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ORGANIZATION OF SAFE MANAGEMENT OF FIRE OPERATIONS ON GAS PIPELINES

Abstract. The article discusses the issues of safe operations on the main gas pipelines of the Republic of Kazakhstan, which, as a result of deterioration of pipelines main part and their active susceptibility to stress corrosion cracking, require repair work. Considered new approaches of repair work organization by open fire using. It has been analyzed that the application of these measures in practice will ensure proper organizational planning and technical training of personnel, and effective provision of necessary level safety for hot work. It was concluded that it is necessary to introduce safety increasing measures during fire work on gas pipelines, it will prevent possible disasters, fires, destruction and human losses due to explosions during repair work on gas pipelines, as well as reduce damaging factors affecting workers health. It is shown that introduction of the named above measures helps to prevent disasters, fires, destruction and loss of life as a result of explosions during gas pipelines repair, as well as damaging factors reduction that affect workers health during these types of work.

Key words: gas pipeline, accident rate, industrial safety, in-line diagnostics, hot work, fire work, safety control stand, instructional cards, fires, explosions, pipe wear, corrosion.

Introduction. The development of gas industry leads to the need to improve gas pipelines operation reliability in order to supply planned products to end users. The main task during gas transportation is to ensure reliable operation of gas pipelines due to implementation of a set of planned measures and repair work. This paper discusses the main hazards arising from fireworks, the methods for their safe handling, as well as the requirements regulated by legislation in the industrial safety field.

The article also describes the use of the stand for comprehensive and continuous monitoring of in-line space gas content, as well as provides regulation of inside sealing devices pressure of disconnected or removed for repair part of gas pipeline.

At oil and gas facilities, every third event occurs as a result of personnel erroneous actions, due to violations of organization and production of repair work requirements. In order to increase the awareness of workers and a more complete study of industrial safety and labor protection requirements, the hypothesis of using instructional cards as a type of production instructions is put forward.

Target setting. In the view of pipeline systems development and implementation of measures and with purpose to increase the productivity of hot works, it is more relevant to provide safe working conditions and reducing the loss of transported natural raw materials during the operation of trunk pipelines [1, 2]. In this paper, was considered the one of possible ways to achieve goals and objectives by increasing labor productivity and reduction values of harmful emissions of gases into the environment to minimum.

According to industry regulations and regulations for hot work on the linear part of gas pipeline, these types of work are allowed to be carried out only after a pressure of 100 to 500 Pa is set in it [3, 4].

Reduced pressure limits or completely disables transportation of product through the pipeline, as a result of which gas pipeline may be idle for a long time. For example, during cutting and replacing a

section of gas pipeline, the linear section is idle for an average of 18-20 hours. Also, the fireworks duration is affected by the presence of a significant probability of accidents, which also leads to a reduction of work productivity.

Information about accidents on the main gas pipeline of the Republic of Kazakhstan. During working on gas pipelines, as well as at other hazardous production facilities (HPF), there are risks of accidents, injuries, incidents. One of the most important tasks of industrial safety is to reduce the likelihood of these events.

Data analysis of main systems of gas pipelines suggests that the main part of gas distribution system of the Republic of Kazakhstan was built in the 70-80s of the last century, as a result of which at present gas pipeline systems are characterized by a high proportion of networks requiring repairs (54%) [5, 6].

Significant deterioration of pipeline system adversely affects the accident rate on hazardous production facilities, including the state of industrial safety.

According to information on accidents on main gas pipelines of the Republic of Kazakhstan, accidents at these facilities mainly occurred due to external and internal corrosion, construction and installation works defects, as well as mechanical damage [7, 8].

In order to eliminate the main accident factors, are planned simulative measures to industrial enterprises to modernize and introduce automated tools, as well as to improve the industrial safety regulatory framework according to modern standards and international technological requirements [9, 10].

The article provides a comparative analysis of fundamentals of industrial safety in the Russian Federation and the Republic of Kazakhstan (Federal Law of July 21, 1997 No. 116-FL "On Industrial Safety of Hazardous Production Facilities" and the Law of the Republic of Kazakhstan of April 11, 2014 No. 188-V 3PK " On civil protection "). As a result of the analysis was revealed the similarity of main directions of ensuring industrial safety on HPFs.

However, there are differences related to division into hazard classes, licensing, as well as the frequency of inspections of HPF. Both countries are working on optimization of control functions, improvement of regulatory and legal regulation of industrial safety at supervised facilities, including using a scientifically-based risk-oriented approach.

For two states, the concept of "increased risk work" is common. In the Republic of Kazakhstan, such works, as well as in the Russian Federation, include repair work on main gas pipelines.

One of the main areas of safety providing during repair work on gas pipelines is timely technical diagnostics.

Methods of repair work on gas pipelines. There are many methods of non-destructive testing: acoustic, thermoelectric, radioscopic, powder, and others. Currently, widespread use of in-line diagnostics based on ultrasound and magnetic methods [11, 12].

These methods of diagnostics have the highest sensitivity and resolution for detecting defects on main gas pipelines, however, there are certain drawbacks inherent in ultrasonic and magnetic methods of in-line diagnostics.

The disadvantages of ultrasonic method of in-line diagnostics are, for example, the contamination of significant volumes of water necessary to ensure acoustic contact, and negative effects of magnetic method such as occurrence of residual magnetization of the pipeline material after the diagnosis [13, 14].

Next step after inspection and assessment of pipeline condition on main gas pipeline linear part is repairs, which are caused by the need to take preventive or technical measures aimed at full or partial restoration of pipeline linear part according to design characteristics [15, 16].

Consider one of the most dangerous types of repair work, the work of increased danger - hot work.

According to [3], hot work is a technological operation performed by using open fire, resulting in sparking and heating of pipeline to high temperatures, followed by ignition of gases, materials and structures.

As a result, the hot works on gas pipelines must be carried out in a certain sequence and in accordance with the established requirements. Violation or untimely execution of a specific type of operation can cause incidents, accidents, and lead to fatal consequences.

Before hot work performing must be carried out some preparation, including organization of working area, gas equipment and the linear section of main gas pipeline to ensure safe working conditions. The main documents according to which pipeline is being prepared for hot work are work permit; plan of organization and work; documentation describing the technical condition and reliability of technological equipment and gas pipeline; report on diagnostic results.

During hot works there is a high probability of accidents associated with fuel ignition and further fire development. This is because hot work associated with the use of open fire and formation of sparks, which flying in the form of splashes of molten metal [17]. According to official data, 30% of fires that occurred on main pipelines are caused by a violation of safety rules [1], so it is necessary to solve the problem of improving industrial safety in this area.

For this purpose, are proposed measures that will reduce the risk of emergencies and production and human victims.

Measures to improve the safe of fire work on main gas pipelines. The dynamics of modern development of welding processes significantly depends on introduction of new high-tech automated welding process and equipment, which will significantly improve the quality of welded joints, as well as the pace of repairs. According to mentioned above, in order to ensure the safety of hot work on gas pipelines, the authors of the article proposed to carry out welding work by using automatic welding with self-shielded cored wire.

Due to the provision of a high deposition rate, the absence of the mandatory use of protective gases, certain selected flux elements combinations, as well as the presence of alloying additives, self-shielding wires have become increasingly prevalent during welding.

One of the installations for automatic welding with self-shielded wire is UAST-1 [18], the technical characteristics of which are given in Table 1. The basic UAST-1 is made up of the universal welding head GAST presented in Figure 1. GAST provides automated welding in different technologies.

Table 1 – Technical characteristics of the installation UAST-1

Diameter range of welded pipes, mm	325 – 1420
The speed of movement of the welding head GAST-1, mm / s	0,5 – 12
Wire feed speed, mm / s	16 – 200
Diameter of electrode wire, mm	0,8 – 2,0
Torch oscillation amplitude, mm	0 – 20
Torch oscillation speed, mm / s	10 – 100
Time “delay at the edges”, with	0 – 1,0

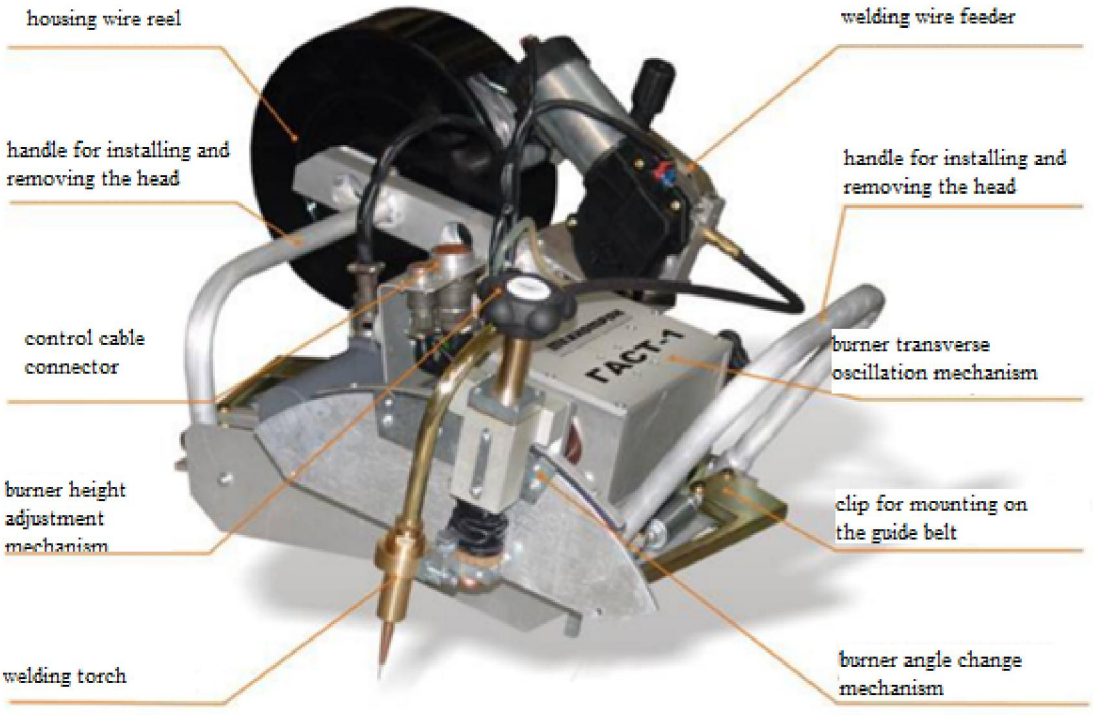

Figure 1 – GAST welding head

It is known that automatic welding, in comparison with mechanized welding by self-shielding wire, has very high toughness values. Moreover, automatic welding ensures good-looking seam, also it provides high work stability, and it provides constant mechanical properties of welded joints.

As a result, the introduction of automatic welding with self-shielding wire will lead to automation of the welding process, the possibility of increasing labor productivity at relatively low costs, as well as obtaining high values of the viscous-plastic properties of welded joints (primarily impact toughness) [19]. In the field of industrial safety, this technology provides safer work organization of increased danger and reduces the influence of human factor on the likelihood of accidents.

The next measure to improve industrial safety during hot work is the use of a stand that provides control over gas pipeline state [20].

This device is a regulating and controlling system, it allows providing comprehensive and continuous monitoring of in-line space gas content, and regulation of pressure inside the sealing devices of disconnected or removed for repair main gas pipeline.

Figure 2 shows the block diagram of the security control stand and presents the main elements that are an integral part of this equipment.

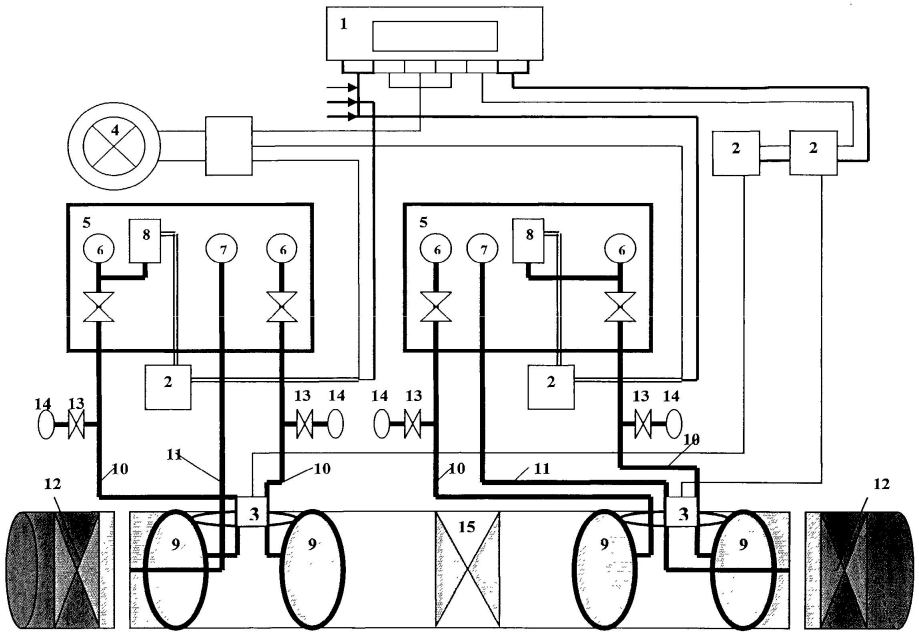

Figure 2 – Stand of safety control in the production of repair work on gas pipelines:
1 - stationary two-channel gas analyzer; 2 - distribution boxes; 3 - gas sensors; 4 - combined fire alarm, 5 - pressure control unit; 6 - pressure control manometer; 7 - gauge control overpressure; 8 - electronic pressure sensor with digital display; 9 - passing temporary sealing device; 10, 11 - rubber hoses; 12 - stop valves; 13 - cranes; 14 - portable compressor

The principle of security control stand operation is given below.

In the stationary gas analyzer 1, presets the required concentration of gas, for example, a 0.5% excess of the volumetric content of CH4 provides an warning signal, and if the content of CH4 is exceeded by 1%, it reproduces an alarm signal.

The gas analyzer makes continuous monitoring of gas in-line space due to remote explosion-proof gas content sensors 3, which must be installed in the technological openings of gas pipeline on each side of the hot work site.

Sensor signals take analog digital forms and pass through the outputs of remote explosion-proof gas sensors 3 to communication channels, and then to the gas analyzer 1. The main gas analyzer control unit compares received and set values. In case of exceeding of threshold value of certain gases, a corresponding signal is generated and immediately transmitted to the gas analyzer input 1. After the "light" and "sound" alarms on the gas analyzer control unit 1, the signal goes to the siren 4, after which you can get the necessary information about the state and situation plot of the under repair object.

Table 2 – Form of instruction card

<table>
<tr><td colspan="5">Instruction card
Safe methods and techniques for performing work
(indicate the name of the type of work).
Part 1. Characteristics of the equipment
Part 2. Occupational safety requirements during work
Table 2.1.1 – Harmful and dangerous production factors, and measures to reduce or eliminate the impact of these factors on the employee.</td></tr>
<tr><td colspan="2">Harmful and dangerous production factors</td><td colspan="3">Measures to reduce and / or eliminate exposure</td></tr>
<tr><td colspan="2">Put the name</td><td colspan="2">Put measures to reduce and / or eliminate the impact of this factor on the employee.</td><td>Photo</td></tr>
<tr><td colspan="5">2.2 Tools, equipment, ISD required for work</td></tr>
<tr><td colspan="3">Name</td><td colspan="2">Picture</td></tr>
<tr><td colspan="3">Put the name</td><td colspan="2">Photo</td></tr>
<tr><td colspan="5">Part 3. The procedure and safety measures during the work
3.1. Organizational events</td></tr>
<tr><td rowspan="2">№ operation</td><td colspan="4">The content and sequence of the elements of operations (the number of employees - 3 people). Special attention during the operation</td></tr>
<tr><td>Worker 1</td><td colspan="2">Worker 2</td><td>Worker 3</td></tr>
<tr><td rowspan="2">1</td><td>Performs function 1.</td><td colspan="3">Performs function 1.1</td></tr>
<tr><td colspan="4">Photo</td></tr>
<tr><td>2</td><td></td><td colspan="2"></td><td></td></tr>
<tr><td colspan="5">3.2. Performance of work (name of work)</td></tr>
<tr><td rowspan="2">№ operation</td><td colspan="4">The content and sequence of the elements of operations (the number of employees - 2 people). Special attention during the operation</td></tr>
<tr><td colspan="2">Worker 1</td><td colspan="2">Worker 2</td></tr>
<tr><td>1</td><td colspan="4">ATTENTION!
During the operation 1 it is necessary ...
Photo</td></tr>
<tr><td></td><td>Performs function 1.1</td><td>Photo</td><td>Performs function 1.2</td><td>Photo</td></tr>
<tr><td rowspan="2">2</td><td>Performs function 2.1</td><td>Photo</td><td>Performs function 2.2</td><td>Photo</td></tr>
<tr><td colspan="2">ATTENTION!
It is forbidden ...</td><td colspan="2"></td></tr>
<tr><td colspan="5">3.3 Completion of work.</td></tr>
<tr><td rowspan="2">№ operation</td><td colspan="4">The content and sequence of the elements of operations (the number of employees - 3 people). Special attention during the operation</td></tr>
<tr><td>Head</td><td colspan="2">Worker 1</td><td>Worker 2</td></tr>
<tr><td rowspan="2">1</td><td></td><td colspan="2">Performs function 1.1</td><td>Performs function 1.2</td></tr>
<tr><td></td><td colspan="2">Photo</td><td>Photo</td></tr>
<tr><td rowspan="2">2</td><td>Performs function 1.1</td><td colspan="3">Performs function 1.1</td></tr>
<tr><td>Photo</td><td colspan="3">Photo</td></tr>
</table>

The use of a safety control stand during hot work, and continuous monitoring of gas pipeline individual parameters, provides immediate notification of personnel about emergency situations. Because of this, repairs are immediately stopped and people are evacuated from the zone with increased danger before the causes of the alarm signal are identified and eliminated [21].

Another method of fire work safety improvement is directly related to the personnel who are responsible for the management and conduct of high-risk work.

According to statistics on accidents and industrial injuries at oil and gas facilities, every third event occurs as a result of erroneous personnel actions due to violations of the requirements for organizing and repair work carrying out on main pipelines.

These violations of the requirements arise either because of the scornful attitude of workers to requirements of industrial safety and labor protection, or because of the lack of knowledge and skills to perform relevant types of work.

In order to increase the awareness of workers and a more complete study of requirements for industrial safety and labor protection, the hypothesis of using instructional cards as a type of production instructions is put forward. The basis of these cards should be the structuring and visualization of information necessary for safe performs of high-risk work [22].

Employees, technical devices, facilities where relevant work is carried out should be systematized into a single coherent system [23]. On this basis, it is necessary to understand that the malfunction of one element of this system will lead to accidents or incident. This principle should be fundamental in preparation of instruction cards [24]. The form of the card is presented in table 2.

The instructional cards provide a visual presentation and a detailed description of each work performance, focus employees attention on key points, eliminate inaccurate definitions and operations [25], which provide employee with the right to wrong actions choose to perform necessary types of work.

Conclusion. In this paper, was made an analysis of main stages and striking factors that can affect an employee during hot work on main gas pipelines.

In order to improve the safety of fire work were proposed measures that include planning of organizational and technical training of personnel, as well as automatic control of technological processes as more efficient methods of performing necessary operations.

The introduction of named above measures helps to prevent possible disasters, fires, destruction and loss of life as a result of explosions during the implementation of repair work on gas pipelines, along with a decrease in damaging factors that affect health of workers during the performance of these types of work.

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ГАЗ ҚҰБЫРЛАРЫНДА ОТ ЖҰМЫСТАРЫН ҚАУІПСІЗ ЖҮРГІЗУДІ ҰЙЫМДАСТЫРУ

Аннотация. Зерттеу нәтижесінде мұнай-газ өнеркәсібі объектілерінің тік болат резервуарларында өрт туындаған кезде жаңа көбік түзетін құрамдар мен жалынның таралуын шектеу құралдарын қолдану технологиясы жетілдірілді. Тез тұтанатын сұйықтықтарды сөндіруге талдау жүргізілді, егер бастапқы кезеңде өртті жою жүргізілмесе, өрт ұзаққа созылатын сатыға ауысатынын куәландырады. Резервуарлық парктердегі өрт салдарын жою үшін осы кезеңде қосымша күштер мен құралдар қажет болады. Өрт таралуынан қосымша пассивті қорғаныс ретінде түйіршіктелген балқитын жанбайтын заттардан жасалған резервуарлардың қабырғалары мен шатырларына арналған қорғаныс жабындары әзірленді және эксперименталды сынақтан өткізілді. Сонымен қатар, зертханалық және жартылай өнеркәсіптік жағдайларда ішкі және сыртқы жабындарды пайдалану мүмкіндіктері зерделенді. Тік болат резервуарлардың қабырғалары мен шатырларына арналған қорғаныс жабындары отқа төзімді қасиеттерге ие болады. Олар тік болат резервуарлардың қабырғаларының температурасын төмендетуге мүмкіндік береді. Сонымен қатар түйіршіктелген балқымалы жанбайтын заттардан жасалған тік болат резервуарлардың қабырғалары мен шатырларына арналған ұсынылып отырған Қорғаныс жабындары жалынның таралуын шектеуге және оларды оңтайлы оқшаулауына ықпал етеді, сондай-ақ статикалық электр разрядтарынан өрттердің туындауын болдырмайды.

Түйін сөздер: өртке қарсы қорғаныс, өрттен қорғау технологиясы, мұнай өнімдері, резервуар, жанғыш қоспа, жылу ағыны, көбік тұрақтылығы, пленка қалыңдығы, көбіктің бұзылуы, тез тұтанатын сұйықтық.

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ОРГАНИЗАЦИЯ БЕЗОПАСНОГО ВЕДЕНИЯ ОГНЕВЫХ РАБОТ НА ГАЗОПРОВОДАХ

Аннотация. В статье рассмотрены вопросы безопасного ведения работ на магистральных газопроводах Республики Казахстан, которые в результате износа основной части трубопроводов и их активной подверженности коррозионному растрескиванию под напряжением, требуют выполнения ремонтных работ. Рассмотрены новые подходы к организации проведения ремонтных работ, связанных с применением открытого огня. Проанализировано, что применение указанных мероприятий на практике обеспечит должное планирование организационно-технической подготовки персонала, а также обусловит эффективное обеспечение необходимого уровня безопасности проведении огневых работ. Сделан вывод о необходимости внедрения мероприятий по повышению безопасного ведения огневых работ на магистральных газопроводах, которые позволят предотвратить возможные катастрофы, пожары, разрушения и человеческие жертвы вследствие взрывов при осуществлении ремонтных работ на магистральных газопроводах, а также уменьшить поражающие факторы, оказывающие влияние на здоровье и состояние работников. Показано, что внедрение вышеуказанных мероприятий позволяет предотвратить возможные катастрофы, пожары, разрушения и человеческие жертвы вследствие взрывов при осуществлении ремонтных работ на магистральных газопроводах, а также уменьшение поражающих факторов, оказывающих влияние на здоровье и состояние работников при выполнении данных видов работ.

Ключевые слова: магистральный газопровод, аварийность, промышленная безопасность, внутритрубная диагностика, огневые работы, стенд контроля безопасности, инструктивные карты, пожары, взрывы, износ труб, коррозия.

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