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Formalized description of a hierarchical organized system for managing a dynamic object

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Abstract: The issues of the formalized structure of management system based on hypergraphs are discussed in the article. The logical-graphical models proposed are intended for analysis and risk assessment at all stages of accident development; they are aimed at the subsequent use for safety management, are applicable for any types of risks and classes of chemically hazardous objects, and take into account the specifics of the source of danger - a chemically hazardous object. The relationships of the hierarchy of system elements, presented in the form of hypergraphs, make it possible to represent in the model non-elementary processes, data, and executive devices and must be specified between the process and its subprocesses, the information object and its components, and the executive device and its components. The development of a logical-graphical model created on the basis of graph theory methods is proposed as a mathematical apparatus.

Keywords: pre-emergency situation, petrochemical production, graph theory, fuzzy situation, logical-graphical model, fuzzy set.

Introduction: When automating technological processes in petrochemical enterprises, little attention is paid to the tasks of recognizing and assessing pre-emergency situations due to the complexity of their formalization and the subjectivity of perception. At existing technological processes, problems of monitoring and control of individual technological parameters, automatic signaling, and protection are generally solved by means of automatics when they reach a certain critical level. The actuation of protection systems often causes a violation of the technological regime or an emergency stop, which can lead to significant economic losses, since start-up modes at technological control objects require significant costs. Failure of protection systems can cause catastrophic aftermath. In this regard, one of the main tasks of a technological process control system of this class is to identify pre-emergency situations, predict trends in the process condition and accident prevention, and ensure the technological safety of the entire complex.

Mathematical model. The development of modern management theory, intelligent systems, and information technologies has opened up broad opportunities and prospects for managing the safety of petrochemical production. The main scientific research was aimed at creating databases for the analysis of industrial hazards and risk assessment, the use of intelligent methods for supporting decision-making in safety management, preventing the occurrence of failures and technological violations leading to emergencies, and reducing the severity of their consequences. This contributed to the development of a qualitatively new approach to managing the safety of petrochemical production using methods of situational analysis and fuzzy logic.

When monitoring the parameters of the technical condition of equipment at petrochemical enterprises, various background information about the monitored objects and reliable information about the current values of the observed parameters is required. The variety of technological parameters and their standard values significantly complicates the solution to the task and determines the creation of an information-analytical system for technological monitoring of equipment parameters, which will allow automated operation of acquisition, storing and processing of operational information to support decision-making with the timely implementation of the necessary actions to ensure technological safety of production.

The conceptual model of the management system (CMMS) for the petroleum products refining process has the following form:

$$KMCM=\langle E_s, E_p, E_m, E_c, H_e, \mathrm{Re}c, Sen\rangle\ , \qquad (1)$$

where $E_s \cup E_p \cup E_m \cup E_c$ are the systems of executive means: E_s - computing systems, E_p - information processing procedure; E_m - information storage process; E_c - data transmission process; $H_e \subseteq E_s \times (B(E_s) \cup B(E_p) \cup B(E_m) \cup B(E_c)) \cup E_p \times (B(E_p) \cup B(E_c)) \cup E_m) \times (B(E_m) \cup E_c \times (B(E_c)$ - relations of the information exchange hierarchy; $\mathrm{Re}\, c \subseteq B(E_c) \times E_s \cup B(E_c) \cup E_p \cup B(E_c) \times E_m \cup B(E_c) \times E_c$ - information switching relations between levels; $Sen \subseteq E_s \times B(E_c) \cup E_p \times B(E_c) \cup E_m \times B(E_c) \cup E_c \times B(E_c)$ - output switching relations.

Each element of the conceptual model of the petroleum products refining process corresponds to an element of the computational tools model:

$$A = \langle A_{pp}, A_{pm}, A_{om} \rangle , \quad (2)$$

where $A_{pp} \subseteq P \times (E_s \cup E_p)$ is the relation of processing to processes, $A_{pm} \subseteq P \times (E_s \cup E_m)$ - relation of storage, $A_{om} \subseteq O \times (E_s \cup E_p)$ - relation of information storage.

Hierarchy relations make it possible to represent non-elementary processes, data, executive devices in the model and must be specified between the process and its subprocesses, the information object and its components, and the executive device and its components.

To solve this problem, it is proposed to use an information and analytical system for monitoring the technological safety of equipment at petrochemical enterprises. At that, the development of a logical-graphical model created on the basis of graph theory methods is proposed as a mathematical tool.

Let us assume that each set of parameters $x_i \in X$, $X = (x_1, x_2, \Lambda , x_p)$, the values of which describe the state of the object, corresponds to linguistic variable $< x_i, T_i, D_i >$, where $T_i = \{T_1^i, T_2^i, ..., T_m^i\}$ is the term-set of linguistic variable x_i (a set of linguistic values of the feature), m_i is the number of feature values; D_i is the basic set of feature x_i. To describe terms $T_j^i (i \in L = \{1,2,...,m_i\})$ corresponding to the values of feature x_i, fuzzy variables $< T_j^i, D_i, \tilde{C}_j^i >$ are used, i.e., the value of T_j is described by fuzzy set $\tilde{C}_j^i$ in base set D_i.

$$\tilde{C}_j^i = \{< \mu_{C_j^i}(d)/d >\}, d \in D_i .$$

Then the fuzzy situations that arise during the operation of the system can be represented as a fuzzy set of the second level:

$$\tilde{S} = \{< \mu_s(x_i)/(x_i) >\}, x_i \in X ,$$

where $X = \{x_1, x_2, ..., x_p\}$ is the set of features characterizing the state of the system, and each feature $x_1 \in X$ corresponds to linguistic variable $< x_i, T_i, D_i >$.

In this case, the task of assessing technological safety and making a rational decision in various emergencies can essentially be formulated as the task of identifying and classifying fuzzy situations - $S_i \in S = \{S_1, S_2, \Lambda\ S_n\}$ and making a situational logical conclusion, i.e. comparison of the input fuzzy situation $\tilde{S}_0$ with each fuzzy situation from a certain set of typical fuzzy situations $\tilde{S} = \{\tilde{S}_1, \tilde{S}_2, ..., \tilde{S}_N\}$ and determining the optimal response alternative (sequence of actions), which transfers the system from state S_t^0 to state $S_{t'}^*$ where the set of system parameters is at the center of technological safety.

There may be elements in the model with matching names or type names. Objects of the same name in the conceptual model are treated as completely identical. The coincidence of type names indicates the identity of the implementation of such elements. In this case, for information objects, implementation identity means the use of the same data structures (set and types of components).

The logical-graphical models proposed are intended for analysis and risk assessment at all stages of accident development; they are aimed at the subsequent use for safety management, are applicable for any types of risks and classes of chemically hazardous objectsб and take into account the specifics of the source of danger - a chemically hazardous object.

Conclusions: The developed models and algorithms are implemented in the form of software packages of a universal nature, designed to solve the problem of operational analysis of operating modes of units for identifying production situations, assessing risk, and making management decisions.

References

1. Akimov V.A., Lesnykh V.V., Radaev N.N. Fundamentals of risk analysis and management in natural and man-made areas. M.: Business Express, 2004.

2. Igamberdiev Kh.Z., Marakhimov A.R., Siddikov I.Kh. Fuzzy-situational management of technological safety of petrochemical plants and complexes // Journal "Industrial Automated Control Systems and Controllers", Moscow, No. 8, pp. 3-7. 2014.

3. Siddikov I., Sherboboeva G. Hybrid Model management of Information messages in multiservice networks // The Advanced Science Journal. Volume 2014 Issue 2. pp. 38-41. 2014.

4. Siddikov I.Kh. Ganiev A.A. Development of technological modeling system for refining processes. Journal "Bulletin of TUIT: Management and Communication Technologies" Vol. 4, article 4.

5. Siddikov I.Kh. Ganiev A.A. Current state of issues of technical diagnostics of petrochemical facilities. Proc. of the Republican scientific and practical conference "Innovative technologies for processing mineral and technogenic raw materials of the chemical, metallurgical, petrochemical industries and production of building materials." Tashkent - 2022.

6. Siddikov I.Kh. Ganiev A.A. Algorithms for Diagnostics of Technological States in Petrochemical Industry. 5th International CEO Communication, Economics, Organization & Social Sciences Congress. Indonesia-2022.

7. Ganiev A.A. Fuzzy situational control of technological safety of petrochemical installations and complexes. Journal "Bulletin of TUIT: Management and Communication Technologies" 2023.Vol-1(2).