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THEME: "THE INCREASING OF RESISTANCE TO FRICTION CORROSION OF FOUNTAIN FITTINGS CONNECTOR AND THE SCIENTIFIC BASIS OF THE DESIGNING"

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ABSTRACT

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GENERAL CHARACTERISTICS OF THE WORK

Topic relevance and elaboration rate: Binding units are included in the set of industrial equipment and are designed to direct, completely prevent or open the flow of the product. High pressure binding structures are also designed to close or open the passage diameter of the fountain armatures. The main problem of this equipment is friction and mechanical wear of tribotechnical joints. Their tribotechnical joints are made of metal-metal and metal-rubber materials. Currently there is a problem of wear in both joints. Although the issues of wear resistance in tribojoints of existing binding units have been looked at in certain directions, the distribution of relative pressure on the working surfaces of their bending parts, the change of mechanical wear depending on the friction force, taking into account the characteristics of the environment, and the wear resistance of its curing rubber elements in cold (-55^{0}C) and hot (55^{0}C and above) climates in aggressive environments have not yet been fully studied. Currently, the main reason for the loss of functionality of binding units is the mechanical wear of their working joints (stopper, stopper joint) and its rubber sealings. At high pressures, due to the increase in the scale of various types of mechanical effects on the parts and joints of the equipment and the change of the temperature factor in the rubber elements, their failure occurs more quickly. Fasteners working under pressure are subject to hydroabrasive, abrasive, cavitation, erosion, fretting and adhesion wear based on mechanical impact. In front of modern science, this problem and the elimination of its complications remain an urgent issue. According to the class of binding units, they are divided into three types, including stopcocks, taps and valves. Locking structures are the type of valves that are widely used in industry at high pressures. The tribojoints of the valves bend due to the working pressure (in microns). Since the distribution of pressure on the working surface of the bending joints is different, non-parallel wear occurs on the surfaces along with the increase in the intensity, speed and amount of mechanical wear caused by friction. As a result, the binding units loses its functionality because the sealing is broken. Because it is technically impossible to use taps and valves at high pressures (more than 250 MPa), in such cases, straight-flow valves are used. Despite the fact that valves are mainly used at high pressures, the above-mentioned problem also reduces the reliability of valves and causes them to lose their functionality. The systematization of the reasons for the failure of the valves included in the class of fastening structures shows that the problems with the full opening and closing of the valves themselves are mechanical wear of the working surfaces of the gate and seat ring (25%), the breaking of the tray-shaped spring (18%), the failure of the fastening elements (30%) and the spindle and rejections occurring in the valve joint are evident as (27%). As you can see, the case of sealing failure is one of the more common occurrences. In order to provide stability in the metal-to-metal interface of these equipments, there is a high need for rubber seals that can work in the temperature range (-55^{0}C and +500^{0}C) and under aggressive environmental conditions. Renovation of the construction and strengthening of the structure of the rubber materials of the mentioned sealings remains one of the urgent issues in front of science. It is necessary to develop new matrices for sealings that can work at low temperatures and in various aggressive environments. The availability and industrial application of valves created with this type of matrices has resulted in great economic benefits. The renovation of the design of the new model rubber sealing requires the development of new rubber materials resistant to the temperature range operating in an aggressive environment (-55^{0}C and +500^{0}C). By injecting hard binders into the rubber matrices to obtain a new material, i.e. by subjecting different rubber matrices to double matrixulation, it is possible to obtain new models of rubber panel matrices that are resistant to freezing and wear in a low-temperature, high-pressure aggressive environment. The development and preparation of the technology of these matrices can be applied not only to valves, but also to equipment used in environments with variable temperature ranges in various industries. In the parts of the tribojoints of the valvess that are pressed against each other under pressure, frictional wear occurs due to the force of friction a state of stillness or when moving, and the change in the amount of this wear depends on the constructive structure of the equipment. The main disadvantage in the construction of valves used in industry is the uneven distribution of relative pressure in the closing joint. The uneven distribution of the relative pressure increases the influence of all types of wear factors and accelerates the breakdown of the tribod by increasing the speed and intensity of wear. The mentioned issues are the main priority issues in increasing the reliability and efficiency of the valves, and their solution remains relevant. Despite the high result of increasing the pressure resistance index of the existing valve, scientific experiments are being conducted in the direction of increasing its efficiency. Based on these experiments, it was determined that in order to increase its efficiency in cold climates, the sealing joints of the valves should be provided with new model rubber matrix sealings and a special structural change should be made in its construction to choke the product at the entrance and exit. For this, the design of the valve and the structural materials of the sealings must be updated. By injecting solid binders into the rubber matrices resistant to freezing and thermal expansion, new models of sealings can be obtained with a special design. For the preparation of this type of sealings, the scientific idea ofmaking two layers of rubber matrix sealings and new valves provided with these sealings has been developed. From this point of view, the solution of the problem involves the development, preparation, testing, certification and industrial application of the new model valve manufacturing technology provided with new model rubber matrices.

The object and subject of the research: The object of the study was a straight-valve and plug valve, which are included in the class of high-pressure binding units. İn the research work, the dependence of the sliding friction force on the contact surface during the movement of the bent gate under the minimum driving force due to the compressive force that compresses the working surfaces of the plug joint of the linear motion valve was determined, the dependence of the compressive force generated on the sealing contact surface of the plug joint of the improved plug valve on the working pressure was determined, the condition of ensuring the workability of the new plug valve was defined, for the first time, a new fuzzy model was proposed based on the theory of fuzzy sets to predict the probability of the improved valve's non-stop operation, and a model for predicting their workability was proposed, and a training algorithm of the fuzzy model was developed based on statistical data.

Objectives and tasks of work: The following goals have been set in carrying out the research work.

Increasing their resistance to wearing by determining the dependence of mechanical wear on working pressure and friction in the tribotechnical joints of binding units, creation of a control model for the non-rejection operation process of straight valves during operation and development, preparation and industrial application of valve constructions equipped with new two-layer rubber matrix sealings.

The research work includes the following tasks.

- Determining the regularity of change of friction forces in the tribojoints of valves depending on relative pressure and development of the method of ensuring equal distribution of relative pressure;
- Determination of mechanical factors that create uneven distribution of wear on the contact surfaces of tribojoints and determination of the effect of these factors on the friction formed on the meeting surfaces of the tribojoints;
- Acquisition of new panel matrixes by the double matrixing method to ensure resistance to wear of the sealing elements of the valve at very low and high temperatures and development, preparation and tribological testing of the construction of sealing elements based on this material;
- Determination of their load resistance based on the data obtained as a result of the calculation of its stress state in large deformations of the sealing elements (membrane type) used in valve constructions;
- Development of new rubber panel matrices resistant to freezing and aggressive environment by double matrixing method by injecting a hard binder into the B 14-type rubber matrix based on the "Honeycomb Panel matrix" model;

- Construction and study of the dependence of the degree of deformation on the load based on the computer simulation of the double matrix;
- Development, preparation and testing of the technology of a new valve with a double rubber panel matrix based on the received scientific results;
- Development of recommendations for industrial application of valve equipped with rubber panel matrix sealing that meets API standards and application in various fields of industry.

Research methods: The following methods were used to solve the issues raised in the research work.

1.Tor method;
2. Simulation with SOLIDWORKS software;
3.Fractal analysis of deformations;
4.Rinch method;
5.Variation method;
6.Fuzzy set theory.

The specified sequence of the structure of the scientific research work is as follows.

- Comparative analysis of modern binding units, critical review and determination of reasons for failure and methods of increasing reliability indicators;
- Working out the scientific theoretical basis of the regularity of change of friction forces depending on the relative pressure and the equal distribution of the relative pressure on the contact surfaces in the tribojoints of the existing binding units;
- In order to ensure the free movement of surfaces of different materials on one another, in the appropriate cleanliness class, ensuring the equal distribution of the compressive force along the contact surface and justifying the choice of material;
- Investigation of friction and wear in tribojoints and sealings with different materials selected according to the cleanliness class of the contact surfaces;

- Acquisition of new rubber panel matrices using the double matrixing method, development and preparation of the construction of a new model of rubber sealings based on the purchased material;
- Development of the scientific methodology and production technology of designing a new valve construction equipped with new model sealings;
- Preparation and testing of valve according to API standards;
- Based on the theory of fuzzy sets, a working model is constructed and defined, which expresses the regularity of changes in its reliability depending on the amount of wear of the valve tribojoints.;
- Application of the research work to the oil and gas industry and development of recommendations for application in various areas of the industry.

Valves used in various fields of the oil and gas industry are mainly used as a part of the set of devices and equipment used in extracting, transporting, diverting and storing oil and gas, and are used in all areas of the industry to create and prevent liquid-gas flow. The scientific issues raised in the research work include the study of the state of friction in metal-metal and rubber tribojoints and friction surfaces of high cleanliness class of machines and equipment used in various fields of industry, as well as the scientific basis of increasing the resistance to wear of equipment. The purchased rubber panel matrices (new material) for rubber sealings intended for use in valves can be used as a new material resistant to heat, freezing and wear in rubber material constructions used in all fields of industry, from household appliances. Purchase of new model rubber panel matrices that can work in a high-pressure aggressive environment at ((-55^0C) – ($+105^0C$)) temperatures, development and preparation of the technology of these matrices not only for valves, but also for non-metallic equipment used in cold or hot climate zones in various industries can be applied as a wear-resistant formulation. Based on what has been mentioned, it can be said that the result of the work done has its own effect in all areas of the industry.

The main provisions defended:

1. The regularity of change of the friction force depending on the bending of the friction part under the conditions of mechanical wear in the bending joints of the binding units has been determined;
2. Analytical expression expressing the regularity of change of the frictional force under the driving force in the sliding friction joints depending on the deflection of the frictional part;
3. The obtained analytical expression is an analytical expression expressing the sliding friction force generated on the contact surface during the movement of the gate, which is applied to the locking joint of the valve and is bent under the influence of the compressive force under the minimum driving force;
4. A new expression obtained for determining the dependence of the compressive force on the sealing contact surface of the plug node of the improved plug valve on the working pressure;
5. A new expression obtained to determine the relative contact pressure and the allowable value of the relative pressure on the contact surface that ensures the mode of the plug joint of the plug valve;
6. The condition of ensuring the functionality of the improved constructions (plug valve and linear motion valve);
7. Analytical expression that determines the regularity of friction-dependent change of the amount of wear on the contact surface of the plug details;
8. A new fuzzy model that provides improved valve functionality prediction based on the proposed fuzzy set theory and a fuzzy model training algorithm based on processed statistical data;
9. Fuzzy model that determines the dependence between the amount of wear of the working surface of the valve gate and its reliability;
10. A fuzzy logic inference model of the distribution of radial stresses generated in rubber sealings within its structural volume was established for the first time;

11. In order to increase the longevity of plug valve sealings, the application of sealings made on the basis of a new material, rubber panel matrix, to plug valves;
12. Industrial application of corrosion-resistant plug joint improved sealing structures for use in various operating conditions.

Scientific innovations of the study The following innovations were obtained in the dissertation work.

- An analytical expression has been obtained that will express the sliding friction force generated on the contact surface during the movement of the bent gate due to the compressive force generated due to the relative pressure on the working surfaces of the improved straight-sided valves stopper joint and based on the obtained analytical expression, it was found that the selection of the gate deflection under the condition $y < x$ (the average pitch length of the board surface unevenness) ensured the minimization of the sliding friction force and the rate of mechanical wear generated in the blocking joint;
- A new expression was obtained to determine the relative contact pressure and the allowable value of the relative pressure on the contact surface that ensures the mode of the plug joint of the plug valve and the dependence of the compressive force generated on the sealing contact surface of the plug joint on the working pressure is determined and based on the received statements, the condition for ensuring the functionality of the improved plug valve was determined;
- For the first time, an analytical expression was obtained that determines the regularity of the friction-dependent variation of the amount of wear on the contact surface of the blocking parts;
- A new fuzzy model based on the theory of fuzzy sets was proposed for the first time to predict the probability of sliding operation without fail and a training algorithm of the fuzzy model was developed based on statistical data;
- For the first time, a fuzzy model has been developed that determines the regularity of variation of the reliability of the valve depending on the amount of wear in its tribojoints and based on the model, the

dependence of the probability of working without refusal on the amount of wear was determined;

- A new material, rubber panel matrix, is proposed for use in the construction of valve sealings to increase their longevity;
- Based on the condition of minimization of potential energy, an analytical expression expressing the stress state of the circular sealing elements of binding units operating under high pressure in an aggressive environment was determined;
- Based on the theory of fuzzy sets, depending on the operating parameters of rubber sealings, a fuzzy model was developed that expresses the dependence of the radial deformation distribution along its volume on the relative deformation;
- For use in various operating conditions, an improved valve construction with new matrix sealings has been proposed, improved binding units for wear-resistant stopper joints have been developed;
- The new valves have been tested for compliance with APİ standards by Hydrasun, and the valves have been tested and certified under the ISO quality mark.

Theoretical and practical significance of the study:

- The solution of the issues raised in the research, the scientific innovations obtained from the determination of the dependence of friction and wear on the material of the tribojoints and the characteristics of the working surface on the contact surfaces, and the application of the scientific results obtained from the study of the resistance of the new material to repeated deformations will serve the development of the science of tribology;
- Determination of the speed, amount and intensity of mechanical wear caused by friction (stillness and sliding) depending on the friction force on the bending surfaces of tribojoints, depending on the material of the parts;
- Organization of the control of the valve's operation by developing the software of the dependence of the reliability of the valve on its rejection parameters on the basis of the theory of fuzzy sets due to the received static data;

- Development of new models of different types of sealings on the basis of a double rubber panel matrix with the method of double matrixing and application to different machines;
- Preparation and testing of new binding units equipped with new model sealings, provided with equal distribution of relative pressure in tribojoint;
-Proposing new constructions designed on the basis of the proposed methodology and achieving economic efficiency by using the valve with high reliability indicators in various environments in the industry;

Applying the developed APİ and İSO quality mark improved valve to the oil and gas industry and also achieving economic efficiency as a result of the use of rubber matrices resistant to freezing, heating and wear as a quality material in the joints of non-metallic equipment. Theoretical solutions are used in the direct extraction of oil and gas, as well as in the design of binding units used in the machinery and equipment of oil refining and chemical production, new constructions of reliable and long-lasting binding units are developed and used in various fields of industry, and they are applied in every field of industry, including household tribotechnical equipment.

The presented scientific issues can be applied in the selection of materials for increasing the wear resistance of machines and equipment used in various fields of industry, in the joints working against friction and bending due to working pressure, as well as on friction surfaces with a high cleanliness class.

Approbation and application: The main results of the dissertation work were reflected in 65 scientific works, including 56 articles and theses, 2 patents, 1 invention and 6 useful models. In 2005-2023, the main provisions of the dissertation were presented and discussed at various conferences and seminars included in the WOS and SCOPUS databases in the country and abroad.

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- MMS100x65 valve with ISO quality mark was used in Umid Babek International Operating Company and applied to Industry;

- An agreement was signed between Makvelsan and ASOIU for mass production of MMS100x65 valves by Makvelsan in Turkey, and the physical model was produced and internationally certified.

The name of the institution where the dissertation work was performed: Dissertation work was carried out at the "Industrial machines" department of ASOIU, at "NeftgazMaş" OJSC and at Makvelsan company of the Republic of Turkey.

Candidate's personal contribution to the research conducted: Dissertation work is the product of personal labor of the candidate and won the competition (EIF-MQM-ETS-2020-1(35)) within the internal project of the Azerbaijan State Oil and Industry University and within the grant competition announced by the Azerbaijan Science Foundation.

The structure and volume of the dissertation: Dissertation work consists of introduction, 6 chapters, conclusion and list of literature and additions. The dissertation is presented in 360 pages of computer writing, the work contains 152 pictures, 29 tables, and 206 names of literature sources in the list of used literature.

CONTENTS OF THE WORK

In the introduction of the dissertation, the relevance of the topic, the goals and tasks of the work, research issues, scientific innovations, the practical significance of the results, the main achievements defended, the state of application in production and the approval of the dissertation are indicated.

In the first chapter, the fountain armatures APİ6A, APİ14D, APİ17D, İSO 10423 and DÜST 13846-84 used in our country are mainly assembled in three throated or four throated schemes (Fig. 1.) and made according to different pressures. The structural structures, deficiencies, reasons for rejection and reliability indicators of the connectors of these equipments were analyzed in a broad background and the design methodology of their new constructions was given.

In addition to high working pressure, binding units included in the complex of topside equipment used in the operation of wells by the fountain method work in complex working conditions with varying temperatures, under the impact of abrasive and mechanical parts contained in the working material, aggressive environment and in contact with highly saline reservoir waters.

These processes are sometimes further complicated by abnormal and high temperature indicators (200…250^{0}C) of the product extracted from the formation. In general, binding units are operated at a temperature of ±60^{0}C, depending on the area where they are used [1][1].

Extracted oil and gas with various chemical composition, wide range of working pressure and production volume, temperature changes are directed to the complexity of universal preparation, specialized implementation of binding units in fountain armatures. Depending on the operating conditions of the binding units working under high pressure, the observed data in order to find out the reasons for the failure, the vast majority of the reasons for the failure of the fountain armatures equipped with a straight-flow drawer were

[1] Tıxaclı kranların tıxac düyünün sürtünməsinin tədqiqi.Aslanov, C.N.

attributed to the binding joint of the valves. The service life of fountain armatures until failure varies between 2520÷3430 days.

From our research, it appears that most of the rejections of binding units fall on the share of binding joints. Also, the causes of failures are mainly related to the failure of sealings of binding units. Analyzes of both research directions show that failures in binding units occur in different types and frequencies, reducing the reliability of the fountain armature as a whole. Most often, the loss of functionality occurs in the binding units installed in the main pipe of the fountain armature. The failure intensity of the binding units installed in the arms and buffer of the fountain armature is low[30]. Binding units that have lost their functionality for any reason reduce the reliability of the fountain armature.

The systematization of the reasons for the failure of the valves included in the class of binding units shows that mainly the problems are whether the valves themselves open or close completely, such as wearing the working surface of the gate and seat ring (26%), breaking of the bow of the gate (38%) and failure of the hermetic elements (36%) reveals. Due to the fact that the valves remain closed for a long time, their management is impaired at one level or another. During commissioning of the valves from this part, it is observed that the movement nut and sometimes the "T" wedge slot of the gate are broken. The study of the failed parts shows that one of the main reasons for the collapse of the wedge socket is the aggressiveness of the environment The intermittent flow of liquid and gas through the valves corrodes and mechanical wear its parts [2][2].

Due to the friction created on the contact surface of the parts of the slide under pressure at rest and in motion, its parts and joints fail without being wear. When the relative pressures in the affected parts are unevenly distributed, the scale of external wear factors affecting the working surfaces increases many times, causing its rapid failure.

Abrasive particles in the composition of the working solution have a serious effect on the longevity of the valve.

[2] Təkmilləşdirilmiş tıxaclı kranın işqabiliyyətliyinin yüksəldilməsi. Aslanov, C.N.

Depending on the abrasives in the solution, the service life of the valves can vary from several weeks to several years.

The processing of the above shows that the short life of the parts is mainly caused by the mechanical wear on the working surfaces. The criterion for mechanical wear is friction. Every scientific research work conducted in this direction can be considered relevant.

Currently, research work on increasing the working capacity of valves is being carried out in 3 directions:

- study of the effect of physical-mechanical properties of contact surfaces on inter-pair friction and wear, taking into account the influence of the environment;
- application of polymer materials to the contact pose between the metal surfaces of the stopper joints parts and to ensure equal distribution of the relative pressure in the contact areas;
- through the supply of lubricating liquid and solid lubricants to the contact surfaces.

The results of studies on the dependence of contact wear on the method of processing contact surfaces show that the value of wear varies depending on the chemical-thermal strengthening of contact surfaces and contact pressure.

The cost of mechanical wearing also depends on the aggressiveness of the working environment. The rate of wear varies depending on the corrosion properties of the product passing through the valves. This is especially observed in the transportation of products containing H_2S [3][3].

Our observations on the effect of the product from 125 heavily watered wells located on the Absheron peninsula on the durability of the valves showed that the average service life of the valves (t_{or}) depends on the volume of water contained in the product extracted from the well (Q_s).

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[3] Təkmilləşdirilmiş siyirtmə konstruksiyalarının tıxayıcı düyünlə işlənməsi. Aslanov, C.N

Depending on the production technology, genetic defects (cracks, gaps, pores) may appear in the binding structures.As a result of slight wear on such surfaces, defects are detected and cause rapid disintegration of the surface. Defects of this type in the parts of the stopper joint quickly cause the valve to fail. Eliminating such defects caused by technological reasons can create the basis for increasing the reliability of the valves and increasing the longevity of the locking joint.

Another factor that affects the working ability of the jamming joint and the solution of which is obtained from a technological point of view is the unevenness of the contact surfaces and their flatness.

The results of scientific research have shown that as the pressure of the liquid in the valves increases, the roughness and unevenness of the surfaces of the stopper should be under strict control. (70 – 140)MPa working pressure valves, contact surface unevenness should not exceed 5...8mkm and roughness should be between 0.32...0.08mkm. The studies conducted on the wear resistance of the locking joints of the valves showed that the wear resistance of the sealing surfaces is a complex, multi-factorial process that depends on the correct solution of the construction of the parts involved in the contact, the selection of the material taking into account the operating conditions, the manufacturing technology, and the degree of aggressiveness and abrasiveness of the environment [4][4].

The contact surfaces of the currently used valve stopper joint are obtained on the basis of three principles. These are the following:

- metal – metal;
- provision of metal-metal sealing lubricating oil;
- metal-rubber (elastic element).

Regardless of the choice of these principles, one or another wearing process takes place in the parts included in the stopper joint. Among them, abrasive wear is important.

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[4] Təkmilləşdirilmiş siyirtmə konstruksiyalarının hissə və düyünlərinin seçilməsi. Aslanov, C.N.

The vast majority of oil-gas-mining equipment, including fountain armatures, are exposed to abrasive wear due to the influence of the working product during operation. This is due to the presence of sand grains and other solids in the working product.

Abrasive particles that fall between the contact surfaces of the locking joint of the valves participate in the friction process and transfer force from one part to another, forming scratches on the surfaces. Later, these scratches turn into cracks in the sliding direction, breaking the locking joint of the valves and causing failure.

Since abrasive wear occurs with the presence of the working product (gas, oil, condensate, formation waters, etc.), the intensity of wear is determined by the physical and chemical properties of the liquid or gas. The results of the works conducted in this direction show that the intensity and mechanism of abrasive wear in different oil environments are different. Oil with different viscosities and oil emulsions containing a wide range of reservoir waters were adopted for the tests by the authors. According to the research results, it was determined that as the viscosity of the oil increases, the depth of the scratches formed on the contact surfaces and the value of the sawdust formation coefficient decreases. The depth of scratches increases as the amount of formation water in oil emulsions increases [5][5].

A similar situation is observed during the study of friction force and friction coefficient.

As a result of the study of the reliability and durability of the valves in sandy wells, it was determined that their efficiency is very low. Most of them have lost their functionality as a result of wear of sealing working surfaces.

Inspection of the valves after use shows that abrasive wear has occurred on the working surfaces. During the opening and closing of the valves, grains of sand falling between the gate and the seat ring scratch the gate or the working surface of the seat ring. Over time, these scratches become channels.When these surfaces are fully aligned,

[5] Siyirtmələrdə nisbi təzyiqin bərabər paylanmasının tədqiqi. Aslanov, C.N.

these channels create gaps between the surfaces, and these gaps will cause the product to leak into the outlet throat. The high-pressure fluid will turn these gaps into grooves, causing the valve to fail. This is abrasive and hydroabrasive corrosion that quickly destroys the binding units in sandy wellsIf such cases are discovered in time, the work is stopped, the binding units is dismantled and repaired. When the blocking joint is restored, the work is resumed.

The functionality of the valves and its locking joint depends very much on the optimal solution of their material supply and the correct determination of the operational parameters depending on the working conditions. Optimum solution of material provision refers to correct selection of materials strength, hardness and other physical-mechanical properties of the parts in contact (gate- seat ring, plate–ring, etc.).

Determining the operating parameters depending on the conditions takes into account the effects of corrosion conditions, vibrations and shocks, as well as temperature and pressure changes.

According to the API standards, the choice of material for the parts of the stopper joint of the valves is determined depending on the corrosion environment. Thus, the parts of the stopper joint of the valves used in the transportation of the working product containing up to 25mg/l mechanical mixtures and up to 6% H_2S and CO_2 should be made of steel 38XMЮA, steel 20X13 and steel 30X13. Parts (seat ring and gate) can also be made of carbon and low alloy steels. In this case, their working surfaces should be covered with wear and corrosion-resistant materials [6][6].

In order to increase the operating performance of the valves, it is proposed to cover the surfaces of the gate and the seat ring with wear resistant metal powder, as well as to polish these surfaces using a technologically new method. As a result, the improvement of the tribotechnical properties of the stopper joint of the valve and the increase of the service life by 1.4...1.5 times were achieved.

[6] Neft-mədən avadanlıqlarının əyilməyə işləyən düyünlərində yaranan sürtünmə halının tədqiqi. Aslanov, C.N.

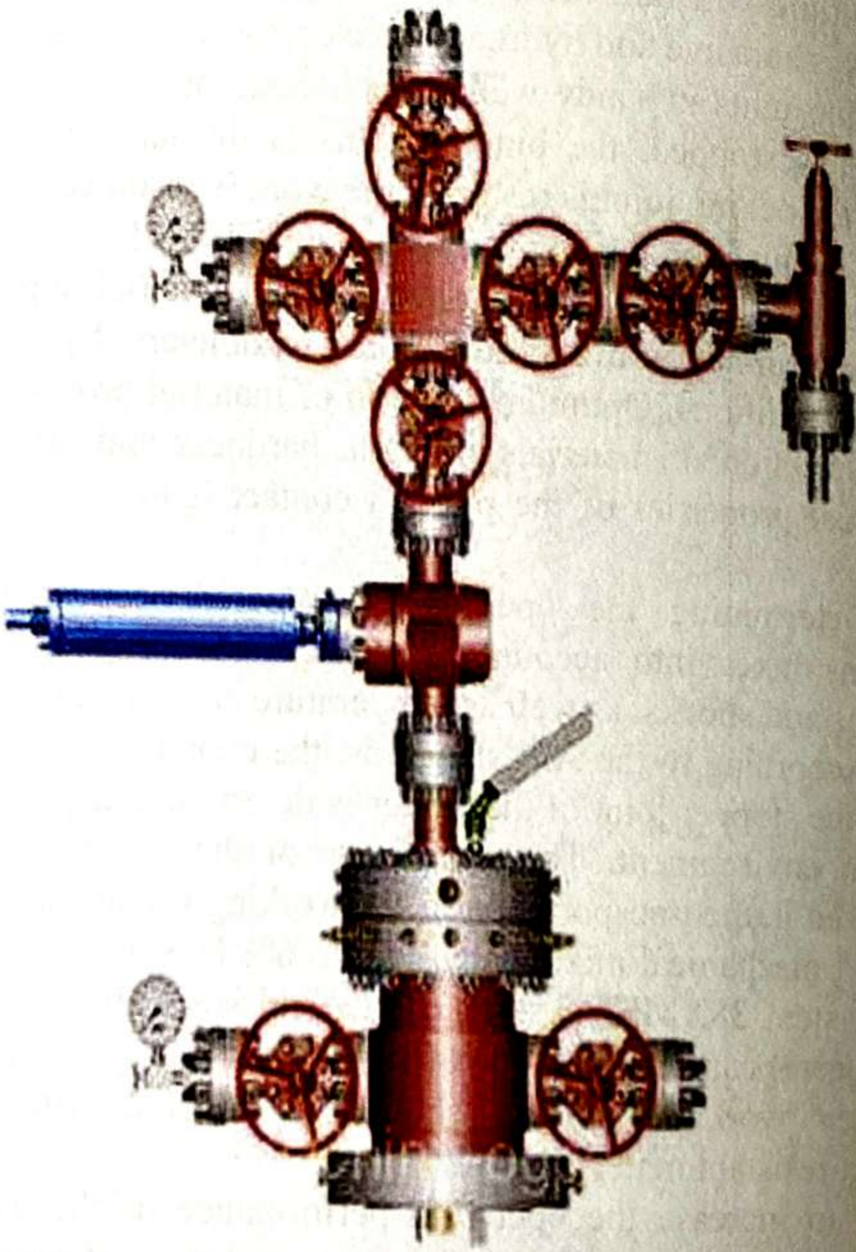


Figure 1. General view of the fountain armature

As a result, the improvement of the tribotechnical properties of the stopper joint of the valve and the increase of the service life by 1.4...1.5 times were achieved.

In the preparation of the stopper joint, along with the accurate preparation of its parts in terms of size and shape, their corrosion resistance should also be ensured.

The results of the research of the materials recommended for the parts of the stopper joint in different environmental conditions showed that the Al_2O_3 layer impregnated on the surface of the tip by means of hot shock is second only to stellite in terms of corrosion resistance. In an environment containing H_2, the Al_2O_3 coating is more durable than stellite. The carbonitrided surface, which is unstable in formation water, is more resistant to corrosion than steel 20X13 in an acid mixture and in an environment containing H_2.

The contact corrosion resistance of stellite material with aluminum oxide is higher than other materials. Carbonitrided samples aren't resistant to contact corrosion. But in this case, the corrosion rate is 280-290 times lower than the general corrosion rate [7][7].

One of the causes of wear in the valves is related to pressure changes in the well. Inspection of valves operating under this type of condition shows that fretting wear occurs at the gate-seat ring joint. Pressure changes cause relatively small-amplitude vibrations in parts of the jammer joint, and the frequency of these vibrations varies from 3 to 273 hs.

As a result of the conducted bench experiments, it was determined that depending on the cycle of pressure changes, the sealing of the valves is broken. After the value of the cycle exceeds the limit of $2{,}2 \cdot 10^5$, as a result of the collapse of the geometric forms of the contact surfaces, the working product began to fill the inner surface of the body of the valve.

During the visual observation of the parts of the plug joint, it was determined that traces of the seat ring are visible on the working

[7] Tribodüyünlərdə yeyilməyə davamlılığın artırılması. Aslanov, C.N.

surface of the gate. This fretting is explained by the occurrence of corrosion wear. As a result of the research, it was determined that the samples made of 20X13 steel from 40X, 38X2MЮA and 20X13 materials showed high resistance to fretting wear in the tests on the durability of the parts of the plug joint in the conditions of aggressive oil and oil products.

As a result of research conducted on the selection of optimal valuesof structural parameters and strength limits of the parts of the stopper joint, as well as on obtaining full sealing, it was determined that the effect of pressure changes must be taken into account at the design stage [8][8].

By adopting the necessary structural solutions to increase the efficiency of the Fontan armatures and the binding units used with their assembly, it is possible to increase their sealing and facilitate the work mode. In this direction, in the design process, it is one of the important issues to ensure the correct material supply of valves and cranes according to their working conditions.

Ensuring hermeticity behind the metal-metal surface, between the joints and at the ends in the nests of the joint details of the binding units is carried out directly by means of elastomeric sealings. Sealings are mainly made of rubber material and have different constructions. Mainly circular, rectangular, trapezoidal, triangular and Y-shaped sealing rings are used in binding units. Round cross-section and Y-shaped sealings are the most used sealings.

The mentioned sealings are designed to create complete hermeticity between metal-to-metal sets, as well as behind and in the slot of threaded joints.

Generally, the best sealings used in the design and design of machine and equipment sealingss are rings with a circular cross-section. According to API standards, the materials of the circular cross-sectional sealing rings are Ethylene Propylene (EPM, EPDM, EP, EPR), Fluorosilicone (FVMQ), Nitrile (NBR or Buna-N),

[8] Neft-mədən avadanlıqlarınn bağlayıcı qurğularının tribotexniki düyünlərində yeyilməyə davamlığın tədqiqi. Aslanov, C.N.

Perfluoroelastomer (Kalrez ® (FFKM), Silicone (VMQ), Polyurethane (AU , EU) Fluorocarbon (Viton, FKM), Neoprene (CR, Chloroprene) are used. According to the technical indicators of circular cross-section sealings, their technical parameters are standardized according to the BS1806 standard and DÜST 14896-84.

In other words, both rubber and metal elements are exposed to the influence and pressure of the working environment. In this regard, many studies have found that friction problems and fatigue are the main reasons for the failure of this joint, depending on the nature of two main effects:

I. Uneven distribution of relative pressure in the structure of the structure;

II. Resistance to friction and wear of the material of its parts and connections.

Our research shows that it is necessary to ensure equal distribution of pressure, to update the structure of the faucet sealings and their constructions. New sealings should have such a construction that the compressive force caused by the working pressure on their sealing surface is evenly distributed. Binding units with such a sealing have been constructed and approved by the patents of the Republic of Azerbaijan. The design feature of these valves is that, depending on the working pressure, its stopper section has the ability to bend to the right and left by micromillimeters. The rigid resistance of one of the parts included in the design of the stopper joint, and the micron deflection of the other into the internal cavity above, is the reason for the uneven distribution of pressure within the structure. Thus, the gate placed on the seat of the seat ring is folded into the inner cavity of the seat under high pressure .As a result, the pressure is unevenly distributed in the gate-seat pair. Bending of the gate with the seat ring included in the plug joint of the proposed constructions will ensure the equal distribution of the relative pressure between the surfaces as possible, and will also create the friction between the contact surfaces.

As a result, wear caused by wear between the surfaces will occur evenly across the surface. This will ensure that the sealing effect is maintained for a long time.

Conducted theoretical and experimental studies have shown that the following parameters should be taken into account when developing new binding units.

1) ensuring equal distribution of pressure on the working surfaces of the structural unit;
2) creation of joint between pairs to ensure the creation of parallel wear on working surfaces;
3) selection of parts material based on friction correlation.

In order to design efficient and reliable binding units, it is necessary to determine and justify the design parameters of construction.

The construction parameters of binding units are as follows:

a) geometric dimensions of details;
b) mechanical stresses arising in details;
c) properties of materials of details;
d) strength and hardness levels of working surfaces;
e) the structure of placing details within the construction;
f) required ergonometric indicators.

In the design of binding units, the operating parameters of the environment are the main required design parameters. Thus, the working pressure of the environment is the cause of the mechanical tension in the details of the construction, and the increase in its value will lead to an increase in the value of the tension.

The long-term performance of parts directly depends on the hydrostatic pressure acting on them and their stabilityto pressure. The structural structure of the details should be chosen in such a way that, while performing their duties, they can withstand the stresses they experience due to the effect of working pressure. At this time, the most important goal is the equal distribution of the relative pressure on the working surface of the details.

The clogging joint of the valve is the source of its rejection. Its gate and seat ring pair are pressed against each other with high pressure to ensure the sealing. A rectangular gate sits on an annular seat ring and is in contact under the force created by the working fluid. Here, the width of the contact between the two details is determined depending on the value of the pressure that can be released by varying between 12...32mm. Under pressure, the gate bends over the annular surface of the seat ring. The amount of this deflection is one of the main conditions for ensuring the sealing between the gate and the seat ring. To ensure the functionality of the valve, the amount of bending should not exceed 5 mkr.

In this case, the thickness of the gate is one of the main parameters characterizing the bending. Its thickness is determined depending on the value of the allowable deflection caused by the working pressure when the valve is closed.

One of the main reasons for the acceleration of their rejection in the contact of this pair is the uneven distribution of the relative pressure on their contact surface. Uneven distribution of relative pressure prevents the completion of inter-pair contact, causing non-parallel wear. This issue also gradually leads to rejection of the valve. It should be noted that uneven distribution of relative pressure increases the scale of mechanical wear during operation many times, so ensuring equal distribution of relative pressure by numbness between surfaces is one of the main issues that we set in our research work.

- equal distribution of relative pressure in the stopper joint;
- resistance to mechanical wear;
- ensuring the strength of the contact surfaces, taking into account the influence of the environment;
- resistance of materials of body and parts to mechanical stresses;
- having low metal consumption;
- ease of manufacturing technology;
- resistance of materials of parts to low or high temperatures.

Conducted studies show that depending on the working pressure and small particles inside the product, erosion wounds exist in the inlet throat of the valve and inside the connecting tube. These wounds reduce employee resources and increase the risk of refusal. In the investigation of pressure-dependent changes in the depth of wounds, it was found that regardless of the properties of the material, the characteristic result is an increase in the depth and length of wounds as the pressure increases.

The long-term functionality of the valves depends on the equal distribution of the compressive force generated by the working pressure in its tribotechnical joints along the contact surface, the achievement of inter-pair contact in the initial contact, and the selection of materials suitable for the working principle of each part. Vanaların sıradan çıxmasına səbəb olan aşınma növlərindən biri də aşınmadır. This wear is caused by the dynamic forces on the contact surfaces of the gate-seat ring pair. Fretting wear in valves remains a pressing issue today.

The operability of faucets with plugs of fountain armatures mainly depends on ensuring the sealing of its plug. During operation, due to the force generated by the working pressure of the liquid, the contact surface and the connecting parts of the plug of the plug valve, which ensure the shape, are subjected to deformation. The sulfur compounds inside the product will gradually erode the metal-to-metal surface of the gate and seat ring. Abrasive particles inside the liquid will enter between the pair of gate and seat ring and deform their working surfaces, making it difficult for them to open and close.

As a result, the material will be tired from the mechanical stresses and repeated deformations arising from the dynamic forces, and due to the formation of cracks or scratches on the working surface of the details of the plug, the stopper jointwill gradually disintegrate.

As a result of research, it was found that the factors that lead to the gradual failure of the jammer are the following:

1. Deformation of working surfaces depending on the working pressure of the product;
2. Generation of long-term tensions due to dynamic forces;
3. Surface destruction due to abrasive and hydroabrasive wear;
4. Mechanical wear on working surfaces.

It should be noted that the provision of molding on the back surfaces of the metal-metal moldings of tribotechnical joints of the equipment is carried out by the application of rubber moldings. Sealing cuffs and rings are made using ANQ type rubber elements. Since the rubber elements are the weak point of the equipment and perform the sealing work, their failure leads to the failure of the binding units

During operation, the sealing joint of the binding units are deformed due to dynamic load. Time-varying deformations and long-term mechanical stresses tire the material and cause the formation of internal cracks. Rubber elements are destroyed due to vibrations, friction and partially wearing surfaces meeting with impact and physical resonances generated in the sealing joint[112, 200].

As a result of the conducted research, the factors that will lead to the rejection of the sealing joint have been identified and are as follows:

1. Generation of uneven internal stress along the contact surface due to cyclic (periodic) driving force;
2. Generation of stresses and relative deformations on the spatial plane in cuffs;
3. Fatigue of rubber material from physical resonances and repeated deformations caused by dynamic forces inside the joint;
4. Formation of microcracks inside rubber elements as a result of fatigue.

Based on the above, it can be said that the failure of the plug or jamming joints will lead to the failure of the binding units so the failure of the rubber elements will lead to the failure of the sealing joints. These failures will lead to failure of the entire fountain armature.

The preliminary result of the research raises the need to design new binding units. Based on these indicators, the main directions of the research and improved valve and faucet constructions were selected as objects.

The second chapter is devoted to the determination of the main directions of the research work, the research object and methods of implementation.

As a result of the investigation and analysis of the current structural structures of existing valves, efficiency criteria and the reasons for their failure, on the basis of the materials collected about the scientific research works characterizing the scientific basis of the development of new valves, the spindle-nut joint is released from pressure without maintaining the working process, and the sealing elements are highly self-adjusting the scientific idea of capable, wear-resistant, easy-to-operate valve and plug faucet constructions has been developed. These structures are designed for fountain armatures, fountain and drill manifolds, center blocks and pipelines.

A new valve construction of the MMS 100x70 (Figure 2.1) type was chosen as the research object. The advantages of the new valve construction are that the spindle nut joint is free from the working pressure of the liquid, the pressure is evenly distributed in the stopper joint, it is equipped with rubber seals with a self-priming effect of a new design to ensure that the pressure is evenly distributed on both sides of the stopper joint, and it is resistant to friction, scraping and wearing. increasing.

The general assembly line of the selected valve structure was developed and working drawings of its individual details were prepared. In order to ensure the principle of equal distribution of pressure in the plug joint of the structure, the thicknesses of the first and second seat ring and gate added to the structure were worked out based on the established methodology and practically applied to the valve structure. It was also determined that the selection of the dimensions of the sealing intended to sit between the first and second seat ring is a matter of principle, and its material is determined depending on the environment. The working drawings of the trapezoidal clamping rings and the molds necessary for their preparation have been developed. On the basis of the mentioned technological processes, a new type of valve structure and technical passport was developed [See attachments].

The general working drawings of the new valve construction were developed by me as a result of the methodical calculations mentioned above, and MMS 100x70 (Figure 2.1.) and MMS 65x35 type valves were made at "Neftgazmash OJSC"..

The MMS100x70 valve is designed to ensure and prevent intra-pipe transport of high-pressure liquids, directed in any direction, in oil and gas wells drilling manifolds used in oil and gas well drilling, oil refining and chemical industry facilities, and also in various industrial areas under aggressive environmental conditions at a working pressure of 70MPa. intended to receive [27][9].

On 17.06.2021, the functionality test of the valvewas successfully carried out in the Azerbaijan branch of Hydrasun Ltd and with my participation. In order to obtain a certificate confirming compliance with the requirements of ISO 102423 (API 6A), all the joints of the valve were perfectly tested for 8 hours. On 23.06.2021, the MMS100x70 valve was issued a certificate of compliance with international standards.

Also, the new model MMS100x70 valve was checked for compliance with API International standards, the pressure resistance and durability of its parts was checked at 105 MPa, and the ISO quality mark for workability was applied to the valve by Hydrasun Rapid Solutions LLC. On 23.06.2021, Hydrasun company presented International Quality Certificates to ASOIU.

We are looking for the innovations to be achieved in the new valves in the solution of the following issues.

- In improving the construction of parts of machines and equipment
- In automating their management
- Design and self-monitoring (diagnostic) systems at the top level (in predicting the information obtained on the guarantee of their functionality) and so on.

Our overall goal is to define new principles in the issue of improving the construction of machine and equipment parts and to improve the valve construction used in the oil and gas industry based on this principle. Parts of machines and equipment working under pressure undergo a state of tension deformation due to the pressure force. These deformations create negative effects and reduce the longevity of the machine and equipment.

9 Düzaxınlı siyirtmə, Faydalı model U2007 0006. Aslanov, C.N.

For this reason, in addition to using certain methods to eliminate complications caused by stressful situations, we can use these deformations to obtain a positive effect for another joint of machines and equipment.

Such an effect can be called a combined effect from the movement of any of the parts and details of machines and equipment (deflection, deformation, running distance, etc.).

The main issue in designing new valve structures is to generalize the shortcomings of existing valve structures. The main problem factor in the existing valve constructions is the uneven distribution of relative pressure in its sealing joints. A complication caused by this problem is a scraping phenomenon caused by the valve gate bending over the seat ring. In Chapter 1, the reasons for the uneven distribution of relative pressure are fully explained. As a result, we can say that in order to get rid of the cutting of the working contact surface caused by the scraping event, it is accepted to ensure that the deflection of the gate on the seat ring varies between 3-5 microns.

Even if the acceptance of bending in the specified amount prevented of scratching, it did not prevent the uneven distribution of the relative pressure on the working surface. However, in the contact between the gate and the seat ring, the value of the relative pressure is maximum in the central parts, and minimum in the edges.

In this case, in addition to the beginning of non-parallel wear, it increases the scale of various wears that occur in the sealing joint of the valve, causing the valve to fail. This issue is the first problem that existing valves give up.

A second problem with existing valves is the leakage of the sealing elements. Leakage of rubber cuffs placed mainly in the spindle-nut joint has become a common occurrence in practice. These cases occur regularly due to the fatigue of the materials of the cuffs and the instability of the environment. The main factor in this matter is the temperature and aggressiveness of the environment. Also, cracks occur on their seating surfaces due to incorrect seating of the sealing elements in their lairs or, if we mention it as a reverse issue, due to incorrect selection of the structural parameters of the lairs.

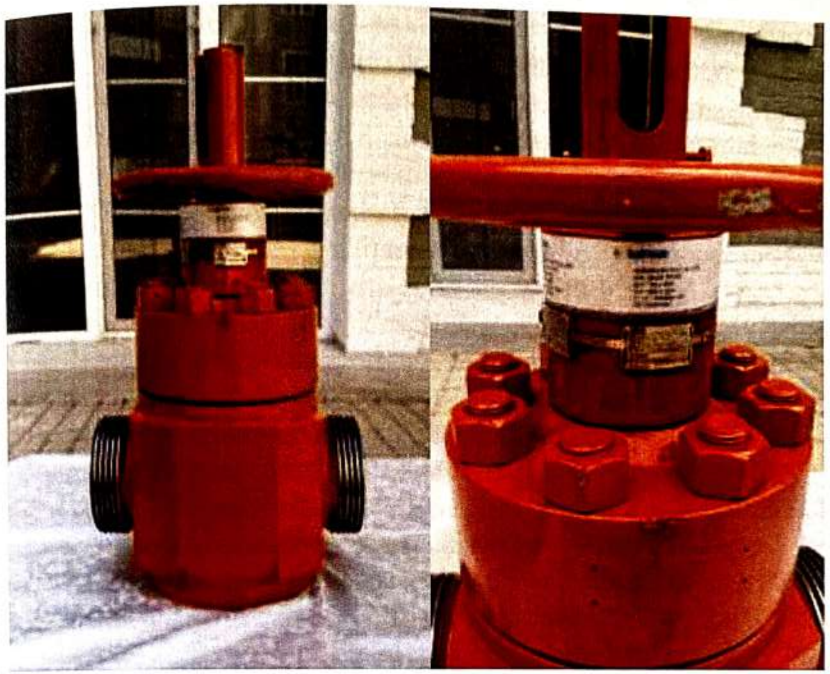


Fig. 2.1 Prepared MMS 100x70 type general view of the valve

The third problem is the abrasive, hydroabrasive and gasoabrasive wear caused by the small solid particles and sulfurous compounds contained in oil and gas products on metal-metal and metal-rubber contact surfaces. In a word, the material of the parts and joints of the valves is still somewhat unstable against the ambient temperature and mechanical wear. Therefore, proper selection of materials is required in the design of new constructions.

In order to solve the mentioned problems, the design of new valves was carried out in the following scientific-methodical sequence.

- Equal distribution of relative pressure between gate and seat ring pair is ensured in the valve;
- Its cuff and rubber elements are made of panel rubber matrices;
- The degree of relative deformation of the sealings was taken into account in the selection of the design parameters of the sealings' lair;
- In the selection of the material of the parts and joints of the valve, the selection of material was ensured based on international practices and it was subjected to a special thermal treatment process.

Thermal processing of valve parts was carried out as follows:

In the preparation of the valve, it is necessary to choose the material in such a way that the material meets the necessary requirements and has an economically advantageous price. The body is made of Steel 20XGS brand material by casting method. After casting, normalization process is followed by mechanical processing. In the process of normalization, the hull is kept in an electric or gas furnace at a temperature of 8600-8800C for 5 hours. Then the furnace is turned off and the hull together with the furnace is heated in the furnace to a temperature of 5000 C, and then removed from the furnace and cooled in air. When the hardness is 216... 255HB, the body is suitable for processing.

The gate is made of Steel 20X13 brand material. The preparation process is carried out in the following sequence of operations. First, it is carried out by cutting, forging, mechanical processing, thermal processing and polishing. Even if the steel is made of 40X brand material, the manufacturing process is carried out in the following sequence of operations. First, it is carried out by cutting, forging, mechanical processing, thermal processing and polishing. The procedure of plating and annealing is carried out according to the mentioned rules. During the plating process, the parts are kept in an electric or gas furnace at a temperature of 8600 ± 100C for 2 hours and cooled in oil. During the annealing process, the parts are kept in an electric or gas furnace at a temperature of 2500 ± 300C for 1.5 hours and cooled in air. The seat ring is made of steel 40X brand material. The preparation process is carried out in the following sequence of operations: İt is carried out by cutting, initial mechanical processing, thermal processing, final mechanical processing and polishing. The procedure of plating and annealing is carried out according to the mentioned rules. During the plating process, the parts are kept in an electric or gas furnace at a temperature of 8600 ± 100C for 1,2 hours and cooled in oil. During the annealing process, the parts are kept in an electric or gas furnace at a temperature of 2500 ± 300C for 1 hours and cooled in air. The drive screw is made of steel 20X13 material. The preparation process is carried out in the following sequence of operations. İt is carried out by cutting, initial mechanical processing, thermal processing, final mechanical processing and polishing. During the plating process, the parts are kept in an electric or gas furnace at a temperature of 8600 ± 100C for 1,2 hours and cooled in oil. During the annealing process, the parts are kept in an electric or gas furnace at a temperature of 2500 ± 300C for 1 hours and cooled in air. Plate-shaped spring steel is made of 60C2A brand material. The preparation process is carried out in the following sequence of operations. İt is carried out by cutting, initial mechanical processing, thermal processing, final mechanical processing and polishing. The procedure of plating and annealing is carried out according to the mentioned rules. During the plating process, the parts are kept in an electric or gas furnace at a temperature of 8600 ± 100C for 0,5 hours and cooled in oil. During the annealing process, the parts are kept in an electric or gas furnace at a temperature of 2500 ± 300C for 0,3 hours and cooled in air.

Rubber elements: Sealing ring (a sealing element between two seat rings) is made by baking ИРП 1293 rubber through a specially prepared press form (mould) and is made in the form of a panel matrix by a special method. Sealing ring 118 -124 -36. ИРП 1293 brand rubber is prepared by cooking through a specially designed press form (mould).

The third chapter is devoted to the study of the friction generated in binding units. The reliability and longevity of equipment used in various industries depends on the durability of friction parts. Depending on the type of binding units, their tribotechnical joints have different constructive forms. Valve stoppers, the most common type of fasteners, are tribotechnical joints that work on bending. The influence of the friction force between the gate and the seat ring on the wear of the surfaces as a result of the bending of the gate by sitting on the annular surface due to the pressure force and the movement of the gate under this bending has been studied.

The dependence of the friction force on the deflection of the gate was determined.

$$F_{s\ddot{u}r} = \frac{3d^4}{1024Exh^3} \cdot P^2{}_i \cdot \frac{(1-\gamma^2)(5+\gamma)}{(1+\gamma)} \cdot \pi\mu \qquad (3.1.)$$

where, h-is the thickness of the board; E-Yung module; P-is the working pressure; y-the maximum deflection of the board; x- the path traveled by the average step length of the surface unevenness of the board during sliding friction; β-the angle between the direction of the pressure force and the direction of the deflection of the board; α- is the angle between the direction of movement of the board and the direction of the force that ensures its movement.

The expression (3.1.) will express the sliding friction force caused by the minimum driving force when the board changes from the stilness friction state to the sliding friction state. If we analyze expressions (3.1)- mutually, the minimum force required to move the board at different deflections of the board without changing the

surface cleanliness class under a constant force becomes $F_h = F_{six}$ when $y = x$, $F_h < F_{six}$ when $y < x$, $y > x$, then $F_h > F_{six}$ is true. This means that the value of sliding friction force will also change in the same sequence. The sliding friction force changes to a minimum when the deflection of the plate $y < x$ under the minimum driving force when $y = x$ the sliding friction force varies within the mean range and when $y > x$ it will have changed to the maximum limit. So, under the condition $y < x$ of the deflection of the frictional parts of the equipment joint, the sliding friction force on the contact surfaces will have changed to a minimum.
The sliding friction is as follows,

$$F_{sür} = \frac{12d^2}{1024Exh^3} \cdot \frac{(1-\gamma^2)(5+\gamma)}{(1+\gamma)} (\pi \frac{D^2{}_k}{4} \cdot P_i + F_{kq})\mu, \qquad (3.2)$$

here, the coefficient of sliding friction for metal-metal contact is assumed to be $\mu = 0.1$.

The formula (3.1) will express the sliding friction force generated on the contact surface during the movement of the curved gate under the minimum driving force due to the compressive force in the plug joint of the valve.

According to the expression (3.1) when the deflection of the gate under the minimum driving force for the existing valve structure is $y < x$, the sliding friction force will change to a minimum limit depending on the driving force.

In the choice of the parameters of the gate of the locking joint of the slide, ensuring the change of its deflection in the $y < x$ condition will ensure that the rate of mechanical wear on the contact surfaces is reduced to a minimum.

In order to solve the mentioned reasons, the following conditions were taken into account in the development of new constructions of the occludering joint.

- the construction of the seat ring should be chosen in such a way that the working surface of the seat ring is equally bent during the maximum deflection of the gate;
- the sealing joints must be reworked based on this deflection;
- the material selection of the occlusioning joint details should be renewed and the renewal should be carried out according to the working principle of the structure;
- In order to ensure the smooth flow of liquid in the working of the occlusioning joint in wedge valve constructions, the back and forth movement of the seat ring must be ensured at the moment of tightening and opening of the wedge angle during the back and forth movement of the gate.

In order to ensure the workability of the proposed structure, the thickness of the stopper, which ensures the workability of the maximum deflection of the gate, must meet the following conditions.

$$h \in \left[\sqrt[3]{\frac{12 \cdot P \cdot D_0^4 \cdot (5+\gamma)(1-\gamma)}{1024(1+\gamma) \cdot y_{min}}}; \sqrt[3]{\frac{12 \cdot P \cdot D_0^4 \cdot (5+\gamma)(1-\gamma)}{1024(1+\gamma) \cdot y_{max}}} \right] \quad (3.3)$$

The specified thickness of the gate is 1.5 times smaller than the existing thickness of the gate, which leads to a decrease in material consumption. New constructions of the opening and closing mechanism of the valve must be developed to ensure the safe operation of the valve at the specified thickness of the gate. In this sense, keeping the existing thickness of the gate, the newly developed and proposed valve construction has demonstrated high reliability and durability during the experiment. The back and forth movement of the gate becomes 1.2 times easier.

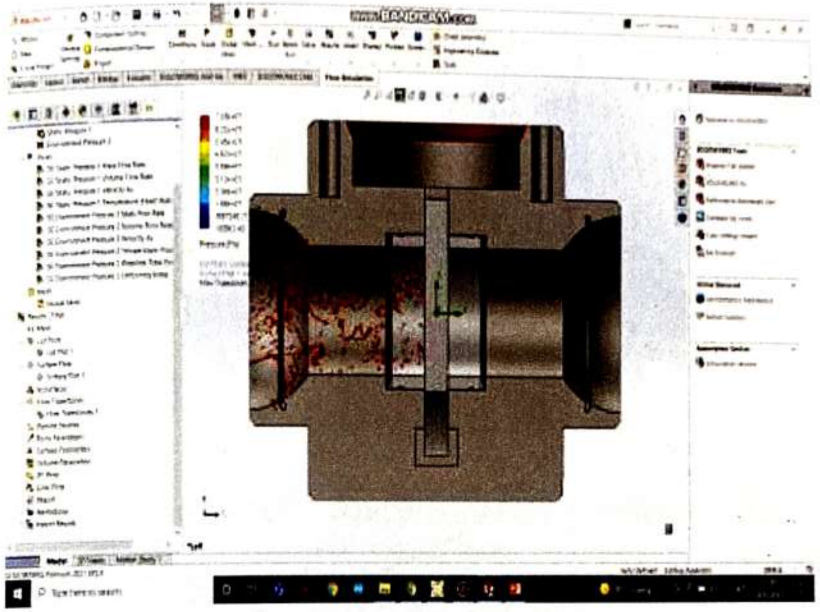


Figure 3.1 Fluid flow trajectory in the closed state.

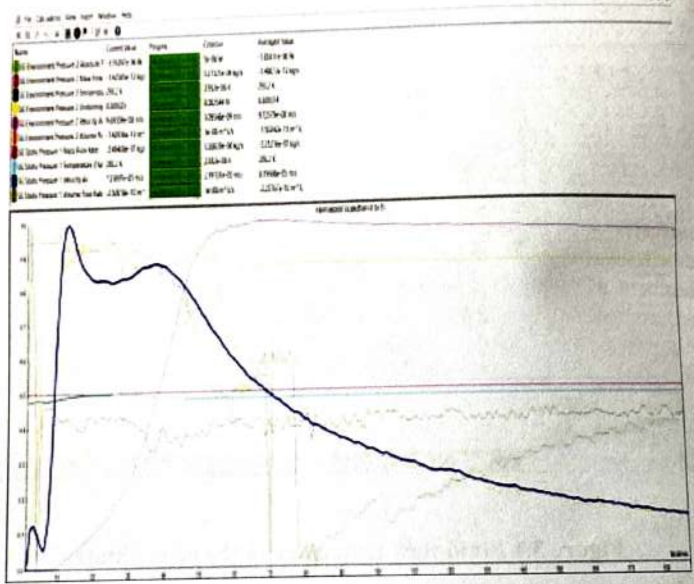


Figure 3.2 Results of liquid flow analysis in the closed state.

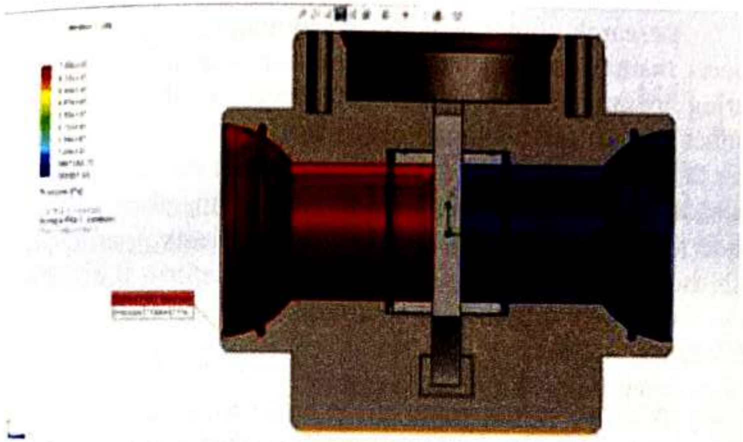


Figure 3.3 Distribution of fluid pressure along the inner surface in the closed state.

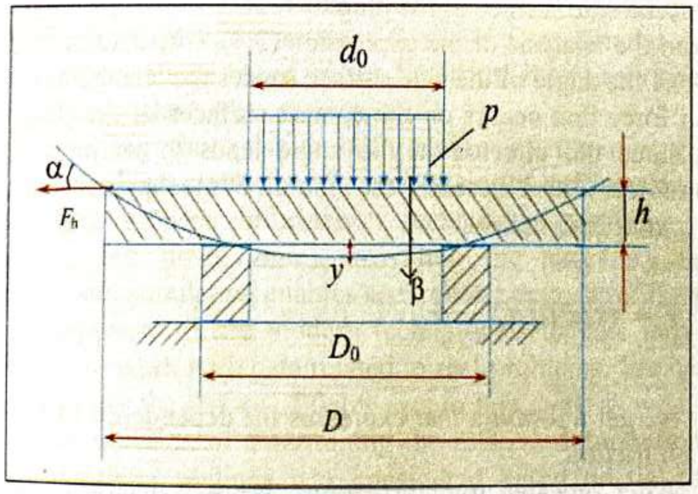


Figure 3.4. Bending characteristics

Research shows that the performance of high-pressure plug faucets mainly depends on how to ensure the sealing of its faucets. During operation, due to the pressure created by the working fluid, the contact surface and mating slots of the parts of the plug joint of the plug faucet are subjected to relative pressure. At the same time, sand grains and sulphurous compounds moving together with the liquid inside the liquid erode the metal surface. Abrasive particles, together with the liquid, enter the working area and deform the surface of the plug, making it difficult to open and close it. The reason for this difficulty is friction.

Frictional force in improved cranes

$$F_{s\ddot{u}k} = \pi D_k^2 \cos\alpha \, p\mu \tag{3.4}$$

will be determined by the expression.

The expression (3.4) will determine the dependence of the silence friction force in the contact area of the plug with the body on the angle of the side surface of the plug.

From the analysis of the expression (3.4), it is determined that the change of the angle of the side surface causes the change of the silence friction force that occurs on the contact surfaces of the plug with the body. Since the increase in the angle leads to an increase in the friction force, it also increases the amount of mechanical wear.

After conversions

$$Y = \pi k \mu P D_k^2 \sigma_k^m \frac{\omega R_t}{F_{s\ddot{u}k}} \tag{3.5}$$

we get a formula that expresses the dependence of the wearing speed on friction.

After repeated transformations, we will determine the law of variation of the amount of wear depending on the friction force.

$$U = \pi k \mu t P D_k^2 \sigma_k^m \frac{\omega R_t}{F_{sük}} \tag{3.6}$$

The expression (3.6) will express the regularity of the amount of wear depending on the friction.

The constructive structure of the newly improved plug valve should be close to the valve construction and the requirement to create the first sealing in the plug pair should satisfy the following condition to ensure its operability.

$$q_m \leq q_s \leq [\, q_s \,]. \tag{3.7}$$

Here qm - the minimum value of the relative pressure at the outlet of the tap (in the closed case) is determined by experiment.

qs – is the relative contact pressure created by the working pressure on the plug's sealing contact surface on the outlet side, it is determined theoretically.

qs - is the allowable value of the relative pressure generated at the outlet of the tap (when it is closed), it is theoretically determined by.

In the fourth chapter, the issues of determination of radial stresses in rubber matrix sealings based on the theory of fuzzy sets and correct fitting in their sockets were sealing.

Determining the relative deformation of the sealings using traditional methods does not allow obtaining a sufficiently accurate result. Using modern information technology methods (artificial intelligence and fuzzy logic), providing the necessary analytical predictions and simulation enables accurate assessment of issues.

It is necessary to use modern technologies to take into account uncertainty, to work with data related to real problems. We consider it necessary to use the theory of fuzzy sets in this work as well. For this purpose, the question of determining the relative deformations in the housing of rubber sealings was considered based on the theory of fuzzy sets.

Based on the obtained data, a fuzzy model was built for determining relative deformations.

Decision 1. Type-1 fuzzy sets. Let X be the set of classical objects whose common elements are denoted by x. The membership of X in a classical subset A is often viewed as a characteristic function μ_A from [0,1] to {0,1} such that

$$\mu_A(x) = \begin{cases} 1 & if\ x \in A \\ 0 & if\ x \notin A \end{cases}$$

where {0, 1} is called the evaluation set; 1 and 0 indicate membership. If the evaluation set is allowed to lie in the real interval [0, 1], then A is called a fuzzy set, where x is the membership degree in A: X → [0, 1].

A fuzzy set *A* is a subset of X and is defined as follows.

$A = \{(x, \mu_A(x), |x \in X)\}$

Decision 2. A triangular fuzzy number can be defined by a triple, where the membership can be defined as the following equation:

$$\mu_{\tilde{A}}(x) = \begin{cases} 0, & x \in [-\infty, a_1] \\ \dfrac{x - a_1}{a_2 - a_1}, & x \in [a_1, a_2] \\ \dfrac{a_3 - x}{a_3 - a_2}, & x \in [a_2, a_3] \\ 0, & x \in [a_3, +\infty] \end{cases}$$

As a fuzzy logic inference model, we will use Mamdani type model. The Fuzzy Toolbox Matlab package was selected as the Simulation tool.

Fuzzy rules for Mamdani extraction are built based on certain input and output variables. Three input and one output models are proposed, some of the rules are shown below. According to the expression (4.3.1), the problem posed will be defined as a set of "IF-THEN" production rules. Based on the receives, the model will be expressed as follows.

İF x_i is A_j, **THEN** $y = B_k$.

Fuzzy logical inference is performed based on the following fuzzy knowledge base, based on the Mamdani model.

Rule 1. If the scattered force acting on the sealing is small and the thickness of the sealing is constant AND the diameter of the sealing is constant, THEN the radial stress is close to 0.

Rule 2. If the scattered force acting on the sealing is less than normal AND the thickness of the sealing is less than normal AND the diameter of the sealing is greater than normal, THEN the radial stress is low.

Rule 3. If the scattered force acting on the sealing is close to normal AND the thickness of the sealing is much lower than normal AND the diameter of the sealing is much higher than normal THEN the radial stress is slightly lower.

Rule 4. If the scattered force acting on the sealing is normal AND the thickness of the sealing is much less than normal AND the diameter of the sealing is much more than normal THEN the radial stress is normal.

Rule 5. If the scattered force acting on the sealing is greater than normal AND the thickness of the sealing is much lower than normal AND the diameter of the sealing is much higher than normal, THEN the radial stress is greater than normal.

Rule 6. If the scattered force acting on the sealing is much larger than normal AND the thickness of the sealing is much lower than normal AND the diameter of the sealing is much higher than normal, THEN the radial stress is dangerously high.

The model is based on fuzzy sets with 3 input and 1 output variables [55][10].

The analysis of the distribution of the radial deformation of the rubber sealing within its structural volume shows that the deformation at the moment of saturation corresponds to the maximum value of its internal stress. From this moment on, a given excess load will cause the element to collapse. The processing of the results shows that the residual deformation at the moment of saturation at the limit loading exists only in the outer contour of the sealing.

---

[10] Forecasting of improved straightforward valves technical condition using fuzzy inference models. J.N.Aslanov, A.B.Sultanova.

Table 4.1

Results of the study

F; Scattering force $10^6 N$	δ; mm thickness of sealing	r;mm The sealing diameter	Radial tension
0	8	60	1,5e+05
1	7,74	60,1	1,87e+05
1,5	7,4	60,3	1,84e+05
1.6	7,35	60,35	1,84e+05
1.7	7,32	60,4	1,47e+05
1.8	7,3	60,4	1,47e+05
2	7,15	60,6	1,34e+05
2,5	6,88	61,00	1,34e+05
3	6,5	61,2	1,18e+05
3,5	6,3	61,5	1,16e+05
4	6,2	62,00	1,5 e+05
4,5	0,00	Saturation	-

As the additional loading again forces the sealing to re-deform throughout the volume, it causes physical resonance within the sealing. Nəticədə rezin kipləndirici dağılır. Deməli rezin kipləndiricilərin dağılmasının qarşısının alınması üçün onun həndəsi ölçülərinin doyma anındakı deformasiyası dəyişmə miqdarına uyğun təyin edilməlidir. The outer diameter of the housing of the rubber sealing provided in the construction should be taken 2% more than its outer diameter [47][11]. **The fifth chapter:** It is devoted to predicting and determining the reliability of improved linear valve under conditions of imperfect information based on fuzzy sets and linguistic variables.

[11] Model design for predicting the efficiency of improved valve constructions during statistical data based exploitation. J.N.Aslanov, A.B.Sultanova, İ.A.Habibov

Figure 4.1. Dependence of the radial stress on the scattered force.

Figure 4.2. Dependence of the radial stress on the diameter of the sealing.

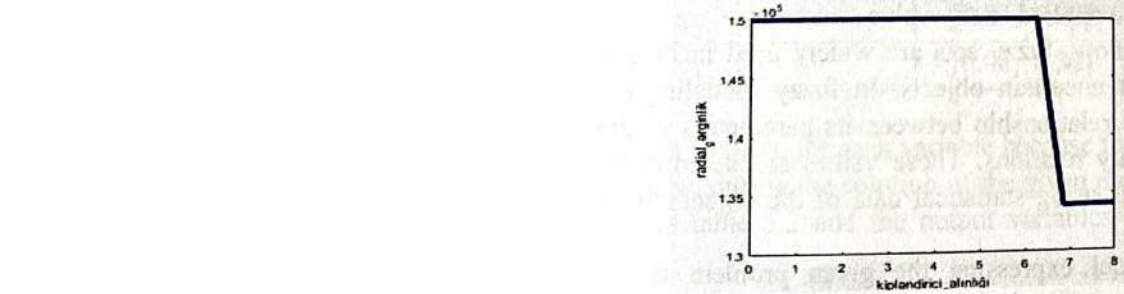


Figure 4.3. Dependence of the radial stress on the thickness of t

Developing industrial enterprises require the need to create safe machines and equipment. The creation of a control system for the operation of the equipment used in industrial enterprises and the prediction of their reliability indicators are among the innovative issues that lie ahead. Ensuring the safe working mode of binding units working in difficult and complex working conditions, turning off the working fittings in the event of an accident and the possibility of an accident, and automating the process based on forecasting will ensure the prevention of accidents in a very high probability. In order to ensure the automation of the mentioned processes, we are required to obtain various statistical data of the occurrence of a mechanical event. In many cases, information about the processes is obtained either partially or 70%, and we make decisions in uncertain conditions.

The valve type of binding units working in hazardous conditions is mainly used. In the case of oil and oil products, leakages that occur without wearing in valves cause environmental pollution and fires. The main binding units of high-pressure fountain armatures are valves. Shutting off the well in the emergency mode is carried out with valves.

In order to control the operation of the valves, it requires us to know in advance that its reliability indicator changes depending on the wear that occurs in the details of the locking joint.

Let us perform improved valve reliability prediction by applying fuzzy variables based on fuzzy set theory. The mentioned methodical solution can be applied to any valve structure.

As we know, fuzzy sets are widely used in modeling complex nonlinear and uncertain objects. In fuzzy modeling of the object's operation, the relationship between its parameters is changed on the basis of quality relations. These values are determined by a set of linguistic rules using statistical data of the object's input and output parameters.

The model expressing the given problem is built with the following stages of logical deduction:

1. Fuzzy data is formed (fuzzification). For each fluently given, a membership function corresponding to the terms is calculated;

$\mu_T(T_0)$, $\mu_{ST}(S_0)$, $\mu_M(M_0)$, $\mu_{KK}(K_0)$. (5.1)

2. A membership function is found according to the rules of the input signals;

$\alpha_i = \mu_{Ti}(T_0) \cap \mu_{STi}(S_0) \cap \mu_{Mi}(M_0) \cap \mu_{Ki}(K_0)$. (5.2)

The resulting membership function corresponding to each rule is calculated.

$\mu_i(z) = \alpha_i \cap \mu_{ci}(z_0)$ (5.3)

3. Fuzzy composition – a membership function is defined for all rule sets of input variables

$\mu_\Sigma(z) = \mu_1(z) \cup \mu_1(z) \cup \mu_1(z) \cup \mu_1(z)$. (5.4)

In order to solve the above-mentioned problem, 3 input variables were taken as the back-and-forth movement cycle of the gate, the roughness of the surfaces and the unevenness of the contact surfaces, and the output variable was the reliability parameter (probability of malfunction).

The nominal values of the input variables are given in the following table 5.1.

Table 5.1

Nominal values of variables

Login settings	Nominal values of variables
The cycle of the valve - x_1	[0 , 500]
Unevenness - x_2	[0.03, 0.07]
Roughness - x_3	[0.08, 0.32]

Linguistic terms are used for each variable because fuzzy values of the variables are used during the solution of the given problem. The input variables are in table 5.2 and the output variables are in table 5.3. given.

Table 5.2

Input variables

	Input variables	Linguistic values of input variables		
		Less	Normal	Much
1	Valve cycle-x_1	[0 185 250]	[235 410 435]	[435 455 500]
2	Unevenness - x_2	[0.03 0.04 0.05]	[0.05 0.06 0.065]	[0.065 0.07 0.75]
3	Roughness - x_3	[0.080 0.125 0.185]	[0.185 0.225 0.30]	0.30 0.32 0.325]

Table 5.3

Output variable

	Output variable	Linguistic values of the output variable		
		Lower	Normal	Higher
1	Reliability – y_1	[0.704, 0.752, 0.796]	[0.796, 0.86, 0.93]	[0.93, 0.98, 1.0]

Rule 1: IF the valve cycle is low, unevenness is low, roughness is low, THEN reliability is high.

Rule 2: IF valve cycle is low, flatness is normal, roughness is high, THEN reliability is normal.

Rule 3: IF roughness is normal, valve cycle is normal, unevenness is normal, THEN reliability is normal.

Rule 4: IF roughness is normal, valve cycle is high, unevenness is high, THEN reliability is low............................ etc.
Rule 27: (27 rules make up the knowledge base.)
The problem was solved by implementing the MATLAB / Fuzzy Logic Toolbox package and the results were obtained.

Analysis of the findings shows that, depending on the closing and opening of the valve on the contacting working surfaces, such indices of unevenness and roughness reliability are created, which at this time the system has the highest reliability. Results obtained from the Matlab package

$x_1 = 249$ $x_2 = 0.0521$ $x_3 = 0.128$ $Y = 0.932$

confirms what has been said (Figure 5.1, Figure5.2).

The solution of the established model ensures to predict the possibility of its failure in advance by creating a control package for the reliability indicators of the flat valve in a systematic approach.

Solution of the problem: The following algorithm is proposed to solve the problem with the proposed method:

1. Determination of the number of input and output linguistic variables. Determining the set of values for each linguistic variable and the number of terms;
2. Determination of the names of linguistic variables and their terms (affiliation)
3. Determination of the type of membership function for terms of linguistic variables;
4. Defining the structure of logical rules as "If.....Then".

Indicators reflecting the thickness, unevenness and unevenness of the gate were taken as input linguistic variables, and effectiveness was taken as output linguistic variable [16][12].

Values of dependence between gate thickness, unevenness and roughness are given in table 5.4.

[12] Təkmilləşdirilmiş siyirtmələrin etibarlığının qeyri-səlis çoxluqlar nəzəriyyəsi əsasında proqnozlaşdırılması. C.N.Aslanov, A.B.Sultanova.

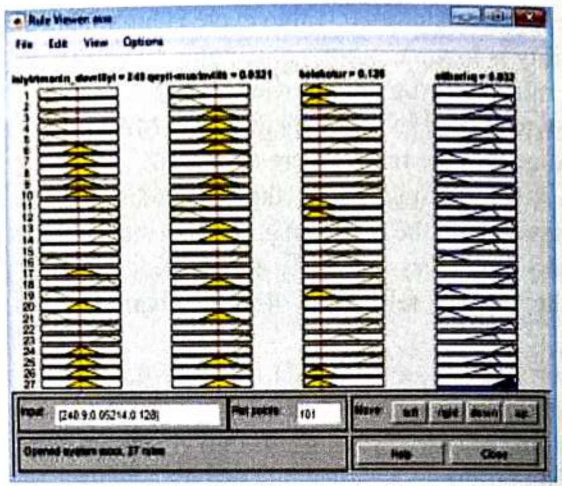


Figure 5.1 Results from the Matlab package

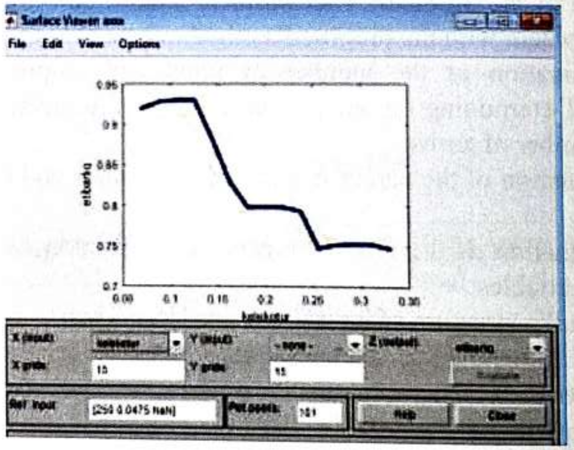
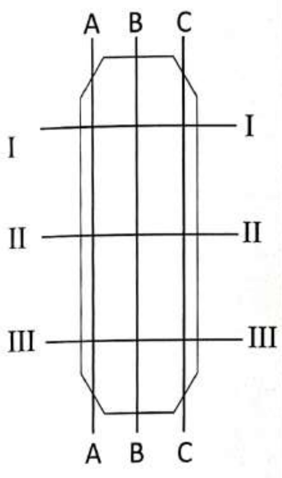


Figure 5.2. The dependence curve of reliability on roughness caused by wearing

Table 5.4

Gate thickness, unevenness and roughness



	Gate thickness -ρ			Roughness -γ			Unevenness -ξ
A-A	I-I	II-II	III-III	I-I	II	III	
	31.852	31.832	31.800	0.25	0.28	0.27	0.051
	31.936	31.913	31.873	0.32	0.30	0.33	0.063
	31.956	31.924	31.873	0,81	0.90	0.88	0.083
	31.957	31.904	31.906	1.63	1.61	1.61	0.051
	31.904	31.854	31.831	0.63	0,65	0,66	0.073
B-B							
	31.883	31.842	31.840	0.20	0.28	0.25	0.043
	31.932	31.870	31.831	0.32	0.31	0.35	0.071
	31.947	31.925	31.856	0.88	0.91	0.91	0.091
	31.826	31.903	31.853	1.58	1.60	1.60	0.073
	31.922	31.862	31.850	0.61	0.64	0.64	0.072
C-C							
	31.834	31.813	31.802	0.24	0.26	0.25	0.032
	31.905	31.882	31.832	0.33	0.34	0.36	0.072
	31.924	31.921	31.862	0.83	0.89	0.90	0.042
	31.964	31.920	31.872	1.61	1.60	1.60	0.092
	31.964	31.913	31.901	0.60	0.62	0.62	0.063

Taking into account the above, it is recommended to build a mathematical model with fuzzy logic elements to determine the special dependence between the thickness, unevenness and roughness of the gate and the effect of this dependence on the system efficiency, the parameters of the system's fail-safe operation.
Input linguistic variables:

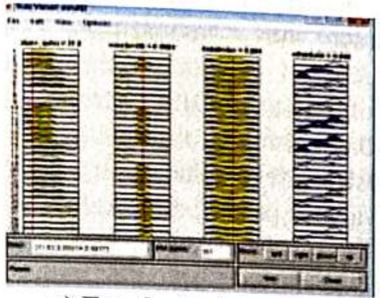
The computer implementation of the algorithm was carried out in the Matlab environment (FIS-editor-Fuzzy Inference System Editor) and the results were obtained. The results are given in table 5.5.

Table 5.5

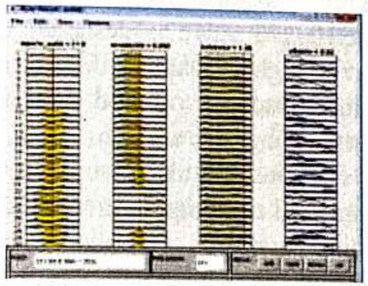
Computer realization of the algoritm

	Gate thickness - ρ(mkm)	Roughness- γ(mkm)	Unevenness - ξ(mm)	Efficiency -E (--)
A-A	31.83	0.9837	0.06834	0.946
B-B	31.88	1.382	0.066	0.95
J-J	31.88	0.93	0.0625	0.93

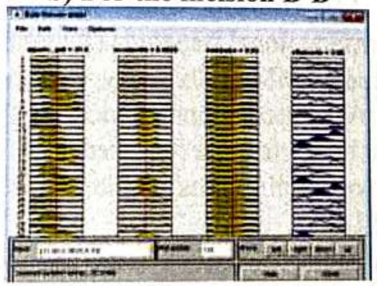
Chapter six is devoted to the design and industrial application of an improved valve structure.



a) For the incision A-A



b) For the incision B-B



c) For the incision J-J

Figure 5.3. Fig.1. The obtained conclusions from the Matlab program (mechanism for fuzzy retrieval):
a) for the incision A-A, b) for the incision B-B, c) for the incision J-J

Valf MMS100x70: Valve MMS100x70 was produced in 2021 under the contract with "Neftgazmash" OJSC. The technical conditions and technical passport of the valve were prepared and approved by "Neftgazmash" OJSC according to the standards in accordance with the legislation of the Republic of Azerbaijan. Initial work capacity tests were conducted at "Nefgazmash" OJSC. The copyright of the valve is protected by AzPatent. The first preliminary physical model of this valve was prepared as MMS for a pressure of 35 MPa and a transition diameter of 65 mm (MMS65x35), and the technological conditions for the preparation of a valve construction resistant to a working pressure of 105 MPa were worked out.

The new MMS100x70 valve is designed to ensure and prevent intra-pipe transport of high-pressure liquids, directed in any direction, in fountain armatures used in oil and gas extraction and drilling manifolds used in drilling oil and gas wells, in oil refining and chemical industry facilities and also in various industrial areas under aggressive environmental conditions at a working pressure of 70MPa.

API international standards compliance certification of MMS valve was conducted by Hydrasun Rapid Solutions LLC. On 23.06.2021, the MMS100x70 valve was issued a certificate of compliance with international standards (figure 6.5 and figure 6.6).

The new model MMS100x70 type valve was checked for compliance with API International standards, the pressure resistance and durability of its parts were checked at 105 MPa, and the ISO quality mark for operability was applied to the valve by Hydrasun Rapid Solutions LLC.

Advantages of valve MMS100x70 are as follows.

- easy assembly and high controllability under high pressure.;
- that the valve has high hermeticity as a result of ensuring two-sided full suffocation of the product at the entrance and exit;
- Increasing the wear resistance of the working surfaces (against adhesion, wear, corrosion, hydroabrasive, gasoabrasive and abrasive wear) due to the provision of equal distribution of relative pressure on the working surfaces of the stopper details and their strengthening depending on the working environment;

- having high quality and affordable price;
- being offered at a price 30% lower than the international market price.

MMS100x65 valve with certificate of conformity to ISO 102423 (API 6A) requirements was put into operation on 14.07.2021 at "Umid-Babek Operating Company" on the platform on the manifold line.

On 14.07.2021 at 19.14, the valve was accepted to the platform (figure 6.1). At 7:15 p.m., the line where the valve will be put into operation was determined (figure 6.2). At 7:36 p.m., the valve to be replaced with the MMS100x70 valve was determined on the line (figure 6.3). At 8:04 p.m., the old valve was opened over the line, and at 8:09 p.m., the new MMS100x70 valve was connected to the line (figure 6.4). At 8:09 p.m., the valve was opened.

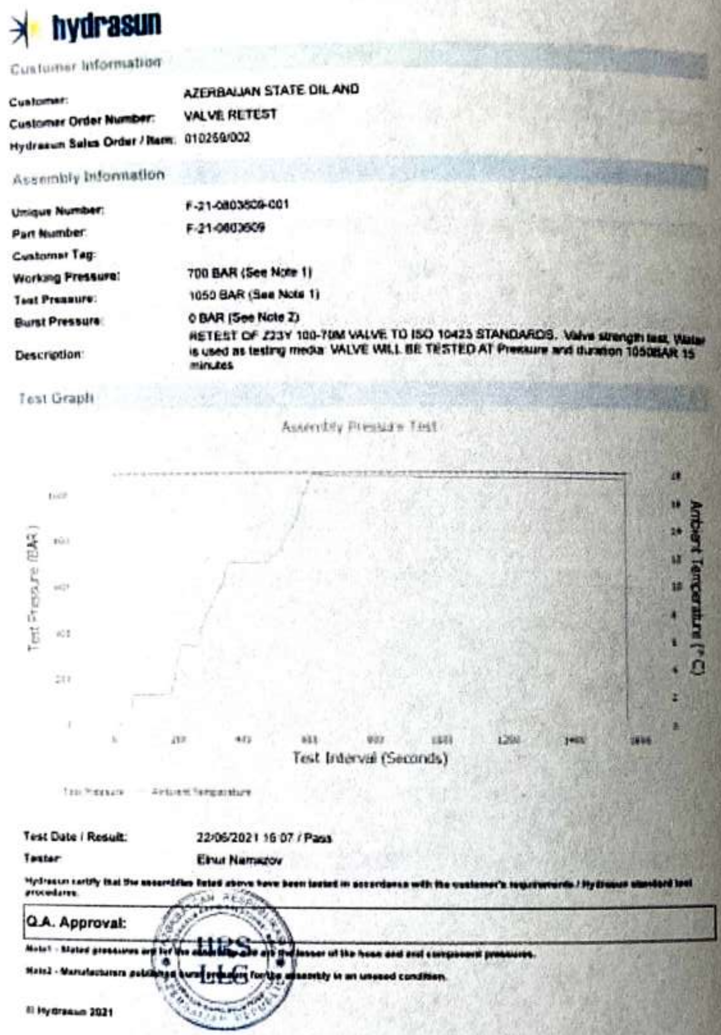
No leaks or failures were observed in the MMS100x70 valve during 3 months of operation. The operational test has been completed successfully. The operation act is given in figure 6.7.

Figure 6.1 New valve.

Figure 6.2 Valve to be replaced

Figure 6.3 Replacement scene

Figure 6.4 After modification



hydrasun

Customer Information

Customer:	AZERBAIJAN STATE OIL AND
Customer Order Number:	VALVE RETEST
Hydrasun Sales Order / Item:	010259/002

Assembly Information

Unique Number:	F-21-0803609-001
Part Number:	F-21-0803609
Customer Tag:	
Working Pressure:	700 BAR (See Note 1)
Test Pressure:	1050 BAR (See Note 1)
Burst Pressure:	0 BAR (See Note 2)
Description:	RETEST OF Z23Y 100-70M VALVE TO ISO 10423 STANDARDS. Valve strength test, Water is used as testing media. VALVE WILL BE TESTED AT Pressure and duration 1050BAR 15 minutes

Test Graph

Test Date / Result:	22/06/2021 16:07 / Pass
Tester:	Elnur Namazov

Hydrasun certify that the assemblies listed above have been tested in accordance with the customer's requirements / Hydrasun standard test procedures.

Q.A. Approval:

Note1 - Stated pressures are for the [illegible] the lesser of the hose and end component pressures.

Note2 - Manufacturers published burst [illegible] for the assembly in an unused condition.

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Figure 6.5 Trial test

MAKVELSAN

EN 10204 – 3.1 MUAYENE SERTİFİKASI
INSPECTION CERTIFICATE

TEST RAPORU / *TEST REPORT*

Sertifika No./*Certificate No.*	2022-170-01	**Sertifika Trh.**/*Cert. Date*	29.05.2023
Muşteri/*Customer*	Azerbaijan State Oil aIndustry Vel.	**Parça İsmi**/*Pieces*	Body+Bonnet
Sipariş No./*Order No.*		**Malzemesi**/*Pieces Material*	20YBG2A
Sipariş Tarihi/*Order Date*		**Şarj No.**/*Heat Number*	
Ürün Kodu/*Product Code*	MGAV-5-100-1	**Çap**/*Size*	DN100
Cinsi/*Type*	Manuel Gate Valve	**Basınç Sınıfı**/*Pressure Class*	PN700
Tag No.		**Adet**/*Quantity*	1 pc.
Notlar/*Notes*			

1. **Kimyasal Analiz**/*Chemical Analyses* (%) (EN ISO 10213)

Şarj No. *Heat Number*	C	Si	Mn	P	S	Cr	Mo	Ni	Cu	N	V	Sn

2. **Mekanik Testler**/*Mechanical Tests* (EN ISO 6892-1)

Şarj No. *Heat Number*	Akma Dayanımı *Yield Strength*	Çekme Dayanımı *Tensile Strength*	Uzama *Elongation*	Çentik *Charpy*	Sertlik/*Hardness* EN ISO 6506
	(N/mm²)	(N/mm²)	(%)	(J)	(HB)
					223

3. **Hidrostatik Testler**/*Hydrostatic Tests*

1.1 **Gövde için Hidrolik Test**/*Hydraulic Tests for Body* (API 6D, 100% Kontrol/*Control*)

Seri No. *Serial No*	TAG No.	İstenen Değer *Desired Value*		Ölçülen Değer *Measured Value*	Sonuç *Conclusion*
		Basınç/*Pressure* (bar)	Süre/*Duration* (mn.)	Basınç/*Pressure* (bar)	
2022-178-01		1050	120	1050	UYGUN/*APPROPRIATE*

3.2 **Sit için Kaçak Testi**/*Seat Tests* (API 6D, 100% Kontrol/*Control*)

Seri No. *Serial No*	Test Akışkanı *Test Fluid*		İstenen Değer *Desired Value*		Ölçülen Değer *Measured Value*	Sonuç *Conclusion*
	Hava/*Air*	Su/*Water*	Basınç/*Pressure* (bar)	Süre (mn.)/*Duration*	Basınç/*Pressure* (bar)	
2022-178-01		X	770	120	770	UYGUN/*APPROPRIATE*

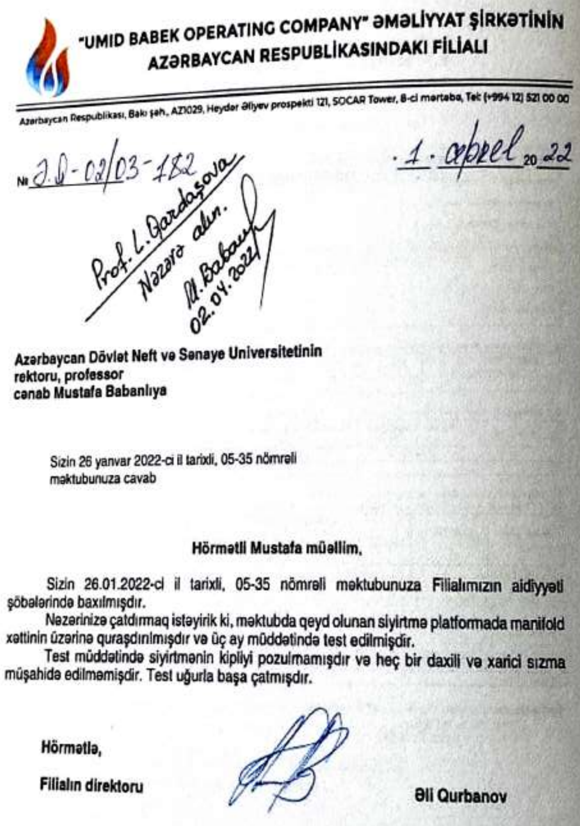
Test Sonucu / *Test Result* : UYGUN/*APPROPRIATE*

ÜRETİM BÖLÜMÜ
PRODUCTION DEPARTMENT

KALİTE YÖNETİMİ
QUALITY MANAGEMENT

MAKVELSAN Elektromekanik LTD. ŞTİ.
İMES San. Sitesi C Blok 302 Sok. No:12, 34775 Ümraniye, İstanbul
Tel : (216) 590 0392 Fax : (555) 225 1819 www.makvelsan.com

Figure 6.6 Trial test



"UMID BABEK OPERATING COMPANY" ƏMƏLİYYAT ŞİRKƏTİNİN
AZƏRBAYCAN RESPUBLİKASINDAKI FİLİALI

Azərbaycan Respublikası, Bakı şəh., AZ1029, Heydər Əliyev prospekti 121, SOCAR Tower, 8-ci mərtəbə, Tel: (+994 12) 521 00 00

№ 2.0-02/03-182 · 1 · aprel 20 22

Azərbaycan Dövlət Neft və Sənaye Universitetinin
rektoru, professor
cənab Mustafa Babanlıya

Sizin 26 yanvar 2022-ci il tarixli, 05-35 nömrəli
məktubunuza cavab

Hörmətli Mustafa müəllim,

Sizin 26.01.2022-ci il tarixli, 05-35 nömrəli məktubunuza Filialımızın aidiyyəti şöbələrində baxılmışdır.

Nəzərinizə çatdırmaq istəyirik ki, məktubda qeyd olunan siyirtmə platformada manifold xəttinin üzərinə quraşdırılmışdır və üç ay müddətində test edilmişdir.

Test müddətində siyirtmənin kipliyi pozulmamışdır və heç bir daxili və xarici sızma müşahidə edilməmişdir. Test uğurla başa çatmışdır.

Hörmətlə,

Filialın direktoru Əli Qurbanov

Figure 6.7 Operation act

Conclusion

1. The regularity of variation of the friction force depending on the bending of the frictional part in the mechanical wear conditions of the bending joints of the binding units has been determined.
2. An analytical expression has been obtained that expresses the regularity of the variation of the friction force generated under the driving force in the gate and seat ring pair depending on the deflection of the friction gate.
3. The obtained analytical expression expresses the sliding friction force generated on the contact surface during the movement of the gate bent under the influence of the compressive force under the minimum driving force, and it was found that the sliding friction force will change to the minimum limit depending on the driving force in the $y < x$ condition of the deflection of the gate. This value of bending will ensure that the rate of mechanical wear on the contact surfaces of the plug joint is reduced to a minimum.
4. The expression of the dependence of the compressive force generated on the sealing contact surface of the plug joint of the improved plug valve on the working pressure is determined.
5. A new expression has been obtained to determine the relative contact pressure and the allowable value of the relative pressure on the contact surface that ensures the mode of the plug joint of the plug valve.
6. Based on the received statements, the condition for ensuring working capasity the improved plug valve was determined.
7. An analytical expression has been obtained that determines the regularity of the friction-dependent change of the amount of wear that occurs on the contact surface of the valve stopper details.
8. Based on the theory of fuzzy sets, a new fuzzy model is proposed, which ensures the prediction of the working capacity of the improved valve, and the algorithm of the fuzzy model is developed based on the statistical data.

9. A fuzzy model has been developed that determines the dependence between the amount of wear of the working surface of the valve gate and its reliability.
10. For the first time, a fuzzy logic inference model of the distribution of the radial deformation in rubber sealings within its structural volume has been established, the simulation analysis based on the model shows that the deformation at the moment of saturation corresponds to the maximum value of the internal stress.
11. In order to prevent the disintegration of rubber sealings, its geometric dimensions should be determined according to the amount of change in deformations at the moment of saturation. The outer diameter of the housing of the rubber sealing provided in the construction should be taken 2% more than its outer diameter.
12. In order to increase the longevity of valve sealings, it was proposed to use this material in the preparation of sealings made of rubber panel matrix, a new material.
13. Wear-resistant stopper joint improved binding units have been proposed for use in various operating conditions.
14. MMS100x65 valve construction, which works under high pressure and aggressive environment conditions, was developed, tested and certified with API standards compliance certificate (by Hydrasun company). ISO quality valve has been applied in the industry. Valve MMS100x65 was used in Umid Babek International Operating Company and applied to industry.

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