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AUTOMATION ARTIFICIAL LIFT SYSTEMS IN THE CIS

АВТОМАТИЗАЦИЯ УСТАНОВОК МЕХАНИЗИРОВАННОЙ ДОБЫЧИ НЕФТИ НА ТЕРРИТОРИИ СНГ

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Abstract. In the article the authors consider the problems of automation oil wells and the industry as a whole in the CIS countries. We present data of the volume of oil production, which confirms the importance of this industry to the economies of the former Soviet Union countries.

Analyzes the overall level of automation of extraction of oil and gas fields in the CIS countries. We consider the automation system for wells operated by sucker rod pumps and electric submersible pumps. The authors reviewed the most common controllers and control stations for well pumps and compared their characteristics.

Particular attention is paid to systems automation, produced in Azerbaijan, as Azerbaijan has been a leader in the automation of process in oil and gas industry in the Soviet Union, and now occupies a leading position in the world. The article considers the production of NGO "Neftegazavtomat" and SKB "Cybernetics" (Baku). Among their advanced development of methods of analysis can be identified using the dynamometer interference technology: position- binary method and Robust Noise Monitoring. These methods allow automatically determine the causes of faults underground pumping equipment.

It is noted that the use of imported automation systems have problems with adapting equipment to local operating conditions, technical documentation and software translation on the Russian language, as well as the repair and modernization of equipment extends over a very long period of time.

Found that the current level of automation of the oil fields in most cases does not meet modern requirements for safety and efficiency. Need to implement a comprehensive automation of all the objects of oil and gas with the ability to collect all the process information to the control room and distance control with it.

Аннотация. В статье авторы рассматривают проблемы автоматизации нефтедобывающих скважин и предприятий отрасли в целом в странах СНГ. Приводятся данные об объемах добычи нефти, которые подтверждают значимость данной отрасли промышленности для экономик стран бывшего СССР.

Анализируется общий уровень автоматизации объектов добычи нефти и газа на месторождениях стран СНГ. Рассматриваются системы автоматики для скважин, эксплуатируемых штанговыми глубинными и электроцентробежными насосами. Сделан обзор наиболее распространенных контроллеров и станций управления для скважинных насосов, сравниваются их характеристики.

Особое внимание уделяется системам автоматики, производимым в Азербайджане, так как Азербайджан был лидером в области автоматизации процессов добычи нефти и газа в СССР, а сейчас занимает лидирующие позиции в мире. В статье рассматривается продукция НПО «Нефтегазавтомат» и СКБ «Кибернетика» (г. Баку). Среди их передовых разработок можно выделить методы анализа динамограмм с применением помехотехнологий: позиционно-бинарный метод и Robust Noise Monitoring. Данные методы позволяют автоматически определять причины неисправностей подземного насосного оборудования.

Отмечается, что при использовании импортных систем автоматизации возникают проблемы с адаптацией оборудования к местным условиям эксплуатации, техническим переводом документации и программного обеспечения на русский язык, а также трудности с ремонтом и модернизацией оборудования.

Установлено, что в настоящее время уровень автоматизации нефтепромыслов в большинстве случаев не соответствует современным требованиям к безопасности и эффективности производства. Необходимо осуществить комплексную автоматизацию всех объектов добычи нефти и газа с возможностью сбора всей технологической информации на диспетчерском пункте и телеуправлением с него.

Key words: oil field, oil production, well, sucker pod pump, electrical submersible pump, management station, controller.

Ключевые слова: месторождение, добыча нефти, скважина, штанговый глубинный насос, электроцентробежный насос, станция управления, контроллер.

Introduction

The economy of the former Soviet Union countries is based on the extraction and export of natural fuel resources, mainly - oil and gas. Such enterprises as "Gazprom", "Rosneft" and "Transneft" in Russia are the constituent nationalities. The situation is similar in other states of the CIS.

Among former USSR republics, the main countries that are engaged in oil production are Russia and the Caspian countries - Azerbaijan, Kazakhstan and

Turkmenistan. Small amounts of oil are also produced in Belarus and Ukraine. Table 1 and Figure 1 shows the distribution pattern of oil extraction between there [1].

Table 1. Annual volume of CIS countries oil production, 1 mln tons/year

Azerbaijan	50,25
Belarus	1,56
Kazakhstan	81,21
Kyrgyzstan	0,07
Moldova	0,02
Russia	504,08
Tajikistan	0,02
Turkmenistan	9,42
Uzbekistan	4,6
Ukraine	3,8
All in the CIS	581,94

The main methods the use of artificial lift are sucker rod pumps (SRP) and electrical submersible pumps (ESP). So in the Russian Federation 41% of the wells operated SRP and 54% - ESP. In this case, using the ESP produces 75% of all oil and SRP - less than 20% [2].

In the countries of the Caspian region, such as Azerbaijan, a significant part of oil reserves is extracted from sea platforms.

It should be noted that in recent years actively developing new ways of operating wells, for example by means of progressive cavity pumps and jet pumps, but the number is still extremely small. Also, there is a modernization of the existing pump drives, so the drive to SRP instead of conventional pumping units installed chain and linear actuators [3], has a higher energy, operating and dimensions and weight.

Down hole automation systems began to be developed in the second half of the twentieth century in industrialized countries such as the USA and the USSR. For the SRP were developed system of dynacard and wattmeter card, later in connection with the development of electronic systems have been created down hole telemetry for ESP.

In the 1990s, the development of power electronics allows a control stations (CS) borehole pumps with variable frequency drive (VFD).

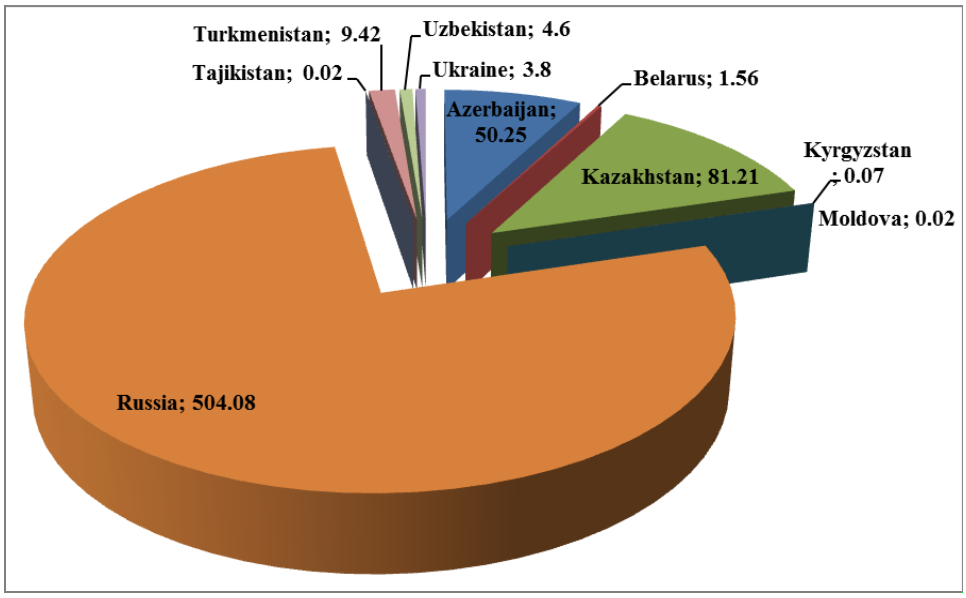

Figure 1. CIS countries oil production volumes distribution, mln tons/year

The development of telecommunications has made it possible to create the oil fields automation systems with remote transmission of information from individual wells and distance control their electric drive.

It should be noted that in the USSR as one of the leaders in the development of well automation was Azerbaijan. A large number of developments in this field were done by specialists of Azerbaijan Institute of Oil Engineering (AZINMASH).

After the collapse of the USSR, many specialized enterprises have been forced to cease development and production of wells and oil automation. Under these conditions, there were offers of foreign manufacturers, mainly from the United States. You can identify such firms as Lufkin Automation, Weatherford, Baker Hughes, and others.

However, in recent years in the oil industry once again started to be implemented domestic developments, as the use of foreign technology poses a number of difficulties: the poor quality of the translation of technical documentation and software on the Russian, equipment repair operations take a very long time, the inability to adapt and modify the algorithms of this language barriers and geographic distance [4].

1 Automation of SRP wells

Currently, most of the oil wells in the territory of the former Soviet Union operated using SRP. At the same time, in many cases, the equipment is very old and obsolete. Under these conditions, increases the need for automated control of the operation of downhole equipment in real time.

As already mentioned, the main methods for monitoring wells operated SRP are dynacard and wattmetercard. For several decades ago to diagnose the state of

submersible equipment used portable hydraulic dynamometer, which was later replaced by electronic. Currently, a significant portion of the well and remains unreached systems remotely controlled and monitored through periodic rounds of operators with a handheld dynamometers.

The control and protection systems are implemented in the SRP control stations. Figure 2 shows the control station type ShGS-5805 for wells with SRP (1986). Safety functions are implemented on CS current transformers and electromechanical relays. The control unit enables automatic motor after interruption of power supply with adjustable time delay, and implement periodic regime of the well, setting time and pause. Although the CS already obsolete, many wells are old and new CS with much less functionality.

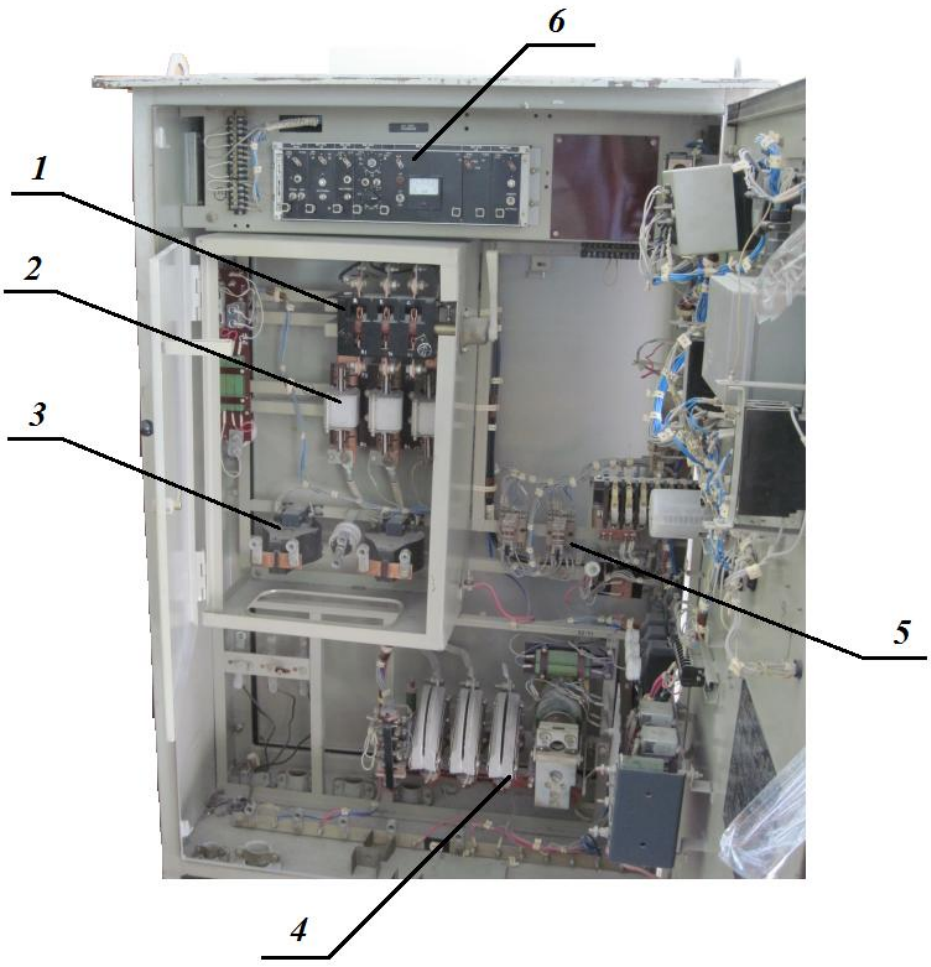

Figure 2. Control station type ShGS-5805 (1986)
1 – switch, 2 – fuses, 3 – current transformers, 4 – contactor,
5 – unit electromagnetic relays, 6 – control unit

Now Azerbaijan's oil production facilities are used the remote control system of the "Gilavar", "NUR", the development of the "Neftegazavtomat" and complex measurement, monitoring, diagnosis and management "Aina", the development of SKB

"Cybernetics", while the remaining fields is frequency Remote Control fishing "ChTP ", developed 40 years ago in NIPINeftehimavtomat [5].

Remote control system "Gilavar", "Nour" and " ChTP " designed for dynacard, which reflect the dependence of the force on the head of the balance of the course of the last cycle of the pumping unit. The interpretation of these dynacard to troubleshoot SRP and regimes is well qualified staff.

However, the qualification of the specialists do not always high and often, especially for deep wells even qualified person cannot clearly identify the equipment failure.

The complex "Aina", in contrast to the function of these systems in addition to receiving dynacard, has additional functions:

- getting plunger dynacard, which simplifies the diagnosis of deep well pump, especially for deep wells;
- ability to control wells in the periodic mode of operation;
- ability to control the rotational speed of the rotor of the motor, that is, the regulation number of swing without changing the pulleys;
- rapid tracking of the operation of the equipment fund of mechanized harvesting and reporting of activities;
- tracking equipment well against vandalism;
- getting wattmetercard to diagnose the state of the ground equipment;
- algorithmic analysis of dynacard using methods of noise technologies such as position-binary and Robust Noise Monitoring for a more reliable and automated determination of the cause of damage of underground equipment.

To perform these functions in the complex "Ayna" designed station smooth control wells with sucker rod pumping units (SSC SRP), which combines the functions of a controlled point the remote control and the motor control board.

Note that the CS SRP equipped with modern microprocessor-based controller, energy meter, VFD, wireless modem, as well as provide for the connection of various sensor: dynameter, pressure sensors, flow, level, wattmeter [6].

Among the foreign CS SRP, widely used in the fields of the former Soviet Union, highlight the controller and CS of Lufkin Automation (USA) (Figure 3).

Figure 3. The control station of SRP with controller Lufkin Automation (USA)

Automation Systems of SRP Lufkin Automation used in Belarusneft, were tested in the fields of TNK-BP and Surgutneftegaz. However, the most widespread introduction they received in OAO "Tatneft", which are in operation a few thousand of these controllers.

Controllers of SRP Lufkin Automation has a sufficiently powerful software and mathematical tools for processing the measurement results of dynacard, dynacard analyze each cycle of oscillation, have automatic withdrawal wells in the mode, periodic operation. Among the shortcomings can be identified lack of control of electrical parameters (voltage and current per phase) and the consumption of electricity, poor conditions of the Russian translation of software and technical documentation.

It should be noted that due to the lack of direct contact with the developers promptly correct these deficiencies is not obtained, then the developers of the domestic systems already resolved these issues.

2 Automation of ESP wells

With the installation of ESP in Russia produced three-quarters of its oil (75%). Therefore automation systems ESP are the most urgent task. Development and implementation of energy saving measures on motor ESP provides a significant energy savings and reduction of the cost of crude oil.

The most perfect means of monitoring the work of the ESP units are unit of submersible telemetry. Such units are placed under the ESP and transmitting information to the surface for the following parameters: pressure and temperature of the fluid at the pump intake, the temperature of the motor, vibration axis of the motor,

insulation resistance, liquid flow. Data transfer is performed by applying a high-frequency oscillations in the power supply voltage of the motor. A special unit in the control station decodes the information and displays on the screen, and also sends to the control room. The development of such units engaged in downhole telemetry Izhevskiy Radiozavod (Izhevsk, RF), Elekton (Raduzhniy, RF).

Figure 4 shows frequency control stations IRZ-500 series. Control stations are designed to control and monitor the parameters of submersible electric motors with power from 14 to 320 kW enabling smooth speed-up and stoppage, control of rotation frequency.

Among the most promising ways of improving motor ESP to highlight the introduction of variable-frequency induction submersible motors [7] and the use of submersible BLDC. The development of variable-speed drives and BLDC in Russia engaged company Tirol, ALNAS, Ritek.

3 Automation systems of oil fields

The specifics of automation of oil and gas companies is that objects (production and injection wells, Group Metering, pumping stations) are dispersed over large areas and geographically distant from each other. Currently, most of the objects are not covered by the remote control and monitoring of their condition by the operator by means of direct bypass with portable appliances.

Figure 4. Frequency control stations IRZ-500 series for ESP enabling smooth speed-up and stoppage, control of rotation frequency

First of automation and remote control systems of the oil fields began to be introduced in 1990s. System “STKRNK-LEP” is known to the transfer of measured dynacarf and wattmetercard powerline designed VNIIR Institute (Cheboksary). Later, with the advent of radio modems available information transfer was made by radio.

Among the oil fields of automation systems, implemented in Russia and the CIS, the system can distinguish the "Region +" (JSC "NizhnevartovskASUneft"), a system of Izhevsk Radio Plant “KDU-IRZ”, SCADA-system XSPOC (USA), a system ARMITS (JSC "Tatneft") and others. Separately, you can highlight the automated systems of technical and commercial accounting.

Consider the typical functions of the oil fields of automation systems.

ESP wells for measurement of pressure is provided at the mouth and in the annular space of the well, operational control of the submersible motor parameters and remote control of ESP.

For wells operated by SRP, made operational control of the pumping unit, the operational view of dynacard, and wattmetercard, currentcard, the control of pressure at the mouth and in the annulus of the well.

When you turn into the complex automation group metering stations automatically switches wells, burglar alarm facilities Group Metering, monitoring the output pressure of hydraulic ash removal, the definition of debit Group Metering.

For pumping stations is provided by:

- Operational control of the pumps and motors;
- Monitoring levels of containers;
- Control of pressure in different areas;
- Fuel oil and water.

In the future, all of the objects fields to be covered by the automation systems with the ability to control all the settings and remote control from the control center.

Conclusion

1. Currently, the CIS countries, only a small portion of oil production facilities covered by automatic systems with the transfer of information to the control room.

2. In most of the wells in the CIS installed and obsolescent CS does not provide operational control and remote control.

3. When selecting automation systems is made, many oil companies give preference to products of foreign companies. However, foreign system worse adapted to local conditions, are usually quite poor Russian translation software and technical documentation. Also, all the issues related to the repair and modernization of the equipment will be unduly prolonged in time.

4. In the short term, all of the objects fields to be covered by the automation systems with remote monitoring and remote control of all the parameters from the control center.

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