Logic-sense model of primary oil processing plant safety assurance

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Abstract. Safety of oil refining processes, their further technical improvement depend on how soon effective methods of information processing will be found, generalized schemes of reflection of the main dangers of these processes. Modeling of oil refining processes takes an important place in the study of safety issues. The results obtained are the basis for the subsequent systematization of the conditions for the occurrence of accidents and the systematic synthesis of measures to prevent and (or) localize them, eliminate the consequences (in case of occurrence) and reduce possible damage. The proposed model gives a clear idea to the production personnel of the main risks of the primary oil processing process, the consequences of accidents and the main directions of reduction of the plant risk.

1. Introduction
An important place in modelling is the ability of people to build relevant hypotheses and use analogy [1-3]. The first concept is often defined as a prediction or assumed judgment based on some experimental data, observations, and guesses. While analogy generally refers to the notion of any particular similarity, such similarity may be both essential and non-essential, depending on the level of abstraction determined by the ultimate goal of the study. Hypotheses and similarities, which to a certain extent reflect a real, objectively existing world, should have clarity or be reduced to human-friendly logical schemes [1, 3-6]. This is why models also consider some images or logic schemes that simplify reasoning and logical constructions or allow for experiments that clarify people 's perceptions of the world around them. In other words, the model usually plays the role of sort of some substitute for a real object and is used to study it. In this way, the following definitions are formulated.

Model - there is a material or mentally represented object, which in the process of knowledge (study, recognition) replaces the original object, preserving some of its typical (basic) features important to this researcher [7]. Modeling is the process of building and using a model [8-10].

In our opinion, the didactic multidimensional tools developed by V. E. Steinberg - logical-sense models (LSM), for the representation of knowledge in natural language, which allow to combine figurative and conceptual forms of representation of knowledge, are of considerable interest. Models of this type differ from other visual means in nature and "all-round" universality, complement known poorly instrumented methods of training, including recognition. The functionality of such models has led to their wide application in pedagogical and scientific practice, and work on this issue is found in philosophy, informatics and medicine [11-13].
2. Experimental procedures
The use of a system analysis technique based on reference-node matrix systems can be illustrated by a system analysis of EDP-AVT-6 installation security problems.

Designing of models includes:

I The study object is placed in the center of the future coordinate system (conditional focus). In this case, it is EDP-AVT-6 crude unit.

II Formation of sense groups is carried out on the basis of risk analysis:
- the safety of the installation depends to a large extent on the peculiarities of the equipment used. Taking into account the factors determining the actual state of safety of each set, the danger groups of the sets are identified;
- each oil refining plant consists of certain devices typical for this process;
- equipment failures resulting from loss of their operability lead to unplanned shutdowns of process plants, and in some cases cause development of emergency situations;
- assessment of accident consequences;
- development of recommendations for risk reduction.

III A set of coordinates (range of problems) is defined to ensure the safety of the crude unit, which include the meaning groups discussed above.

IV The set of reference nodes - "sense granules" for each coordinate is determined by logical or expert (intuitive) identification of node, main elements of content, key factors for the solved problem. Reference nodes are ranked and arranged on coordinates, the sense connection between which forms a future theme.

1. There are proposed 3 groups of apparatus hazards:
   - 1 hazard group - particularly dangerous;
   - 2 hazard group - medium hazards;
   - 3 hazard group - low-hazard.

2. Crude oil processing plant consists of the following devices: columns, furnaces, heat exchangers, tanks, pumps of electric separators, electric dehydrators.
3. Given the significant wear and tear of the equipment, the main direction of ensuring its safety is to determine possible defects leading to complete depressurization.
4. Oil release is the most common emergency event.
5. In the general evaluation of the risk of product expiration from the plant, note the ambiguity and inconsistency of the source information on the repeatability of the source events. This is reflected primarily in the fact that from all available risk assessments its upper limit - integrated risk - is a comprehensive safety indicator expressed in a single value equivalent.
   Integrated risk includes the following types of risks: risk of social harm, risk of material damage, risk of environmental damage.
6. The main methods of risk reduction are: compatibility of raw materials and reagents with structural materials of equipment; timely diagnostics and repair of equipment, regardless of the hazard group of the devices; control of oil group composition; reduction of energy potential of technological units; training of personnel; timely replacement of obsolete equipment.
V New information is generated by detecting links of nodes of the first coordinate with nodes of the second coordinate by means of meaning communication operators. Space between two coordinates forms inter-coordinate support-node matrix.

3. The results of studies and their discussion

The logic-sense model for ensuring the safety of the crude oil processing plant EDP-AVT-6 is shown in figure 1.

**Figure 1.** Logic-sense model for ensuring the safety.

The K-1 coordinate displays the danger groups of the sets.

On the K-2 coordinate, note the main devices of EDP-AVT-6 plant: heat exchangers (HE, AC), columns (K1-K11), furnaces (F-1,2,3), tanks (T), electric dehydrators (ED), electric separators (ES).

The inter-coordinate matrix K1-K2 defines the hazard group for an apparatus.

The K-3 coordinate contains the factors (specific to this installation) required to build the fault tree. The principle of fault tree construction for all presented sets is the same.
The inter-coordinate matrix K2-K3 shows what defects are characteristic of crude unit devices leading to depressurization.

The K-4 coordinate shows the typical event tree to be built for each set when analyzing the risk of a given process plant. It should be noted that in order to develop any scenario of accident development it is necessary to know how dangerous substance is distributed by equipment, to know the number of equipment in units, the number of units of the installation. Then tables of fire or explosion frequency are drawn up.

K3-K4 - the result of complete depressurization of the apparatus is oil release.

K-5 coordinate. After the construction of the event tree, an assessment of the integrated risk of social, material and environmental damage caused by the accident at the plant is carried out.

The inter-coordinate matrix K4-K5 shows possible damage from oil emissions.

K-6 coordinate allows you to select the most appropriate risk reduction methods.

The inter-coordinate matrix K5-K6 shows that it is necessary to use to reduce social, material and environmental damage of the accident at the primary oil processing plant.

From the inter-coordinate K6-K-1 matrix, it can be concluded that the risk reduction measures for devices of any hazard group are the same.

4. Conclusions
The use of a logic-sense model to ensure the safety of the crude unit allows the integration of: installation devices, characteristic defects of devices, tree of refusals, emergency development tree, damage from the accident, risk reduction measures.

The main methods of risk reduction are: compatibility of raw materials and reagents with structural materials of equipment; timely diagnostics and repair of equipment, regardless of the hazard group of the devices; control of oil group composition; reduction of energy potential of technological units; training of personnel; timely replacement of obsolete equipment.

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