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АВТОМАТИЗИРОВАННАЯ СИСТЕМА УПРАВЛЕНИЯ ВАКУУМНОЙ ПЕРЕГОНКОЙ МАЗУТА
AUTOMATED CONTROL SYSTEM FOR VACUUM DISTILLATION OF MAZUT

Аннотация: В настоящее время, в связи с высокими темпами роста спроса на топливно-энергетические ресурсы во всем мире, на существующих нефтеперерабатывающих заводах, увеличение глубины переработки на предприятиях, осуществляющих первичную переработку нефти, улучшение количественных и качественных показателей получаемых целевых продуктов, повышение эффективности их производства путем снижения затрат на переработку энергоресурсов очень значимо и важно. В последние годы в нефтеперерабатывающей промышленности республики реализуются крупные проекты, как по моделированию старых технологических установок, так и по вводу в эксплуатацию совершенно новых установок, имеющих больше экономических преимуществ. Одним из главных гарантов экономической эффективности новых технологических установок, применяемых в нефтеперерабатывающей промышленности, являются применяемые в них современные системы автоматизации и управления.

Abstract: At present, due to the high growth rates of demand for fuel and energy resources throughout the world, at existing oil refineries, increasing the processing depth at enterprises engaged in primary oil refining, improving the quantitative and qualitative indicators of the resulting target products, increasing the efficiency of their production by reducing the processing costs energy resources is significant. The global oil refining industry has recently implemented major projects to model old process installations and commission new installations with greater economic advantages. The modern automation and control systems used in new technological installations in the oil refining industry are among the main guarantors of their economic efficiency.

Ключевые слова: система управления, оптимальное управление, технологический процесс, первичная переработка, мазут, переработка нефти, ректификационная колонна.

Keywords: control system, optimal control, technological process, primary processing, mazut, oil refining, rectification column.

The presented article examines the issues of developing an automated control system for processes occurring in the atmospheric-vacuum section, which carries out primary oil refining, which is very important and relevant, that is, in the production of commodity petroleum products, it is necessary to implement such measures so that their quality indicators meet established international standards [1-9].

After the benzine-free oil enters the K-2 atmospheric column as raw material, it is split into several fractions (benzine, kerosene, diesel fuel and mazut). One of the main fractions obtained from the decomposition process in the K-2 atmospheric column is mazut. Pump N-2, which receives mazut from the lower part of the atmospheric column K-2, feeds it into furnace S-3. Mazut, heated to a temperature of 375÷390°C in furnace S-3, enters the lower part of the vacuum column K-10. Steam is also fed into column K-10.

Mazut is a residue from the primary oil refining process. Light mazut or mazut with low density (> 330°C) can be used as boiler fuel, while heavy mazut or mazut with high density (> 360°C) can be used as feedstock for subsequent processing of fatty fractions to tar. Currently, mazut can be used as feedstock in catalytic cracking or hydrocracking installations.

The mazut composition from the atmospheric column to the vacuum section is regulated by the content of boiling fractions up to 350°C. Traditionally, the light fractions' content should not exceed 5% of the mass since their growth increases the diameter of the vacuum column, prevents (hinders) complete vapor condensation on the upper part of the column, and increases the load on the vacuum creation system. The light fractions composition in mazut is determined by the fractional composition (i.e. boiling point) of diesel fuel produced in the atmospheric column.

Fuel oil is the fraction, constituting about 50% of oil, remaining after the atmospheric distillation process. It is used as a fuel in power engineering, metallurgy, and boiler houses. It is a residual, liquid, dark brown product obtained from crude oil or oil refining products after separating the fractions of benzine, kerosene, and gas oil, which is an organic compounds mixture (V, Ni, Fe, Mg, Na, Ca) containing carbohydrates, petroleum resins, asphalts, carbohydrates, carboys, and metals. The properties of fuel oil depend on the chemical composition of the original oil and the degree of distillation of the distillate fractions. Its main consumers are industrial housing and communal services. The mazut properties depend on the chemical composition of the source oil and the degree of distillate fractions distillation. Its main consumers are industrial housing and communal services.

Using various compositions and physical and chemical properties of the source substance, it is possible to produce mazut with various properties. Depending on the density, viscosity, and amount of sulfur in the mazut, its main quality indicators are assessed. Its density is determined at a temperature of 20°C and should be 0.89 g/sm3.

An equally important technological parameter for assessing the mazut quality is the freezing point, which fluctuates between 10°C and 50°C, but the exception is heavy mazut (solid residual fuel) with a temperature limit used in ships from -5°C to -10°C. The mazut viscosity should be from 8 mm2/sec to 80 mm2/sec and measured at a temperature of 100°C. It affects the fuel loading duration operations, the transportation efficiency through pipelines, the quality of mazut powder and its combustion completeness, its ability to protect water in it, etc.

The sulfur content of mazut should be between 0.5% and 3.5%. Due to the operational mazut properties, such as low ash content (less than 0.3%) and high thermal conductivity, the desired temperatures can be achieved with very low raw materials consumption. Since the oil quality (density) entering the installation often changes, the mazut amount in the K-2 column also often changes. Thus, as an experiment result conducted on the considered technological installation, it was established that the density of the processed oil changes in a wide range. In connection with this, the total potential of light oil products also changes in a wide range. In such a case, there is a deficit in the mazut amount supplied to the S-3 furnace and the existing automatic control system cannot regulate the stability of the mazut amount supplied to the furnace when the oil quality changes. The operating principle of the presented automated control system is as follows (Figure 1).

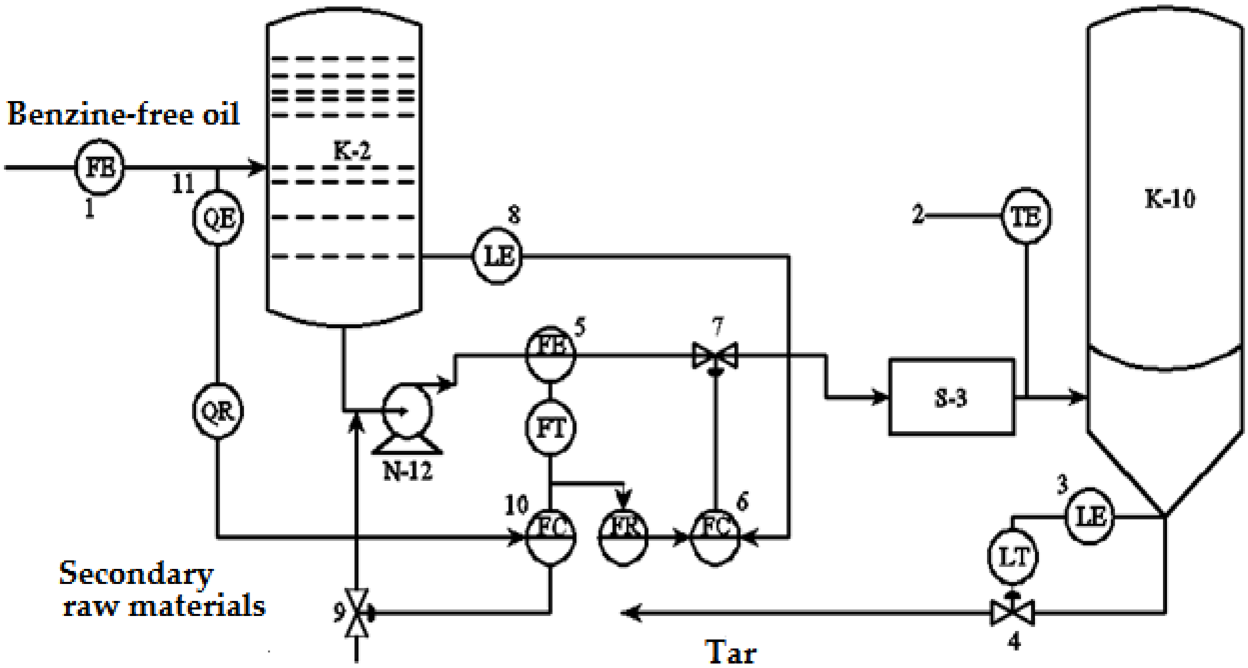

Figure 1. Schematic diagram of the automated control system for mazut supplied to the vacuum distillation

The signal from flow meter 5, installed on the mazut line, fed to the furnace S-3 from the pump N-2, is sent to controller 6. The regulatory force arising from regulator output 6 is sent to regulating valve 7. The output signal of level sensor 8, installed below the K-2 column, is sent as a correction signal to regulator 6. The amount of the secondary raw material mazut supplied to the input of pump N-2 from the liquid fuel (mazut) tanks of the technological installation is regulated using the regulating valve 9 installed on this line. This valve is controlled only by the force of the control action coming from the regulator 10 output. Regulator 10 includes the current value from flow meter 5. The output signal from the analyzer 11 installed on the benzine-free oil line entering the K-2 column enters the regulator 10 as a correction signal. In this case, regulator 10 changes the regulating valve position 9 in such a way that when the density of the benzine-free oil decreases, the additional mazut consumption increases or vice versa. This ensures a stable flow of mazut entering the furnace S-3 and column K-10.

The introduction into production of the proposed automated control system for mazut from stripped crude stabilizes the mazut consumption supplied to the K-10 vacuum column in accordance with the specified value. At the same time, the developed control system changes the flow rate of mazut supplied to the input of pump N-2 as secondary raw material, depending on the mazut density entering the vacuum column K-2 and the mazut level accumulated in the lower column part, and also reduces the possibility of coking and furnace pipes combustion. In addition, in the atmospheric column K-2, the vacuum column K-10, and in the furnace S-3, stable maintenance of optimal technological parameters of the modes is ensured in accordance with the existing regulations.

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