Development of a process safety management system for the acetylene production process by oxidative pyrolysis natural gas

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Abstract

The efficiency of modern chemical production largely depends on compliance with the requirements for ensuring the safety and efficiency of the functioning of chemical technological processes, in connection with which there is a need to develop new approaches to the diagnosis of conditions and safety management of chemical technological systems based on the use of modern information technologies and intellectual means decision support.

The relevance of the work

For the majority of potentially hazardous chemical industries, the tasks of determining states for the purpose of ensuring safety in various situations arising in the technological cycle are especially relevant. This paper considers the process of acetylene production by oxidative pyrolysis of natural gas, which is characterized by increased explosiveness and fire hazard, for which an increase in the efficiency of its functioning is inextricably linked with the mandatory provision of its technological safety.

The aim of the work is to study and develop the main theoretical and applied approaches to the creation of a system for managing the technological safety of the acetylene production process under conditions of uncertainty.

Tasks solved in the dissertation work:

- Based on the analysis of modern approaches to decision-making when managing a complex dynamic object in conditions of uncertainty, develop a functional structure and decision-making algorithms for the system based on the definition of a security center and a security area.

- Justify the use of mathematical models of continuous chemical-technological processes to assess the state of the control object in conditions of uncertainty and incompleteness of information. To develop a system for estimating

the parameters of the model using the apparatus of fuzzy logic. Check the adequacy of the developed model.

- To develop an algorithm for diagnosing and managing the technological safety of the acetylene production process and to test the developed control system using the example of an adaptive situational process control system using a fuzzy logic apparatus.

Scientific novelty:

- An algorithm for analyzing the state of the system based on the use of mathematical models of continuous chemical-technological processes has been developed.

- A method for constructing the structure of a situational model for managing the safety of a chemical-technological process was developed using the example of the acetylene production process

- Proposed and investigated a control system for the oxidative pyrolysis process based on the definition of the area of safety and the center of safety.

- A method for constructing diagnostic models of the development of hazards based on the method of separation of states has been proposed and theoretically substantiated.

Practical significance:

- A methodology for calculating the technological safety center of the acetylene production process using nonlinear programming has been developed.

- The algorithmic and software support of the system for assessing the states and making decisions on the management of the technological safety of the oxidative pyrolysis process has been developed.

- An algorithm for the dynamic correction of regulators' tasks during the functioning of the acetylene production process using a fuzzy logic apparatus is proposed.

The main provisions for the defense:

– Mathematical model of the oxidative pyrolysis reactor, built on the basis of mathematical models of continuous chemical-technological process.

– A two-level control system for the oxidative pyrolysis process based on the use of a fuzzy logic apparatus.
– A software package that allows you to calculate the best technological modes of conducting a chemical-technological process.
– The structure and operation algorithm of the upper level of the automated process control system.