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АНАЛИЗ ФУНКЦИОНИРОВАНИЯ ДОЖИМНОЙ НАСОСНОЙ СТАНЦИИ С ПОСЛЕДУЮЩЕЙ РАЗРАБОТКОЙ СИСТЕМЫ ЕЕ АВТОМАТИЗАЦИИ

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Аннотация

В данной статье приводится описание существующей системы работы дожимной насосной станции (ДНС), поднимается вопрос важности данной установки на современных производствах нефтедобычи и нефтепереработки, а также необходимость её автоматизации. В данной работе была реализована новая автоматизированная система управления блока мультифазного насоса ДНС нефтепровода. Автоматизированная система управления технологическим процессом блока мультифазного насоса ДНС нефтепровода была выполнена на базе программно-технического комплекса SIMATIC PCS7 фирмы Siemens.

Ключевые слова: дожимная насосная станция, мультифазный насос, нефтепровод, SIMATIC PCS7, Siemens, автоматизация, контролер, исполнительный механизм.

ANALYSIS OF BOOSTER PUMPING STATION OPERATION WITH SUBSEQUENT DEVELOPMENT OF AUTOMATION SYSTEM

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ABSTRACT

This article describes the existing system of operation of a booster pumping station (BPS), raises the question of the importance of this installation in modern oil production and refining facilities, as well as the need for its automation. In this work, a new automated control system of the multiphase pump unit of the BPS of the oil pipeline was implemented. The automated process control system of the multiphase pump unit of the BPS of the oil pipeline was made on the basis of the SIMATIC PCS7 software and hardware complex of Siemens.

Keywords: booster pumping station, multiphase pump, oil pipeline, SIMATIC PCS7, Siemens, automation, controller, actuator.

Oil production or oil and gas production is a complex technological process that begins with geological exploration, drilling, well construction, and ends with preparation of well products for marketable form. One of the most important processes of oil and gas production and transportation is a booster pumping station. The main function of the booster pumping station is to collect the produced oil from wells, perform primary separation and dehydration, record the daily production rate of each well and transport the oil with increased pressure from the oil line to the downstream processing stations to the marketable oil.

Oil and gas industry currently occupies one of the leading places in the development of our country. The main task of the oil and gas production field is uninterrupted and reliable supply of resources for production and other domestic facilities.

Oil industry, which is currently in its peak development, is not left without the use of processes and means of automation [1].

The main tasks of automation facilities in the oil and gas production industry are reducing the cost of energy resources for administration, using methods of remote or remote, as well as automatic mode of execution of tasks. Thus, automated control systems reduce the possibility of human error in complex technological processes.

The main purpose of automation of technological processes in the oil and gas industry is to maximize the use of the possibilities inherent in technologies and controls, and, above all [2]:

1. The most complete extraction of well products from oil reservoirs and their transportation to the consumer;
2. Increased efficiency and productivity of petrochemical equipment;
3. Narrowing the scope of personnel's duties;
4. Minimization of losses of any kinds of resources;
5. Increase of quality of oil, gas and water treatment and refining; minimization of losses during oil and gas transportation.

A booster pumping station is a technological part of oil and gas gathering system at the fields and their subsequent transportation to the stations for oil preparation for marketable type. Equipment of booster pumping station provides oil and gas with additional pressure necessary for

their transportation in the direction of high-pressure areas through the collection and preparation systems. The main tasks of booster stations include:

1.

ping oil and gas emulsion through the pipeline using multiphase pump;

2. Primary treatment of well production – separation (discharge) of water and associated petroleum gas with injection of dewatered and degassed oil into the pipeline [3].

Booster pumping stations pump the contents of oil field wells in the form of oil and gas emulsion into the oil pipeline for further transportation. The need to use booster pumping stations is explained by the fact that often the pressure of wells is not enough to transport the well products to the oil treatment facility.

The booster pumping stations also perform the functions of primary purification of oil from mechanical impurities with the help of ground filters and primary separation of liquid from gas extracted from the well products.

BPS facilities include:

1. Site – 1pc. At the inlet of the pad, data is collected on the measurements of oil and gas flow rate, connected to this unit in the collection system. At the outlet of the pad, a chemical reagent is fed into the flow of oil and gas mixture. Shut-off and control valves, instruments for measuring pressure and temperature are installed on the pipelines of the platform;

2. The filter platform – 1 pc. The platform is intended for oil purification. The site is equipped with piping, drainage from the filters into common drainage collector;

3. An oil transfer pump platform – 2 pcs. Multiphase oil transfer pumps are installed at the site, which are factory-assembled (pumps, pipes, fittings, instrumentation and control devices with a local programmable logic controller). The piping with fittings, instrumentation is installed at the site; drainage from the pumps to the common drainage collector is provided. The pressure before and after the pumps is controlled by manometers. Discharges from safety valves of pumps are directed to drainage collector;

4. Gas separator area. The drainage from the equipment is collected in the drainage tank and as it accumulates, it is pumped by a semi-submersible pump installed on the drainage tank to the oil collector before the filters;

5. Oil heater platform – 1pc. After multiphase pumps the oil-gas emulsion is delivered by pipelines to the intermediate preheater of oil, type PNPT-1,6, where it is heated to a temperature of 700C. The intermediate heater PNPT-1,6 is designed for heating the oil and gas mixture before transportation to the oil treatment unit. The oil and gas emulsion enters the heater coil, is heated and then removed from the heater. The furnaces are supplied in a block design, with the automation system of the technological process. Automation system is intended to control technological parameters of oil heating process, equipped with working and emergency alarms, automatic heater protection in case of deviation from norms of technological process;

6. Reagent dosing block – 1 pcs. Chemical agent dosing unit serves for automatic calculation of concentration and dosed supply of demulsifier and corrosion inhibitors into a common collector. The liquid serves for oil demulsification, namely to support separation, separation of water from oil, also to protect pipelines and equipment from corrosion coating;

7. Drainage tank platform – 1pc. The drainage system is designed for draining the technological apparatuses of BPS-3 in case of disturbances, emergencies, equipment repair and maintenance as well as for pressure relief in the apparatuses;

8. Scraper starting chamber platform – 1 pc. Scraper starting chamber is located at the platform. Pig launching chamber is designed for periodic launching into the pipeline and receiving from it of in-line inspection tools, cleaning scrapers and other flow facilities [4].

The rationale for modernization of the existing control system of the booster pumping station is the need for remote control and monitoring of technological processes, namely

multiphase pump unit, in connection with the continuity of oil and gas production process. Location of technological facilities in huge areas also leads to the necessity of development and implementation of new automation systems and organizational structures. For these purposes, it is necessary to select the appropriate equipment that meets the capabilities of our unit.

The multiphase pump is such equipment. Multiphase pump is designed to pump multiphase media (liquid and gas), high viscosity liquids, solutions (including hydrocarbons) from a booster pumping station to oil treatment facilities for further separation and preparation of the product to marketable form. The unit allows pumping oil and gasing mixtures with gas phase content up to 80%. Technical scheme of multiphase pump is shown in fig. 1.

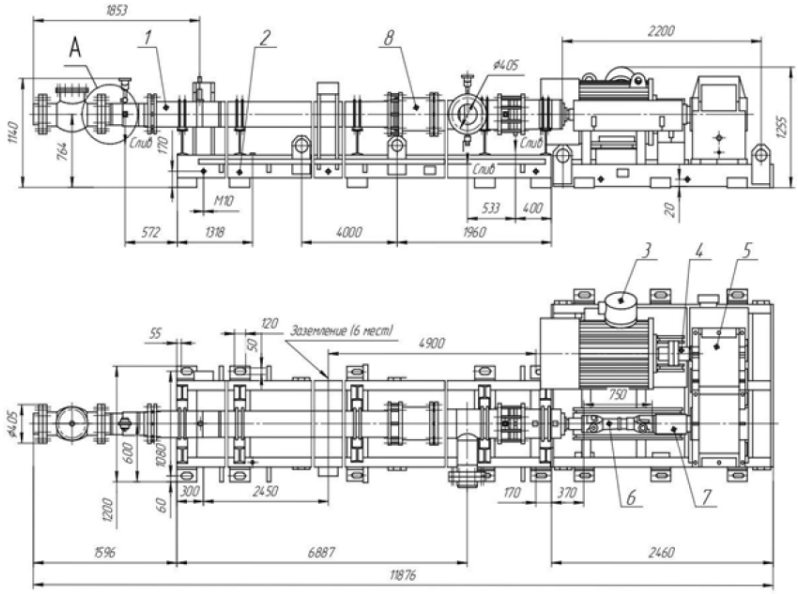

Figure 1: Technical diagram of the multiphase pump [5]

1 – Pump casing, 2 – Electric motor (drive), 3 – Elastic coupling,

4 - Reducer, 5 – Inlet pipe, 6 – Spindle, 7 – Half coupling,

8 – Screw pump section, 9 – Outlet pipe

The main technical feature of the multiphase pump is the pumping of multiphase media. The unit allows to pump oil and gas emulsions (mixtures) with gas phase content up to 80%, operating temperature from 5 to 80 C. When the gas content in the emulsion exceeds 80%, it is necessary to pump additional liquid volume to bring the volume of the gas phase to 80%. Operation of multiphase pump in the complete absence of liquid is not allowed [5].

For this device, it is also necessary to select the appropriate controller, distributed input and output station, control and measuring equipment, execution sensor [6].

As a logical controller should be chosen controller SIMATIC S7 300. This device is a powerful programmable logic controller designed for the construction of control systems of medium and high complexity. Modular design, working with natural cooling, flexible expansion, powerful communications capabilities, easy creation of distributed systems management and serviceability make the S7-300 ideal for virtually any automation tasks. Exterior view of the logic controller SIMATIC S7 300 is shown in Fig. 2.

Figure 2: Controller SIMATIC S7-300 [7]

The ET 200 station of the same manufacturer can be used as a distributed input and output station. It is designed for the construction of distributed input and output systems based on Profibus DP networks. This station is the basic station for the construction of automation systems and allows you to use in its composition a wide range of signal, functional and communication modules. Exterior view of the station SIMATIC ET200M shown in Fig. 3.

Figure 3. Station SIMATIC ET200M [8]

The WIKA 232 pressure gauge can be used as a measuring instrument. Pressure gauges WIKA 232 (Fig. 4) with Bourdon spring are used to measure the pressure of nonviscous, liquid noncrystallizing and gaseous media. The appearance of the pressure gauge is shown in Fig. 4.

Figure 4. WIKA 232 pressure gauge [9]

The last device required in this automation system is the actuator – the AUMA electric valve. The AUMA electric valve is designed for the control of shut-off, shut-off and control valves. The appearance of the AUMA valve is shown in Fig. 5

Figure 5: AUMA electric valve [10].

In the process of studying the control system of the multiphase pump unit of the booster pump the involved equipment, devices, sensors, actuators were considered and the possibility of replacing some of them with more modern ones in order to modernize the whole system of the booster pumping automation was revealed. So, as a result of the works fulfilled and the choice of the means there was made the modernization of the automatic control system of booster pumping station, which is able to provide the operators with remote and automatic control of the technological process with the automated workplace, the system of the operative control and information receiving.

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