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УПРАВЛЕНИЕ ТЕХНОЛОГИЧЕСКИМ ПРОЦЕССОМ ФРАКЦИОНИРОВАНИЯ НЕСТАБИЛЬНОГО ГАЗОВОГО БЕНЗИНА

CONTROL FOR THE TECHNOLOGICAL PROCESS OF UNSTABLE GAS BENZINE FRACTIONATION

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Аннотация. Наряду с развитием нефтяной промышленности в развитых экономиках многих стран быстрыми темпами развивается и газовая промышленность. Одним из важнейших вопросов в газовой промышленности является технологический процесс переработки газа. Качественные показатели продукции, получаемой в результате переработки газа, позволяют повысить энергоэффективность всего производства в целом. Одним из продуктов, получаемых в результате переработки газа, является нестабильный газовый бензин. Предлагаемая статья посвящена проблеме оптимального управления фракционированием нестабильного газового бензина, в дальнейшем, с целью выделения стабильного газового конденсата и его переработки. Для этого необходима разработка автоматизированной системы управления процессом фракционирования нестабильного газового бензина и подготовка предложений и рекомендаций по ее развитию на основе теоретических и научных основ.

Ключевые слова: переработка газа, газовый бензин, технологическая установка, стабильный бензин, очистка газа, природный газ.

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Annotation. Along with the development of the oil industry in the developed countries' economies, the gas industry is also growing rapidly. One of the most important issues in the gas industry is the technological process of gas processing. The quality product indicators obtained as a result of gas processing allow for increasing the energy efficiency of the entire production as a whole. One of the products obtained as a gas processing result is unstable gas benzine. The proposed article is devoted to the optimal control problem of the unstable gas benzine fractionation, in the future, to separate stable gas condensate and process it. This requires the development of an automated control system for the technological process of fractionation of unstable natural gasoline and the preparation of proposals and recommendations for its development based on theoretical and scientific foundations.

Keywords: gas processing, gas benzine, technological installation, stable benzine, gas purification, natural gas.

At present, gas resources occupy an important place among the natural energy oil and gas-bearing countries' resources. As the demand for natural gas in industry and everyday life grows, so does the demand for its production, transportation, and processing [1–5]. Hydrocarbon natural gases are widely used in industry and everyday life, and various products are made from them. Natural gases undergo a primary processing stage and are also dried and purified before being fed into main pipelines. Natural gases contain sulfur dioxide, methane, butane, propane, and heavy hydrocarbons such as helium, argon, and so on. It consists of mixtures of chemicals and water vapor. The most dangerous of these mixtures is a mixture of sulfur dioxide and water vapor, which is very harmful use. During the production process, the above gas mixtures are purified and put into operation in various ways.

Gas processing processes are divided into two groups as follows.

1. Auxiliary processes. These are processes of cleaning natural and associated gases from impurities and separating water vapor and sulfur dioxide.

2. Main processes. In this process, the separation of individual hydrocarbon fractions and acidic components in gases occurs.

The change in the product quality obtained as a result of gas processing depends on the change in the composition of the raw materials supplied to the technological installations. The change in the raw materials composition depends on the density and humidity of the heavy natural gas fractions, depending on the temperature and pressure of the formation layers. In natural gases, an increase in temperature leads to an increase in humidity, and an increase in pressure, in turn, leads to a decrease in humidity.

One of the types of gas processing installations in the industry is a unit for separating unstable gas benzine into fractions, and the separated fractions are determined by quality class. Regulation of the stabilization column at the installation for fractionating unstable gas and benzine is complicated by the high thermal process inertia occurring in it. When regulating the process in the stabilization column, any changes in the mode are propagated from plate to plate, and equilibrium is restored after a very long time.

In production, mechanical and electrical gas cleaning methods are used to clean gas from solid and liquid impurities, and physical and chemical methods are used to clean gas from gas impurities. When using gases as fuel, they often do not need to be completely dried, but only partially cleaned from water vapor in order to prevent restriction of the gas flow in main pipelines.

At present, new modern automation and control systems are of great importance, applied at enterprises with high efficiency rates and gas processing technologies that meet the modern era requirements [6–8].

One of the main stages of natural and associated gas processing is the fractionation process of gas condensate and unstable gas benzine. The raw materials in this technological process are gas condensate and an unstable gas-benzine mixture. At present, the Gas Processing Plant is to modernize the control systems. We are faced with the integrated control problem of the automatic control system in the installations. When solving this problem, the following issues arise:

– the accuracy of the used control and measuring devices and other automation equipment is lower than necessary;
– frequent delays occurrence in the automatic control loops;
– low compressed air quality supplied to the pneumatic system.

Based on all the listed problems, it can be said that it is impossible to solve the above problem using the local control and measuring devices and automation equipment that are part of the current old pneumatic automatic system, i.e. to simultaneously carry out measurements and create an optimal control system and operational control for the fractionation process of unstable gas benzine.

To maintain and implement minimum losses and efficiency indicators in these technological processes, automation equipment is used that meets international requirements, as well as has a high accuracy class and short response time. Statistical data are collected and, based on them, a mathematical model of the process is built and the optimization problem is solved.

When developing the data display program in the control system, a standard software package offered by Honeywell was used. The system is adapted only to the program used for data entry. Standard software is used for this purpose. With the implementation of the Experion PKS control system in the industry, there is no longer a need for devices operating through hundreds of pneumatic automatic elements, small-diameter copper pipes, and thousands of cable meters. It was this system implementation in production that ensured reliable and stable equipment operation, an increase in the products number obtained, and an improvement in their quality. At the highest level, this system solves problems that require very precise calculations.

The advantages of measuring devices used in modern technologies are that they have high accuracy classes, an output signal of 4÷20 mA, or a digital output signal. The more modern automation and control systems are used in industry, the less will be the need for additional control and measuring devices, additional materials, and automation equipment.

Let us analyze the technological fractionation process of unstable gas benzine. Gas processing can be divided into two groups:

1. Primary processing. The extracting process various fractions of petroleum gases and natural gases.

2. Secondary processing. The process of obtaining various fractions from gas mixtures. Several examples of such refining can be given: obtaining motor fuel from condensate, obtaining propane-butane from unstable gas benzine, the pyrolysis process, etc.

Gas processing plants have their characteristics. During gas refining, the density, and in some cases the pressure and temperature of the raw material entering the installations change. This change is associated with the egas field exploitation. One of the technological processes for processing natural and associated gases is the unstable gas benzine fractionation installation. Unstable benzine is processed in this installation and 2 products are obtained:

1) liquefied hydrocarbon fuel gases (technical butane, technical propane-butane mixture). Such gases are flammable, colorless and liquid. When in contact with human skin, these gases cause frostbite, have a narcotic and other negative effects on humans.

2) benzine (naphtha). This substance is liquid, flammable, colorless and transparent. Its vapors have a narcotic effect on humans and disrupt the functioning of their nervous system.

The automated control system for fractionation of unstable gas benzine is shown in Figure 1. On the scheme, a flow meter is installed at position FE-1 to measure the consumption of unstable gas benzine supplied to the tubular part of the heat exchanger. The unstable gas benzine pressure is measured by a pressure gauge installed at position PE-2. In the heater, unstable gas benzine is heated, the temperature of which is monitored by a measuring device installed at position TE-3 and supplied to the 20th plate of the stabilization column. To monitor the temperature, a temperature sensor, related to position TE-4, is installed on the 40th stabilization column plate. The liquefied gas vapors obtained in the column upper part are fed to the condenser-cooler. In the condenser-cooler, the liquefied gas vapors are cooled and sent to the storage tank. To monitor the product pressure stored in the tank, a pressure sensor is installed at position PE-6, and a regulating valve is installed at position PCV2 to maintain the pressure within the specified range. Part of the product collected in the tank is fed to the stabilization column top for irrigation, and the regulating valve at position TCV1 is used to maintain the temperature within the specified limit at position TE-4. The level of the liquefied gas product in the tank is measured by a sensor installed at position LT-7, and a regulating valve LCV3 is installed to maintain the level within the specified limits. The liquefied gas consumption is measured by a flow meter installed at position FE-8 and is collected in the cargo park vats. To monitor the product pressure stored in the tank, a pressure sensor is installed at position PE-6, and a regulating valve is installed at position PCV2 to maintain the pressure within the specified range. Part of the product collected in the tank is fed to the stabilization column top for irrigation, and the regulating valve at position TCV1 is used to maintain the temperature within the specified limit at position TE-4. The level of the liquefied gas product in the tank is measured by a sensor installed at position LT-7, and a regulating valve LCV3 is installed to maintain the level within the specified limits.

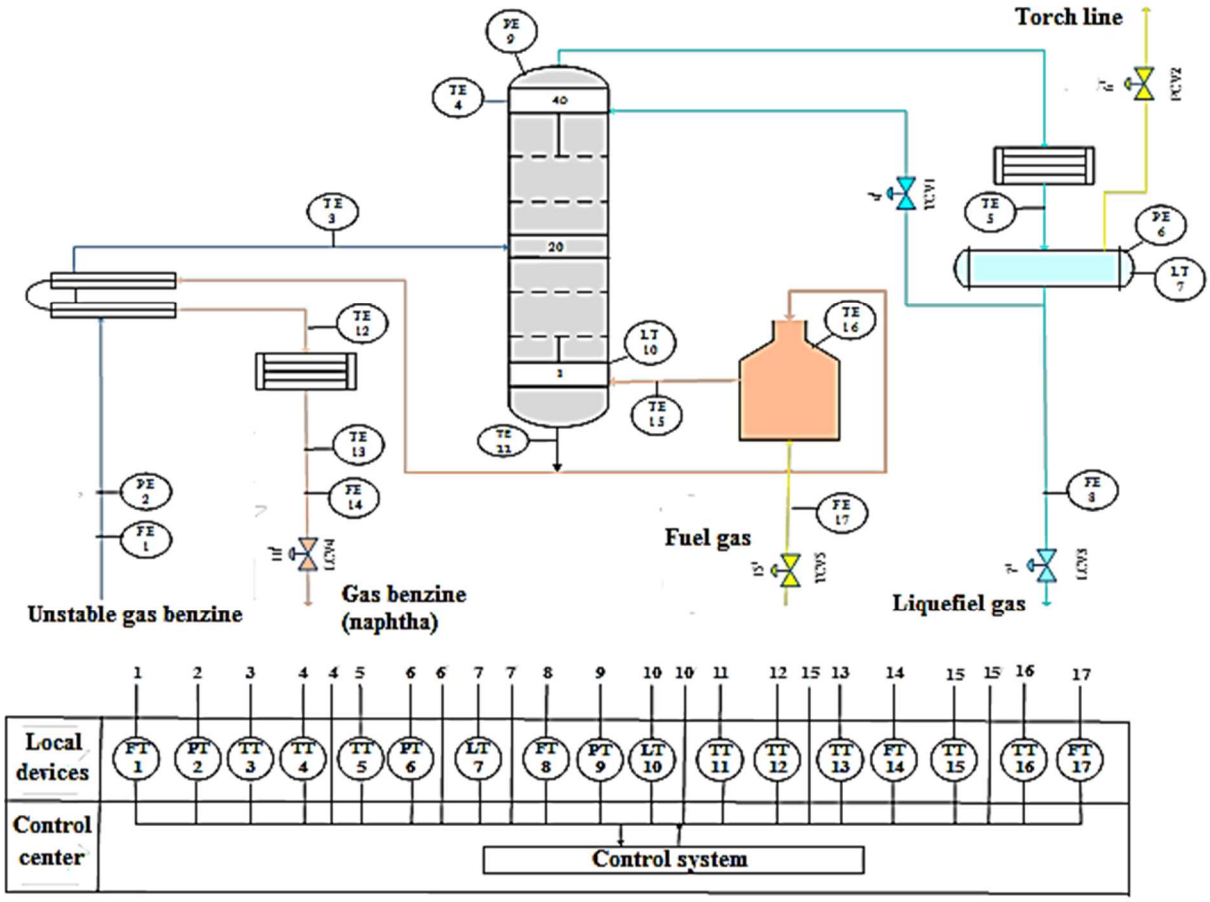

Figure 1 – Automated control system for fractionation of unstable gas benzine

The level of the liquefied gas product in the tank is measured by a sensor installed at position LT-7, and a regulating valve LCV3 is installed to maintain the level within the specified limits. The liquefied gas consumption is measured by a flow meter installed at position FE-8 and is collected in the cargo park vats. To the pressure in the stabilizing column, a pressure sensor is installed at position PE-9. The level of the gas-benzine product settled at the column bottom is controlled by a level sensor installed at position LT-10. To maintain the level in the storage tank within the limits established in accordance with the process mode, a regulat-

ing valve LCV4 is installed on the pipeline pumping the product from the tank bottom to the intermediate park. The naphtha temperature product taken from the column bottom is controlled by a measuring device installed at position TE-11, and some of the product passes through the intertube heat exchanger space, is again monitored by a temperature sensor at position TE-12 and is transferred to the condenser-cooler. In the condenser-cooler, the naphtha is cooled to a specified temperature and collected in the storage tanks of the intermediate park. The cooled gas-benzine temperature is monitored by a thermometer installed at position TE-13. The amount of benzine produced is controlled by a flow meter installed at position FE-14. Part of the gas-benzine product taken from the bottom of the stabilization column is fed to flameless heating furnaces using a pump. The gas fuel temperature in the furnace is heated to a specified value and is monitored by a thermometer installed in position TE-15. The heated gas-benzine enters the 1st stabilization column plate. To determine the fuel gas consumption fed to the furnace, a flow meter is installed in position FE-17. A TCV5 regulating valve is installed on the fuel pipeline to maintain the heated gas temperature at the furnace outlet (in position TE-15) within the limits established in accordance with the process mode. The furnace outlet temperature is monitored by a measuring device installed in position TE-16.

Thus, the investigated technological fractionation process of unstable gas benzine is physically justified. The main technological apparatuses of the considered process have been selected. An automated control system has been developed to maintain the mode parameters in the restrictive conditions established by the regulations. The development of such a control system results in obtaining a target product of higher quality.

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