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LOGIC-GRAPHIC Model of Monitoring of Technological Statuses of Equipment of Petrochemical

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ABSTRACT:The logic-graphic model (LGM) of automated information and analytical system of technological condition monitoring of equipment of petrochemical enterprises is given in article. The principle of creation of LGM of production situations for detection and prediction of emergency operation is formulated. During creation of LGM of production situations the theory of indistinct sets and logic allowing in convenient in the computing relation, the form is offered to provide dynamics of functioning and prediction of behavior of technological aggregates of the petrochemical industry and acceptance of administrative decisions in case of different production situations and to prevent possibility of alert conditions.

KEYWORDS:Logic-graphic, analytical system, technological statuses,graphics etc.

I. INTRODUCTION

Modern requirements aimed at improving the efficiency and safety of industrial facilities management, lead, as a consequence, a sharp increase in the workload of information technology information systems (IS). The most noticeable problem situation manifests itself in monitoring problems petrochemical industry (PChI), which is relevant not only monitoring of large volumes of process parameters, but also their joint analysis derived from the original data of some analytical aggregate information needed for decision-making on management of dynamic processes, occurring in the system [1].

These features of the complex PChI are in context of the overall results of the study of complex systems, which show that with increasing complexity of the structure, the proportion of the information contained in the links of the system increases significantly

Petrochemical plants are chemically dangerous objects on the territory of which is a large number of tanks, storage tanks with gaseous and liquid hazardous chemicals and industrial pipelines for transporting them.

Monitoring the effectiveness of the process can be improved by introducing a common system of technological control IS producing analytical processing of initial information, transforming its volume and structure to the form, the optimal stage for situational analysis and decision making. This allows staff to represent the most important information in a more compact and systematically on specific manufacturing tasks.

During monitoring equipment condition parameters petrochemical plants need different background information on controlled facilities, and reliable information about the current values of monitored parameters. Variety of process parameters and their standard values significantly complicates the solution of the problem and makes the creation of information-analytical system for monitoring parameters of technological equipment that will perform the operation in the form of automated data collection, storage and processing of operational information to support decision-making in a timely manner that the necessary action to ensure technological production safety [2-14].

II. TEXT DETECTION

To solve this problem is proposed information-analytical system for monitoring technological safety equipment petrochemical enterprises. In the mathematical formalism proposed logical-graphic model created on the basis of the theory of graphs.

Logico-graphical models allow us to establish causal relationships between the initial triggering event of emergencies and their development, leading to different types of risks.

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III. EXTINPAINTING

They are presented in the form of semantic networks (or semantic graphs) or network scenarios. Vertices of a semantic network (graph) reflect some domain concepts (situation factors, etc.).

Logico-graphic model can be roughly broken down into a series of layers, each of which displays a certain stage (stage) the emergence and development of the accident or its consequences. Generalized logical-graphical model that reflects the basic levels of the accident and the connection between them is shown in figure 1.

IV.EXPERIMENTAL RESULTS

We consider it in more detail:

1. The first level reflects the causes of emergency (P_o, $o=\overline{1,O}$):manufacturing variation or breach; organizational deviation or violation; failure of control systems (O - total number of causes leading to emergency situations).

2. The second level reflects the actual emergency (S_j , $j=\overline{1,M}$ – the total number of accidents).

3. The third level represents the primary risk factors (F_i , $i=\overline{1,n}$), arising from the sale of some emergency (n - number of primary risk factors, $n \in N$; N – total number of risk factors that may occur during an accident).

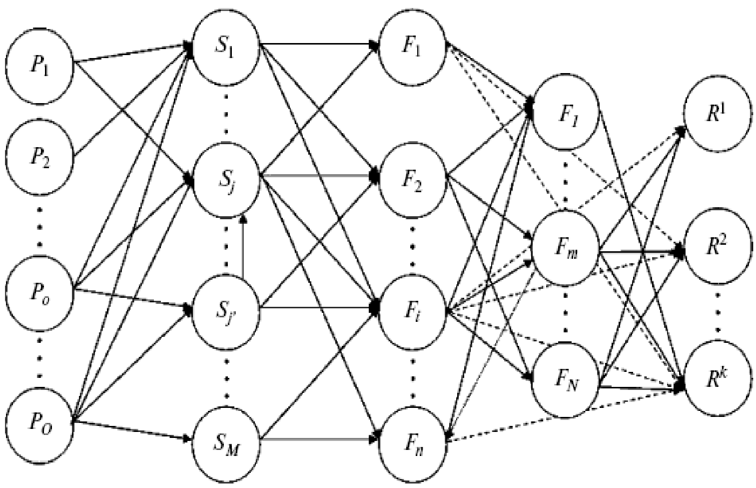

Fig.1. Generalized logical-graphic analysis model emergencies petrochemical facilities

4. The fourth level reflects the secondary risk factors (F_l, $l \in N$), arising from the sale of the primary factors (F_i), and represents a further development of the accident. It should be noted that the active layer may be absent, i.e. primary risk factors can lead directly to various types of risks.

5. Last level reflects the types of risks (R^k, $k=\overline{1,K}$, types of risks that may occur during an accident). Here, the following notation: R^1 – economic, R^2 – social and R^k– environmental risks caused by the nature of the damage.

In figure logical-graphical model is fully consistent with the appearance and characteristics of the accident on the process equipment.

Logical model of risk analysis is a set of logical expressions and statements characterizing the sequence of development of emergency events. It is formed in accordance with the logic-graphical model and is applicable for all types of emergencies.

We write the generic logic model for risk analysis. There are situations, the occurrence of which may be due to one or more different causes internal character or external cause (P_O):

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$$\exists j:(P_1 \vee P_2 \vee ... \vee P_0 ... \vee P_0) \rightarrow S_j, \quad j \in M,\ 0 \in O.$$

Some situations may lead directly to the risk factors:

$$\exists j: S_j \rightarrow F_i, \quad i \in N, \quad j \in M.$$

Some situations may lead to both risk factors and other emergencies:

$$\exists j': S_{j'} \rightarrow (F_i \vee S_j), \quad i \in N, \quad j \in M,\ j' \in M.$$

Some risk factors (F_i) can be caused by one or more emergencies:

$$\exists j:(S_1 \vee ... \vee S_j \vee ... \vee S_{j'}) \rightarrow F_i, \quad i \in N,\ (i=2),\ j' \in M,\ j \in M.$$

$$\exists i:[(S_1 \wedge S_j) \vee ... \vee (S_{j'} \wedge S_M)] \rightarrow F_i, \quad i \in N, \quad j' \in M,\ j \in M.$$

The same risk factor can be invoked as an emergency (i.e. a factor of primary level) and other factors (i.e., be a secondary factor):

$$\exists j: \exists m:(S_j \vee F_m) \rightarrow)F_n,\ n \in N,\ m \in M,\ j \in M.$$

Some risk factors (F_i) can lead to other risk factors (F_l) at any level of the accident:

$$\exists i: \exists l: F_i F_l, i \in N, l \in N.$$

Some risk factors can lead to other (l-м, m-м) the risk factors or social one (R^2) or more social risk (R^2) and ecological (R^k) types of risk:

$$\exists i: \exists l: \exists m: F_i \rightarrow (F_l \vee F_m \vee R^2 \vee (R^2 \vee R^k)),$$
$$i \in N,\ l \in N,\ m \in N,\ k \in K.$$

Some risk factors are at the following levels of the accident may lead to other risk factors (F_l) or all of the k-th types of risks:

$$\exists i: \exists l: F_i \rightarrow (F_l \vee (R^l \wedge R^2 \wedge R^k)),\ i \in N,\ l \in N,\ k \in K.$$

Certain risk factors can lead directly to all types of risk:

$$\exists m: F_m \rightarrow (R^l \wedge R^2 \wedge R^k),\ m \in N,\ k \in K.$$

Thus, the risk of the k-th type (social or ecological) in the development of an accident with less severe consequences can be caused by one of the risk factors:

$$\exists n: k: F_n \rightarrow R^k, n \in N,\ k \in K.$$

Risk k-th species (economic, social, ecological) for further development of the accident can be caused by one of the risk factors that are not directly leads to the risk and lead to its further development:

$$\exists n: k:(F_n \rightarrow R^k) \rightarrow (F_i \rightarrow F_l) \rightarrow (F_l \rightarrow R^k), i \in N,\ l \in N, \quad k \in K.$$

Thus the risk of occurrence of at least one kind of the j-th emergency i'- th at the level of development is expressed as follows:

$$(R^1_{ji'} \vee R^2_{ji'} \vee ... \vee R^k_{ji'}) \rightarrow R_{ji'}, \quad k = \overline{1, K}, \quad j \in M,\ i' \in I',$$

whereI'- the total number of levels of the accident.

Emerging risks of all kinds from the j-th emergency at i'- th level of development are determined by the ratio:

$$(R^1_{ji'} \wedge R^2_{ji'} \wedge ... \wedge R^k_{ji'}) \rightarrow R_{ji'}, \quad k = \overline{1, K}, \quad j \in M,\ i' \in I',$$

In the risk of at least one kind of an accident at a petrochemical facility can be described by the expression:

$$(R^1 \vee R^2 \vee ... \vee R^k) \rightarrow R, \quad k \in K.$$

All types of risk arising from the accident:

$$(R^1 \wedge R^2 \wedge ... \wedge R^k) \rightarrow R, \quad k = \overline{1, K}.$$

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Previous relations represent a common logical model of risk analysis in petrochemical facilities with multi-level scenarios and development of accident.

In accordance with the discussion of the logical model of risk analysis formed probabilistic risk assessment model.

The likelihood of an emergency (P_j) from one of the reasons determined by the ratio:

$$\exists j : P_j = 1 - \prod_{o=1}^{0} (1 - P_{oj}), \quad j \in M ,$$

whereP_{oj} - the probability of the j-th of emergency o-th reasons.

Are not given here designations the probability of occurrence and development of events at all levels of the accident (situations, factors, risks, etc.).

Risk k-th species from the j-th situation on i'-th level of its development on g-th scenario is defined:

$$R_{jigi'}^{k} = P_j F_{jig} \prod_{i'=1}^{l} E_{jigi'}^{k}, \quad j \in M, \, k \in K, \, i \in N, g \in G ,$$

where I'- the actual number of levels of the accident from the j-th situation i-th risk factor for g-th scenario, F_{jig} - the probability of the i-th risk factor of the j-th emergency by g-th scenario of the accident - the probability that the i-th risk factor of the j-th emergency by g-th scenario of the accident at i'-th level will lead to the k-th type of risk, G - the total number of accident scenarios. If part of the g-th scenario, the i-th factor leads to the l-th factor, not at the next level of the accident, then all missing levels accepted $E_{jigi'}^{k} = 1$.

The values of probabilities of occurrence of some of the intermediate events are defined (F_{jig}):

$$F_{jig} = 1 - \sum_{g'=1}^{G-1} F_{jig'}, \quad g' \neq g, \;\; g \in G, \;\; g' \in G ,$$

whereg'- scenario accident, characterized by g-th scenario, which can be a part of the i-th risk factor of j-th situation.
The probability of occurrence of k-risk type of i-th factor, which may result directly from any j-th situation scenario g-th defined by the formula:

$$R_i^k = \sum_{j=1}^{M} P_j F_{jig} \prod_{i'=1}^{I'} E_{jii'g'}^{k}, \; i \in N, \; k = \overline{1, K}, \quad g \in G .$$

The likelihood that the risk k-th species arise from the j-th situation on i'-th level of at least one factor i for one of the scenarios of the accident is determined g:

$$R_{ji'}^{k} = 1 - \prod_{g=1}^{G'} (1 - R_{jigi'}^{k}), \; G' \in G, \; k = \overline{1, K}, \quad i' \in I' ,$$

whereG'- the number of scenarios that lead to the k-th type of risk on i'-th level of the accident.

The likelihood that the risk of at least one species is the result of the j-th emergency at i'-th level of development is determined:

$$R_{ji'} = 1 - \prod_{k=1}^{K} (1 - R_{ji'}^{k}) .$$

With this approach, the probability of the risk of at least one kind of an accident at a petrochemical facility (R) is defined similarly:

$$R = 1 - \prod_{k=1}^{K} (1 - R) .$$

Unlike known proposed logical-graphical models are designed for risk analysis and assessment at all stages of the accident, aimed at their subsequent use for security management, applicable to all types of risks and classes of petrochemical facilities and consider the specifics of the hazard characteristic of petrochemical facilities.

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V.CONCLUSION

Application of information-analytical system for monitoring technological aggregates states petrochemical industries developed on the basis of the above techniques using algorithms regularized adaptive filtering allows you to analyze various production situations and predict the appearance of emergency modes of technological units. These rules became the basis for the creation of algorithmic support information-analytical system technology security PChI.

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