Based on studies performed under production conditions [8, 9, 10, 11], the technological process was automatically adapted to the operating temperature conditions, and the system showed the adaptive property. The ambiguous controller in the object increased the level of control automation by automating the intellectual functions of the technologist who executes the process under the conditions of use of conventional multi-channel process parameter adjustment.

The disadvantages of PID control are related to the reduction of the process flow intensity due to significant amplitude fluctuations, as well as an average 10% increase in the amount of steam while maintaining the same temperature. A control system based on a fuzzy controller with linguistic feedback and automatic change of production rules allows an average reduction in electricity consumption of 8% and energy consumption of 10% [11, 12, 13].

RESULTS

Let us examine the use of CNL in a control system to maintain microclimate parameters as a specific case of a complex of life support systems [14, 15, 16, 17, 18, 19, 20]. The main energy-intensive microclimate parameters of the life support system were chosen for the description:

- indoor ambient temperature;
- quality composition
- external disturbances (environmental impact);
- internal disturbances of the object (control parameters).

Based on the results of the research of the main parameters of the object, the authors proposed a vague system of microclimate parameter management of the control object in question. The general structure of the fuzzy bacterial leaching process parameter control system is shown in Figure 1.

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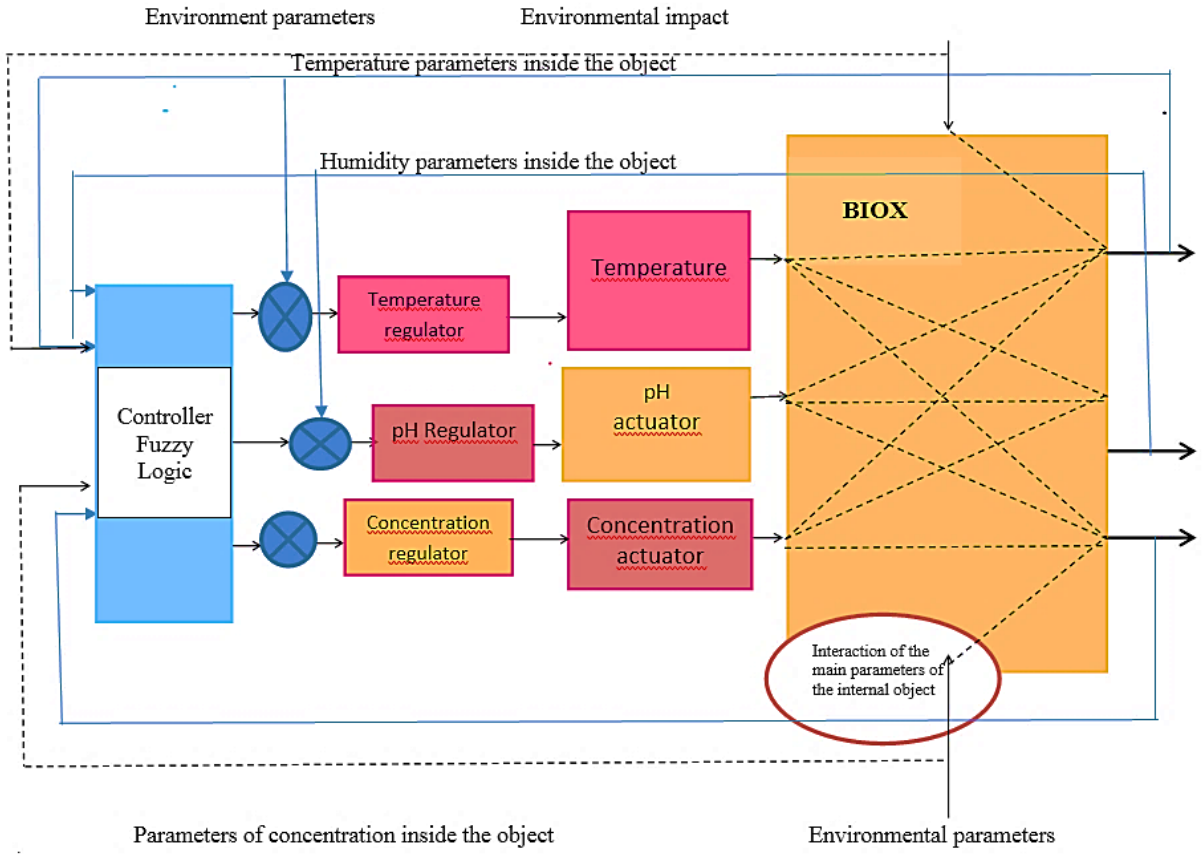

Fig. 1. Structure of the fuzzy bacterial leaching process parameter control system.

CONCLUSION

Thus, based on the review and analysis of research on the application of fuzzy logic methods, despite the existing flaws of systems related to the need to take into account the experience of an expert technologist in the construction of regulators, unclear logic lies in the foreseeable future. The use of fuzzy controllers allows: to achieve better results compared to classic controllers, allows to set the parameters of increasing economic efficiency when a fuzzy logic controller is used in an adaptive control system.

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