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Philosophy of mathematics - characteristics of mathematical thinking

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Abstract: Science is a system of social activities aimed at studying any uncertain information. Since it is possible to group this uncertain information in different ways, new fields of science will always be created. Science is a social phenomenon - each field of science has its own subject matter and methodology. Today, all sciences can be considered a system of knowledge that has studied the world from different angles through their methodologies - different sciences use different aspects in the study of the world. Science and philosophy differ from a historical point of view - if the history of science as a perfect social and spiritual derivative begins in the 16th and 17th centuries, the history of philosophy goes back approximately 2500 years. The history of philosophy also began from the moment when people first began to think about the nature of the world around them, the nature of things and the cause of events. Philosophy is constantly in search - its essence is not to achieve eternal and absolute truth, but to constantly seek this truth. The preexisting interaction between philosophy and science helps them to complement each other, to understand the essence of existence, to clarify the truths of spiritual and material reality, to reveal the complete picture of the world, and to develop a theoretical outlook. The philosophy of mathematics also plays an important role in the fulfillment of this mission.

Keywords: Science, Theory, Empiricism, Paradigm, İmplication, Philosophy of mathematics.

1. Introduction

In science, more people's attempt to understand has found its expression. Modern science is a conglomeration of various disciplines, an irregular collection - they can be conditionally divided into natural, humanitarian, mathematical, applied (technical, medical, agricultural, pedagogical) sciences. Science, like any form of collective activity, has a certain structure, and its structure is primarily expressed in the unity of theory and empiricism, experience. The theory that explains and foretells the future is a system of knowledge, a form of science, and empiricism, which describes, is the collection of knowledge, the content of science, observation or experience. Based on this division of science, it is necessary to distinguish between theoretical and empirical knowledge. Theoretical knowledge that explains what is happening is knowledge of law (law, principle of science), and empirical knowledge that describes what is happening is knowledge of events (facts). As a whole, theory and empiricism, which guide people to understand what is happening, interact with each other. Most scientists have noted the dependence of empiricism on theory - the interaction between them is carried out through hypothesis (positive relationship) and criticism (negative relationship).

"Normal science" is characterized by solving everyday problems based on relevant scientific paradigms. Paradigm is a set of principles, norms, laws, theories, methods that determine its development in a specific period of the history of science. The normal (evolutionary) period in the creation of science is replaced by a revolutionary period - it is connected with the discovery of phenomena that do not fit into the framework of old paradigms. The emergence and self-assertion of new paradigms is expressed by a revolution in science.

The historical aspect of the relationship between philosophy and concrete sciences is determined by the fact that all sciences are separated from philosophy as special types of false knowledge. This relationship is determined primarily by the fact that both science and philosophy are areas of effective and proven spiritual activity aimed at achieving truth. Any science prefers to determine the subject area and never pretends to briefly and honestly express the universal regularity of existence - so physics reveals the laws of physical reality, chemistry-chemical, psychology - psychological reality. However, the laws of physics are directly related to mental life, and the laws of mental life, in turn, do not operate in physical interaction. In this sense, the truth in science is always concrete, and scientists look at the world from the point of view of the subject of any science, not paying attention to other properties inherent to

the object. Mathematics is not interested in the inherent quality of objects, while the sociologist is indifferent to the weight and height of people as elements of any social system. This is the great advantage of science - it allows science to extend its understanding infinitely into the depth of the subject, and at the same time it is also its weakness - it does not allow us to make universal judgments about this being. Unlike science, philosophy makes a universal judgment and tries to reveal the metaphysical laws of the world as a whole.

Another difference between science and philosophy is that science has traditionally been isolated from the problem of value and the problem of making value judgments. He looks for the truth in things and does not want to discuss whether what he finds is good or bad. In other words, science is more about "why?", "how?", "from where?" answers the questions, "why?" and "what for?" tries to get addicted to metaphysical questions of the type. In philosophy, on the contrary, the value components of knowledge are not eliminated.

Philosophy, which claims to solve the eternal problems of existence, is not only directed to the search for truth as a form of agreement between thought and existence, it is also aimed at understanding and confirming values as a form of agreement between existence and human thought. Interrelation and a number of common issues create two poles (two extremes) in the attitude of philosophy to science. On the one hand, philosophy tries to create a universal picture of the world without relying on the data of science, creates a "strong" metaphysical system - this system often gives the impression of speculation isolated from reality. On the other hand, philosophy often follows the specific sciences and abandons the discussion of metaphysical (primarily value) problems, focusing more on the most general positive facts of science - which can greatly unify philosophical research. Philosophy, however specific, is an activity of understanding, so the result of such activity, as in science, acts as a body of knowledge. In addition, philosophy in a certain sense meets an important general criterion such as the principle of objectivity of science, but in relation to philosophy, it requires appropriate clarification. Science should describe the object as it is, and the results of objective understanding should be important for everyone, that is, they should be accepted by everyone. The principle of objectivity is formed in each science depending on its subject area. But this field itself can be quite narrow and describe some aspect of the subject, object or event.

The principle of objectivity is relative, and objectivity in philosophy requires particularly strict specification. On the one hand, philosophy studies how existence exists without dividing it into subject areas, so it claims to be the most general in its results. On the other hand, the limitation of the studied object and the analyzed problem does not allow philosophy to talk about achieving any absolute objectivity in each individual case - it is possible to do this in science.

The difference itself, often the opposite of the fundamental course of philosophical thought, can be considered the best confirmation of this thesis. Philosophy, as the highest form of self-understanding, can question the very concept of the "criterion of objectivity" and show that the criterion of objectivity has undergone a strong change and that subjective factors have not been completely eliminated in science.

The path from philosophy to science. Philosophy and science are different forms of social consciousness - if science is based on experience, philosophy is based on wisdom. Philosophy that rises above wisdom is always above time. For science, time is an important condition. What science, technical progress gave three, five, ten years ago is no longer considered a novelty today and thus loses its importance.

A philosophical work or a philosopher's work does not become obsolete even after centuries, it is not subject to moral erosion, on the contrary, we understand the philosopher better over time, we witness his foresight. Einstein called philosophy the mother of all scientific research. Indeed, behind purely scientific issues and facts, there are such serious philosophical problems that without clarifying them, it is impossible to determine the importance of one or another scientific achievements, discoveries, concepts and theories. Science, like philosophy, does not have a universal character - philosophy includes all existence in its sphere of interest. According to R. Descartes, all philosophy is like a tree - its root is metaphysics, its trunk is physics, and the branches separated from that trunk are other sciences.

Interpretation in history, formalization in mathematics, artistic representation of reality in literature, and understanding in philosophy. Different methods of all sciences have names, but

philosophical understanding has no method, it is intuitive. And science cannot be intuitive - science consists of facts, theories, fundamental laws, ideas, principles, based on purposefulness, its subject is "what is studied?", and its method is "how is it studied?" is an area where the answer to the question is sought. In this sense, philosophy has always acted as a special socio-cultural phenomenon, its form has depended on a specific historical period and the authorial excitement of thinkers. Philosophy responded to the "questions" of the time and acted as a self-understanding of culture.

In order to understand mathematics as a science, it is important to clarify the features of its subject and method, the regularities of its development, the ways of justifying mathematical theories and the conditions of its application to practical sciences. Attempting to answer these questions is at the heart of the philosophical analysis of mathematics. Explaining the main ideas and problems of the modern philosophy of mathematics and showing their connection with the development of mathematical thinking is a very relevant issue for today. For centuries, mathematics has been a model of precision and rigor for other fields of knowledge. This view still holds its influence today: quite a large number of thinkers assume that the laws of chemistry and physics do not have specific properties unique to these sciences, and that behind their quantitative expressions lies the universal property of an abstract mathematical structure that modern science cannot fully unravel. From such a point of view, mathematics acquires an importance far beyond the limits of its immediate field of application - thus it acquires a philosophical dimension.

The earliest information about the origin of such views can be found in Plato's dialogue "Phileb". Explaining the importance of studying musical harmony and the system created by it to the interlocutor, Socrates said: "Our predecessors who created this system bequeathed to us, their future generations, to call them harmony and to give the name of the rhythm and the name of the measure in relation to other similar situations: they are also suggestions they used to consider everything, singularity and multiplicity in general, in the same way... after knowing all this, you will be wise, and when you understand every other unit by considering it in the same way, you will be in a position to lead to what belongs to it" [9]. In these words lies the justification of Pythagoras' famous thesis "Everything is numbers", which in many ways predetermined the later successes of theoretical natural science. In modern works, the views of the Pythagoreans are often called mystical, but the share of mysticism in them is not much. Analyzing G. Helmholtz's explanation of the harmonic phenol-menon of the musical interval described by the first numbers of the natural series, the outstanding physicist-theoretician R. Feyman was forced to admit that we have not gone far from Pythagoras in this matter. "When we decide that we like music, we cannot say with certainty that our ear compares harmony and makes a good calculation" [11].

If there is no universally satisfactory explanation of the simple numerical regularity in the aesthetic perception of music even today, then there is no reason to blame the enthusiasm of those who lived in ancient times to discover the invisible phenomena.

The influence of mathematics is not limited to the field of scientific knowledge. In addition to music, there are various ways of applying it to the fields of art such as architecture, painting and literature. Some authors have commented in detail the role of mathematical regularity in the organization of forms in art [5].

When considering medieval mathematics, it is impossible to deny its deep connection with the religious consciousness of that time. Finally, we should not forget the important role of mathematics in the education and upbringing of personality.

Comparing the mathematics of Pythagoras with the science of mathematics, the following picture emerges: mathematics studies the spatial forms of the real world and the relationships between quantities. The "real world" seen from the rational plane is limited from the "real world" seen from the irrational plane. In such a case, mathematics is a narrower concept within the framework of science, and its limitlessness is revealed in the aspect of reflecting existence, which is the object of cognition. Schopenhauer said: "All natural sciences have an inevitable shortcoming - they forget about the subjective aspects of nature and evaluate it only from the objective side."

In recent years, debates about the changing role of mathematical knowledge in the post-industrial era of human development have increased considerably. The introduction of electronic computing and information technology into the economy and people's daily life has led to ambiguous and contradictory results for the mathematical education system. In 2000, "Mathematics and society. At the

conference held under the title "mathematical education at the turn of the century", the participants admitted with concern that distorted and even negative views about mathematics and mathematical education have been formed in the modern public consciousness [8]. At the conference, it was unanimously agreed that mathematical education is happiness - any person has the right to achieve this happiness, and society (state and global structures) should make it possible for everyone to use this right.
The great modern mathematician V.I. Arnold writes a lot in his writings about the reasons that make this thesis disappear from the eyes of the society and make it suspicious. According to Arnold, mathematicians are also to blame for the decline of public interest in mathematics and mathematical education. They give the following definition of mathematics as a scientific subject to a student of a French university: "Mathematics is the science of proof, evidence, the link of proof-implication (logical conclusion). The most important thing is to understand what an implication is. Its definition is as follows: Suppose that A and B are two arbitrary judgments. If both of them are true, then they say that A leads to B" - a student hearing this will not be able to understand anything from theoretical natural science later.
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Arnold himself avoided the criticism of non-mathematicians that they artificially separate mathematics from other sciences concerned with the real world around us - he suggested that mathematics should be viewed as a part of theoretical physics: "... proof in mathematics is always spelled out or even it plays the role of complete subjugation, like the role calligraphy plays in poetry. Mathematics, like physics, is an experimental science, and the conscious addition of fractions 1/2 and 1/3 is a standard element of universal culture" [2].
Society makes a judgment about the level of importance of this or that field of knowledge, first of all, about the contribution it actually includes in its activity. As in the examples given by Arnold, if he sees the attempts of specialists in this field of knowledge to focus on internal problems that are not related to other fields of knowledge and the life activity of society, then the alienation is mutual. The eminent mathematician's views on bringing mathematics and physics closer seem attractive and deserve serious attention.
Like any other view, Arnold's proposed approach is not free from theoretical difficulties. If we follow this approach in the literal sense, that is, if we replace the "definition-theory-proof" scheme accepted in mathematics with the "observation-model-model study-result-observation" scheme accepted for physics, then even the difficulties in explaining elementary mathematics will arise. For example, although the formula for the volume of a pyramid can be formulated in visual physical terms, its proof assumes the possibility of dividing the sections into any number of equal parts - all of which are impossible to justify strictly without geometric axioms. Mathematical abstraction has a historically formed specificity, and breaking the connection with this tradition in the teaching of mathematics necessarily creates significant methodical and methodological problems - it is impossible to overcome them in a short time. Science is a more sophisticated symbolized and systematic form of the results obtained from experimental, sensory and theoretical knowledge, knowledge is accumulated on a cumulative basis, as information, and science as a mental conclusion refers to the truth of other correct, accepted judgments.
In the philosophy of science, it is accepted to distinguish three aspects of the language of science -

syntax, semantics and pragmatics - used by scientists in their cognitive activity [10]. The syntactic aspect involves viewing the language as a set of signs, which arise according to certain rules and form a certain system in their relationships. In the process of applying this rule, the researcher moves away from the meaning of the terms of the language and looks at the terms only as signs that create formulas in their relations - from which formulas are put forward according to the rules of that language system. It is this aspect of mathematical knowledge that comes to the fore when mathematics is defined as the circle of implication.

2. Experimental details

The nature of mathematical thinking. Mathematics is the study of quantitative relationships between events, processes and objects that can be expressed by strict mathematical formulas. The numbers and signs used in these formulas are a symbolic expression of the dependencies between certain objects and events that exist in nature. These formulas allow us to apply those regularities (laws) to similar events and to arrive at similar results (results). In this sense, mathematics should be considered a science. The development of nature, society and spirituality itself is subject to certain laws and is expressed by complex mathematical formulas. Mathematics studies the part of those laws of nature that can be expressed by mathematical formulas. Philosophy is a science that studies not the quantitative regularities expressed by strict mathematical formulas, but the general regularities underlying quantitative and qualitative regularities. In other words, philosophy should be considered a science that studies general regularities, while mathematics should be considered a science that studies regularities expressed in mathematical dependencies/formulas. Philosophy is the scientific foundation, that is, it is the foundation for studying both qualitative and quantitative laws. And mathematics is a key to learn the part of existing regularities between events, processes and objects that can be expressed by mathematical formulas by people at some level of understanding. Philosophy studies the aspects of nature that cannot and cannot be expressed by mathematical formulas. Any field of knowledge can be considered a science when it has its own philosophy.

The standard of logical rigor that exists today arose only in the late 19th century. This standard is based on the set-theoretic concept of the structure of mathematical theories. From this point of view, any mathematical theory deals with one or more multiple objects that are related to each other in a series of relations. The formal properties of all these objects and relations, which are necessary for the development of the theory, are recorded in the action form without touching the concrete nature of the objects and relations themselves. The theory can be applied to any system of objects in relation to any system that satisfies the axiom system that underlies it. V. N. Molodshiy distinguishes three main periods in the creation of the axiomatic approach: substantive, semi-formal, and formal axiomatization. The principles of substantive axiomatics dominated until the middle of the 19th century, the semi-formal axiomatic method began to spread in the last quarter of the 19th century, and the date of creation of the formalized axiomatic method is considered to be 1904 - when D. Hilbert put forward the main principles of the formation of mathematics. In substantive axiomatics, axioms describe the main properties, relations and relationships of objects, proceeding from a field of objects. Objects receive their immediate definition until the list of axioms considered by the theory is given, but the means of logic used for proof receive no description or specification (implied to use traditional formal logic). As the basis and methodology of all mathematics, the more complete axiomatic structure of geometry for its time was given by Euclid in "The Beginning". Definition, postulates and axioms form the foundation of "Beginning". Euclid's postulate manifests itself as requiring the possibility of realization of being together with ideal geometric objects. Their brief and honest statement is as follows: "Suppose:

1) It is "possible" to draw a straight line from any point to any point;
2) A finite straight line "can" continue straight without interruption;
3) It is "possible" to draw a circle from any center and at any distance;
4) All right angles are equal to each other;
5) If a plane falling on two planes forms one of the sides of the interior and the corner, then the continuation of these two planes will meet on the side

of an unlimited number of corners that are less than two planes.

Axioms (literally "general ideas") include the description of the property of any magnitude and are expressed as follows:

1) Those that are equal to the same thing are also equal among themselves;
2) When the equal is added to the equal, the whole will be equal;
3) If equal is subtracted from equal, then the remainder will be equal;
4) If you add an equal to an unequal, then it will not be exactly equal;
5) When the same thing is doubled, they are equal among themselves;
6) Half of the same thing is equal among themselves;
7) Those who mix with each other are equal among themselves;
8) It is greater than the full part;
9) Two lines have no meaning.

Along with formal logic, the axioms are the logical component of the proof theory of the Beginning.

In the semi-formal axiomatization of a mathematical theory, there is no direct definition of its objects. They are replaced by axioms that describe the relationship and relationship between basic objects. As in substantive axiomatization, the means of traditional logic are used in the proof of the theory. In the semiformal axiomatization of mathematical theories, its axioms and theorems are true for various multiple objects with the same structural relations and connections between the various objects described in the axioms. Each such field is called a model or explanation of an aximatized theory. The substantive character of geometric axiomatics was questioned by Lobachevsky, Boya and Gauss with the construction of non-Euclidean geometry. Absolute truth is no longer axioms - their denial is inadmissible - it has become a hypothesis, the authenticity of which can be verified by experiment and reconciled with previous mathematical truths.

The interpretation of the goals and means of axiomatization of mathematical theories changed fundamentally in the second half of the 19th century - it became clear that each mathematical theory has different interpretations. In connection with this, the expediency of the axiomatic structure of the mathematical theory was realized, while each of them can act as a general theory, and the conclusion is true for the objects of any of its interpretations. The emergence of the axiomatic method as an independent theory is considered to be the time of D. Hilbert's classic "Fundamentals of Geometry" in 1899 - where this method fundamentally completed its final development in a geometric example.

Formal axiomatics was developed for a theory that is more relevant to the foundation of theoretical mathematics. They are derived from semiformal axiomatics in a natural way with the help of formalizing the traditional logic used in the first two types of axiomatics.

The concept of the theoretical set allows not only the basis of standards of mathematical rigor, but also the development and systematization of a variety of possible political theories [6].

Thus, pure algebra is defined as the science of systems of objects, where at the same time it is the last digit of the operation applied to a certain final number of the objects of the system and new system objects created from them (for example, two operations in the algebraic field (addition and multiplication) on two elements of each). Pure algebra thereby departs from analysis and geometry (literally implying the famous "continuity" that studies space) - it requires the positing of a "limit" relation connecting a fundamentally infinite number of objects. An axiomatic interpretation of any particular mathematical theory (for example, probability theory) does not start from scratch, but uses pre-established theories (for example, with the concepts of natural or real numbers).

Reworking the theory-multiplicity of all parts of mathematics with the help of the idea of semi-formal axiomatics makes it possible to eliminate the ambiguity and disagreement regarding the definition of the proof of individual theories and the politeness of their certainty. At the beginning of the 20th century, the uncertainty and contradiction that emerged in set theory itself was mainly related to those areas where the concept of an infinite set was given the property of generality, where any additions were superfluous, and therefore, because it was not strong, it could not make a substantial impact on the main divisions of "working" mathematics. . However, it should be taken into account that the set-theoretical structure of all basic mathematical theories, starting from the calculus of natural and real numbers, requires the application of the theory of infinite sets, and the theory of infinite sets requires logical reasoning.

At the beginning of the 20th century, a number of paradoxes were discovered in the theory of infinite

sets, which called into question its non-contradictory reasoning capabilities. The most famous of them - Russell's paradox - is expressed as follows. Let M- be the set of all normal sets, that is, the set that does not include itself as a private element. Suppose that M- itself is a normal set, then it does not show itself as an element and cannot be considered normal in that case. If, on the other hand, we assume that M is a non-normal set, then it must be included in M, that is, it must be a normal set. As we mentioned, this paradox is particularly dangerous from a pragmatic point of view. From a philosophical point of view, it is quite unpleasant.

A proof by common contradiction in mathematics is based on assumptions about the non-contradiction of mathematics. Since the end of the 19th century, set theory has become the basis of all mathematical knowledge. Eliminating paradoxes from mathematics is considered an important task of universal nature. The attempt to solve it led to the birth of a new scientific discipline - the philosophy of mathematics.

Currently, there are two main directions in the philosophy of mathematics - fundamental and non-fundamental [4].

The fundamental philosophy of mathematics subordinates the study of mathematics to one goal - to reveal the problems of the essence of mathematics, independent of the specific historical situation. It is this goal that pursues various attempts to reduce one theoretical section of mathematics to another and to find a fundamental, fundamental mathematical structure. It is in this way that the nature of mathematical objects and their connection with the world of natural objects and objects of theoretical natural science are studied. This is precisely how the search for a unified essence and non-transitory standards of mathematical proof—standards comparable to the real proofs of different eras—is carried out.

The works of the non-fundamental direction are ambitious in setting and solving the problem of revealing the concept of development of mathematics, searching for the scheme of this development. If for the fundamental direction in the philosophy of mathematics, activity (the research of mathematics is not in "dynamics" but in "statics"), but the problem of its essence is the main one, the non-fundamental direction accepts the possibility of deriving from the real action laws of mathematics from ancient sciences, the solution of the problem of determining its essence sets a goal.

As the first works in the non-fundamental direction, I. Lakatisa's "Proof and refutation. A collection of articles entitled "How theories are proved" can be mentioned - it tried to reveal the general scheme of the development of mathematics in the historical example of proving the important results of topology (the part of geometry that deals with the properties of objects) - Euler's theory of polyhedra.

An important stage in the development of the non-fundamental direction was R. Wilder's work "Mathematics is a cultural system" - where mathematics is viewed as a section of culture as a whole. The mentioned view is based on the concept of "cultural element" - in this concept, the author refers to beliefs, means, rituals (in the broadest sense of the word), etc., belonging to united groups of people in a certain sense. understands collection. On this basis, he builds a typology of the historical interaction of different parts of mathematics - which is fundamentally different from its usual division into special theoretical disciplines. An important event in the development of the non-fundamental direction was F. Kitcher's book "The Nature of Mathematical Knowledge" - where an attempt is made to establish a whole and comprehensive empirical concept of the essence and development of mathematical knowledge as presented in the activity of collective subjects - the scientific community of mathematicians.

Currently, three different areas of the non-fundamental direction can be distinguished:

- the historical field that implies the non-cumulative development of science - it goes back to T.Kun's concept of scientific revolution, but he applies this concept to mathematics. The idea of historical discarding of outdated mathematical theories is developed in numerous publications, especially in the famous book "Revolution in Mathematics";
- the field of social determination, which confirms the dependence of the content of science on social interaction, religious and national characteristics. In the philosophy of mathematics, "mathematics of the proletariat", "mathematics of Europe", etc. on the contrary, views on "Aryan mathematics" (L. Biterbach), "Chinese mathematics", "bourgeois mathematics" were created. This trend was developed more fundamentally by S. Restivo and his followers;
- the field of cultural determination that dissolves in the current of cognitive-cultural determination - meanwhile, in a specific historical period, formal structures pass into basic mathematical structures, which is conditioned by the directions of

understanding, activity-cultural determination formed in that culture - according to this view, the essence of culture is the social relay of activity that provides the appearance of mathematics contane.

Distinctive features of the non-fundamental (social-cultural) direction in the philosophy of mathematics and its attitude to fundamentalism are as follows:

- the main one is the group of problems of the function of mathematics (mathematics in its dynamics);
- if in the study of the essence of mathematics by fundamentalists, the question of its functionality is put into the background, then in this case, its unchanging essence is put into the background, regardless of the development of mathematics;
- the non-fundamentalist philosophy of mathematics looks at mathematics from a broader perspective and is therefore better able to adapt to the turbulent changes taking place in mathematics today, its relation to other sciences, and at the same time its place and importance in culture;
-the non-fundamentalist philosophy of mathematics is close to contemporary research in mathematics and the history of mathematics, which facilitates its effective application to both fields.

The philosophy of mathematics naturally presents a special branch of philosophical knowledge when it deals with the worldview problems of mathematics. The internal problematic of the philosophy of mathematics (and initially its fundamental variant) arose from philosophy - the philosophy that studies the essence and existence of abstract and ideal objects, the truth of the logical conclusion, such an important non-typical phenomenon as mathematical objects (Pythagorean school, Plato), but also developed by a generation of researchers they could not fail to mention the method of judgment, such as mathematical proof (proof of contradiction, often associated with the philosophy of the Aeolians; prof by induction, etc.)

3. Conclusion

Specialization, which inevitably occurs with the development of all fields of science, has not bypassed philosophy. The philosophy of mathematics, a special branch of philosophical knowledge, gradually became a fairly liberal field of study; Philosophical issues corresponding to mathematical essences (about the nature of subjective and objective and their interaction) became internal issues of the philosophy of mathematics, defended its free existence, encouraged its specialization, and increased the interest of scientists in this field.

The main applied problems for the philosophy of mathematics have been the problems arising in mathematics and the history of mathematics, but also the historical-mathematical problems, primarily important for the non-fundamental direction.

A hundred years after the discovery of the paradoxes of set theory, they still challenge researchers working in the philosophy of mathematics. However, for the philosophy of mathematics, the important inventions in the historical problem of science today are no less relevant. Let's take a look at their incomplete list:

- Is it possible to modernize the historical source to some extent (for example, is it possible to apply modern mathematical symbols and achievements of modern mathematics when studying and interpreting the works of Euclid "Beginning", Diofactus "Calculus", the researches of Newton, Leibniz and others?
- What are the principles of the influence of the cultural environment on the development of mathematics, at the same time, how much do the directions of the development of mathematics depend on its internal efficiency and how much on the external influence (interaction of internal and external factors of the development of mathematics)?
- How has mathematics developed as a social institution?
- Is there any historical regularity in "throwing" certain approaches of modern mathematics into the past?
-What was the main direction in mathematics in this or that period of history? Is there a revolution in mathematics?

All these questions are linked to the problem of the search for historical regularity in the development of mathematics. The attempt to answer them in the process of searching for and justifying the historical regularity in the development of mathematics acts as the basis of mutual understanding of the history of modern science and the non-fundamental philosophy of mathematics.

Kant said that any science is a science in proportion to the presence of mathematics in it, that is, mathematics is included in any science that deals

with things to be measured, but it is not science itself. Literature focuses on people's feelings and emotions, there is no science in it - people's tastes are different, some prefer poetry, others novels, some prefer comedy, and others prefer tragedy. And in philosophy, if we are talking about absolute truths, eternal things, absolute essences, it is impossible to prove them - after all, the first criterion of science is whether the propositions it puts forward can be proven or not - and the things that belong to the scope of philosophy cannot be proven - therefore, philosophy is more about worldview .

The application function of the non-fundamental philosophy of mathematics to the inquiries made by mathematics can be described in a similar way. The problem of detecting regularities and tendencies in the development of modern mathematics falls here under the "problems" of interest to any serious specialist:

-Which section of mathematics, that is, its ideas and methods, is more promising, how do they interact with each other?

-What are the development trends of mathematical proof (for example, can EHM be used to prove mathematical theories and how?

- How to build the study of mathematics?

- What are the signs of the possibility of obtaining an applied effect from research in specific fields of theoretical mathematics?

- How will "theoretical" and "applied" researches be connected in the future and in what sense can we talk about their unity?

Attempts to answer these and similar questions are made by "working" mathematicians. It is not difficult to see that the indicated questions are derived from one basis: what are the trends of the development of mathematics, what is its future?

Thus, the non-fundamental philosophy of mathematics seeks ways to answer this question under the pressure of mathematics. Anticipating the future of mathematics is one of the important and urgent problems of the non-fundamental philosophy of mathematics - in this direction, the analysis of the development of mathematics is carried out, and an attempt is made to reveal the regularity of this development.

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Methods of detecting leaks in the oil pipeline

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Abstract: The article will address the traditional method with the addition of a new signal processing method to calculate time differences. This approach will increase the accuracy of determining the coordinates of the leak, reduce the loss of petroleum products, the negative environmental impacts to soil and drinking water, and also the economic costs and emergency risks associated with plant downtime.

Keywords: Detect, Oil, Pipelines, Signal processing, Sensors, Method, Coordinates, Acoustic.

1.Introduction

Currently, one of the most urgent and difficult tasks in the operation of main oil pipelines is the timely detection of leaks, the determination of the coordinates of these leaks and losses. In this article, a leak is understood to be the violation of the integrity of a pipeline by the flow of an oil product. The main reason for the pressure drop in oil pipelines is the use of outdated pipelines and pumping equipment. About 70% of the pipelines have been in operation for more than 20 years, which leaves them in critical condition.

Accidents cause the spillage of tens of thousands of m3 of oil products every year. Spillage of oil products from the pipeline poses a great threat to the environment and people. The results of leaks cause environmental pollution, fire or explosion hazard. That is why it is important to detect and eliminate leaks in time. To detect leaks in oil pipelines, it is necessary to use the traditional method with the addition of a new signal processing method. This approach will increase the accuracy of determining the coordinates of the leak, reduce the loss of petroleum products, reduce the negative environmental impacts to soil and drinking water, and also reduce the economic costs and emergency risks associated with plant downtime.

The formula and essence of the signal processing method for calculating time differences is shown below:

$$x=\frac{L+c\Delta t}{2}$$

where x is the position of the leak from the upstream sensor (m); L - distance between two sensors (m); c - speed of sound (m/s); and Δt is the time difference, which is calculated by cross-correlation according to the given characteristics of the input signals.

Signal processing with this efficient method is of great importance. The method is directly based on the analysis of signal propagation in oil products. The method is used with the help of special sensors installed in the pipeline:

- the algorithm based on the acoustic method uses sensors that record the acoustic noise generated when the product expires or when there is a mechanical impact on the pipe. The signal resulting from this movement is transmitted to the transmitter;
- the algorithm based on the method of pressure wave analysis uses high-quality pressure sensors that record the pressure change during the leakage of the product from the defect.

The new method is based on a combination of old and enhanced methods and is implemented as shown below. The measured signals are processed for the study of approximate and detailed signals. Then, the original or detailed approximate signals are selected as observation signals to develop the improved method. A block diagram illustrating the mentioned process is shown in figure 1.

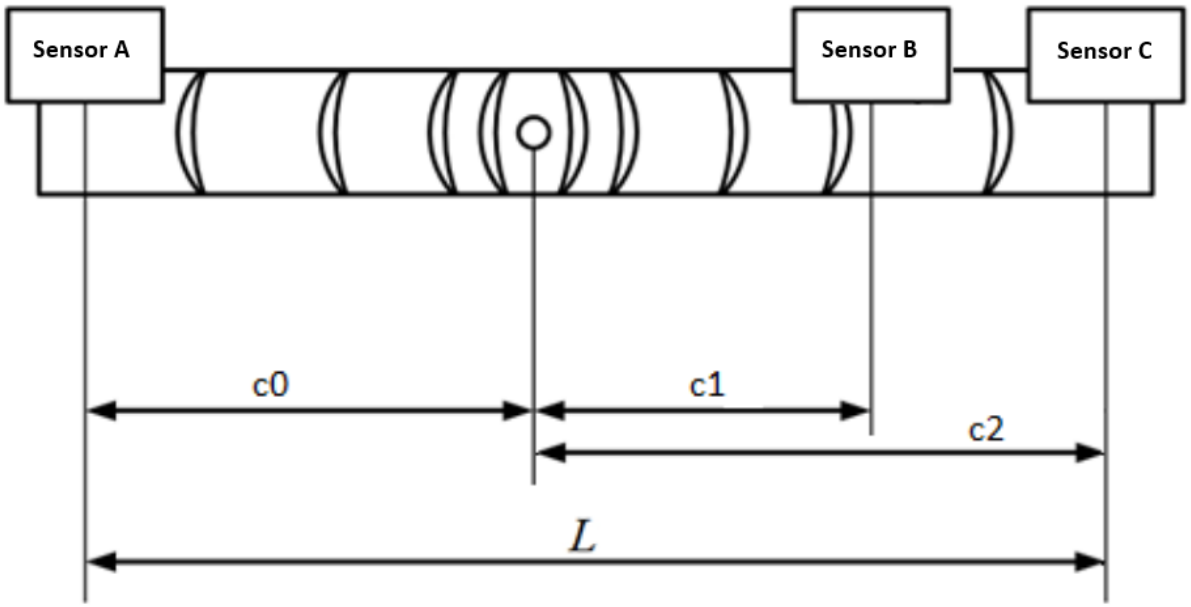

Figure 1. Locations of sensors for the improved detection method

In the end-of-life part, noise spreads in both directions. Sensors are located along a certain section of the pipeline and can detect this effect. We believe that with a certain delay, the signal generated due to the leakage of the oil product will be received by several sensors. This delay depends on the distance to the signal source and the speed of propagation of waves in the medium:

$$T_1 = f(l, V_{ss}),$$

$$T_2 = f(L - l, V_{ss})$$

l is the distance from the sensor to the point of flow; Vss is the sound wave propagation speed (depends on the characteristics of the oil product).

Most of the existing acoustic methods are based on the time difference between transmitters located at two outlying points whose parameters are limited. A new approach based on an equalizer is proposed using the presence of acoustic velocity differences due to changes in operating conditions. The recommendation here is that when one sensor is installed at one end of the pipe, another is installed at a point on the same side of the pipe.

2. Experimental details

For the improved signal processing method, based on the values obtained from sensors A, B, C, a logical conclusion is made to detect the next potential leak. Pressure sensors B and C are located next to the

$$x=\frac{c_1 c_2}{c_1-c_3}\Delta t-\frac{c_1}{c_1-c_3}L$$

Here x is the distance between the first sensor and the leak position (m), c_1 is the speed of sound (m/s), t_1 is the time to reach the first sensor; X + L - the distance between the second sensor and the leak position (m); c_2 is the speed of sound (m/s); and t_2 is the time to reach the second sensor.

It is clear that at this time there is a difference between 2 speeds in the equalizer. This resulting time difference is calculated using the combined method.

Since the proposed time-difference-based combined calculation method allows more accurate time-difference calculation than the traditional velocity-difference-based leakage location method of the signal processing method, and also depends on the time-difference calculation, these two methods can be experimentally tested together.

They experimentally determine the total time for the pressure wave to pass between the sensors along the pipeline segment by arranging a test discharge of the liquid outside the cut. If any of the characteristics obtained by the sensors exceeds the limit, a leak is detected. As a result, all leaks can be detected.

active flow control valves, which often cause unwanted vibrations. These dual sensors form a filter to determine the direction of the wave. Such a filter allows to cut off the waves caused by technological processes without affecting the waves caused by leakage in the protected part of the pipeline. Since sensor A is closer to the potential leak point, the speed of sound is calculated from the distance between sensors B and C, and sensor A is divided by the corresponding time difference. Acoustic velocities are obtained between sensors B and A and sensors C and A. To build the equation, the speed calculated based on the time difference between sensors B and C is used. In order to increase the reliability and mechanical stability during the etching of pipelines, the inclusion of graphene-based samples is relevant [6-23].

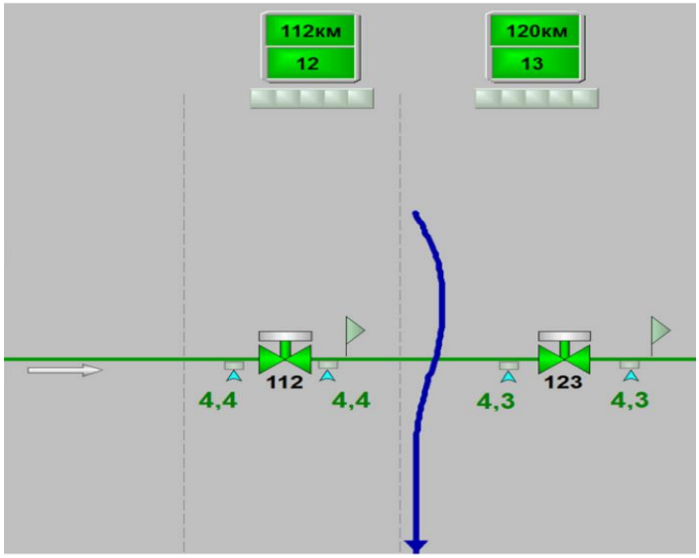

Figure 2. Part of the technological process in the stationary mode under normal conditions.

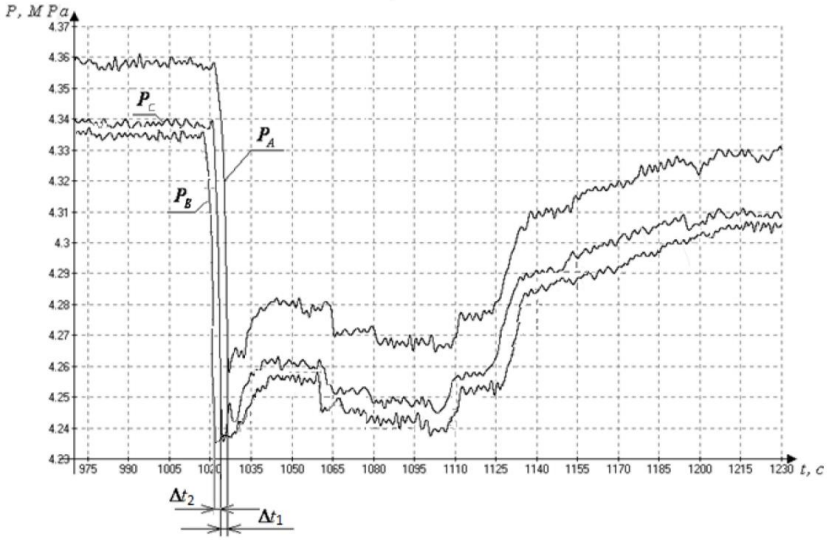

Figure 3. Discharge trend of flowing fluid is given.

P_A - pressure at transmitter A, P_B pressure at transmitter B , P_C pressure at transmitter C

Apparently, sensor B was the first to register the pressure drop in the technological process. The logic

algorithm in Infinity Server for detecting a potential leak is as follows:

1. Sensor X detects a decrease in the pressure difference in the technological pipeline;
2. The next second (closest to the first) sensor records the pressure drop;
3. When the third pressure sensor is stable, it calculates according to the logic of the leak detection system (LDS) by recording all three sensor values of the pressure deviation;
4. In addition, according to the formula known to us, by knowing the distance between all the sensors involved in the process and their acoustic speed, that is, according to the information received from the controller, the coordinate of the potential leak location is calculated.

The result of the experiment, i.e. the result of data processing in Infinity Server, is displayed on the automated workstation.

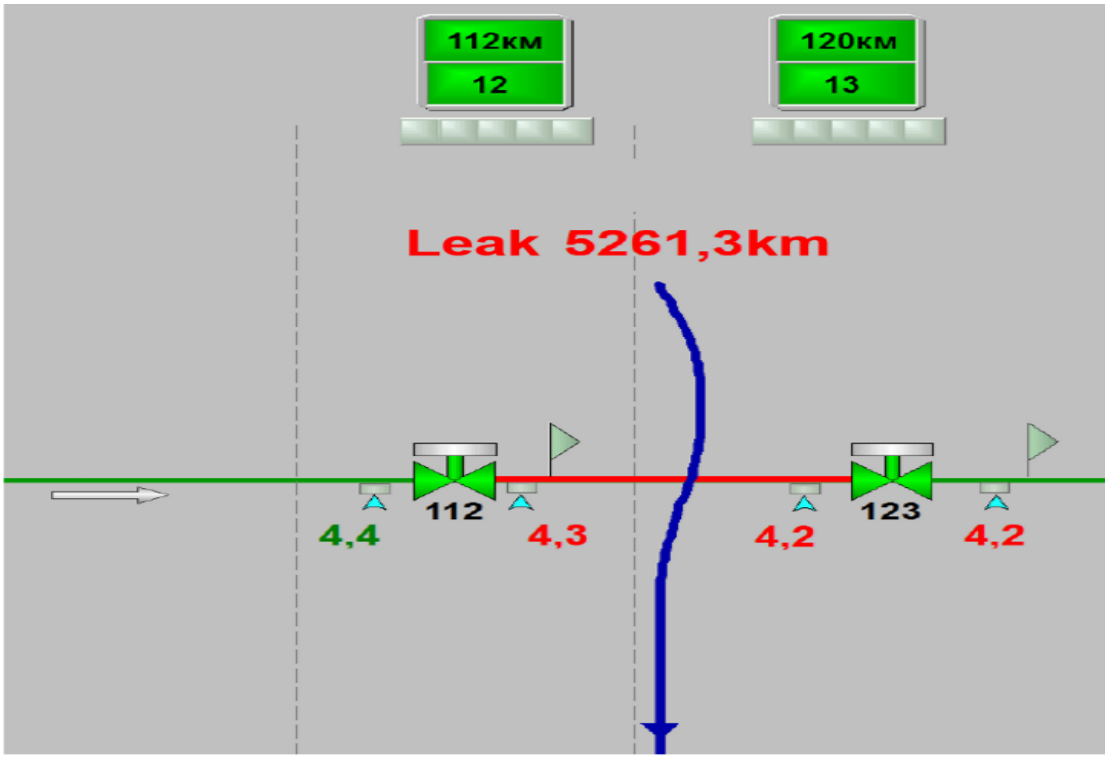

Figure 4.Tthe part where leakage is detected in a technological process in stationary mode under normal conditions.

Tables 1 and 2 show the actual parameters used to calculate the position error of the leak and the calculated parameters obtained after the calculation.

Table-1: Actual parameters

Parameter	Value
Discharge capacity (m^3/h)	990
Leakage diameter (mm)	10
Distance between segments of sensors (m)	7456
Distance from sensor A to leak (m)	5336

Table-2: Calculated parameters

Parameter	Value
Speed of sound, Vss (m/s)	1147,1
The difference in the time it takes for the wave to reach the sensors, Δt_1 , (sec)	2,4
The difference in the time it takes for the wave to reach the sensors, Δt_2 , (san)	2,6
Approximate distance from sensor A to leak (m)	5261,3
Position error (m)	74,7
Position error (%)	1,48

3. Conclusion

Here, a new method was developed based on the velocity difference determined by two sensors with a small distance between them placed at one end of the pipeline. The position error of the new signal processing method using velocity difference is -1.48%. It is possible to further increase this accuracy by improving signal processing methods and accurate calculation of acoustic velocities.

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Overview of the requirements of legislation in the field of production and modification process of resorcinol-formaldehyde oligomers

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Abstract: At present, there is no field where composite materials based on high molecular compounds are not used. Composite materials based on high molecular compounds have many physical-mechanical, physical-chemical, operational, optical properties, production technology, etc. can replace materials based on many heavy and non-ferrous metals. The existing resorcinol-formaldehyde oligomer is an oligomer that differs positively from other oligomers due to its production technology, relatively clean environment and economic indicators. It has certain shortcomings, for example, it is fragile, free monomers remaining in the finished oligomer to a certain extent, etc. In order to eliminate the shortcomings of the resorcinol-formaldehyde oligomer, it was modified for the first time with a compound containing nitrogen in an acidic environment. that the obtained cooligomer was obtained by chemical modification. The synthesis of resorcinol - formaldehyde oligomer was first carried out in aluminum vessels. The products were separated by high performance liquid chromatography and studied by 1H and 13C NMR. The reaction was carried out in two different temperature ranges, 317-332 K and 332-366 K, depending on the concentration and mole ratio of the catalyst. The heat of reaction was between 16.8 and 45.0 kc/mol for the first temperature interval 1:1 and 1:3 molar ratios, respectively. The second temperature interval of reaction heat was 73.5-84.6 kc/mol and was attributed to polycondensation reactions. The activation energy for the addition and polycondensation reactions was 95.0 and 120.0 kc/mol, respectively. Also, the first-order reaction was assumed for the second-order and polycondensation reactions [1].The kinetics of the catalyst-free reaction between resorcinol and formaldehyde are given in the article, because in the last few years resorcinol and especially its condensation products with formaldehyde have been selected for increasing application areas, more solid and reliable scientific bases for these reactions are guaranteed, and a systematic study of the kinetics of the condensation of resorcinol and formaldehyde is carried out. In one of the experiments in which this type of reaction takes place, dioxane is carried out without the presence of a catalyst at different temperatures and in different molar ratios of resorcinol and formaldehyde. In the first visible stage of the reaction, the activation energy (~ 19 kg/cal.) and the temperature coefficient is~2.3/10°C. During the condensation reaction of resorcinol and formaldehyde without the presence of a catalyst, the ratio of resorcinol and formaldehyde remains practically constant.

Keywords: Resorcinol, Formaldehyde, Oligomer, Cooligomer, Modification, Copolycondensation, Coating.

1.Introduction

Resorcinol has a very high functionality compared to phenol and alkylated monophenols. Since there is no kinetic information for the synthesis reaction of the very weak, uncatalyzed phenol-formaldehyde oligomer, and since this study only concerns the reaction of uncatalyzed resorcinol and formaldehyde, a comparison of their kinetics between resorcinol and phenol has been possible only in a few cases. The presented data led to a better understanding of the reaction between phenol resorcinol and formaldehyde [2].

The article presents organic aerogels of polycondensation of formaldehyde oligomer with resorcinol. Polycondensation of resorcin with formaldehyde in an alkaline medium leads to the formation of surface-functionalized polymer "clusters". Covalent cross-linking of these "clusters" produces gels processed under supercritical conditions to obtain low-density organic aerogels ($\leqslant$ 0.1 g sm^{-3}). Aerogels are transparent, dark red in color and consist of interconnected colloidal particles with a diameter of about 10 nm. The polymerization mechanism, structure and properties of resorcinol-formaldehyde aerogels are similar to the treatment of silicon oxide with air gel [3].

In order to improve the mechanical properties of isocyanate cross-linked resorcinol-formaldehyde aerogels, the synthesis of cross-linked air gels was investigated using hexamethylene diisocyanate (HDI) as a cross-linking agent. The effect of cross-linking

and catalyst thickness on the morphology and mechanical properties of RF aerogels was evaluated by various analyses. Fourier transform infrared spectroscopy (FTIR) confirmed the reaction of HDI isocyanate groups with the hydroxyl groups of the resorcin. showed changes in its thickening. For cross-linked aerogels, compared to natural samples, a decrease in compressive modulus and an increase in compressive stress by about five times were obtained. Also, an improvement in impact strength and a decrease in stiffness were observed [4-7].

The role of cations in the structural properties of resorcinol-formaldehyde gels. The production of resorcinol-formaldehyde xerogels provided information about the gelation processes that form the basis of their structures. In this study, the role of cations from the catalyst was studied by simultaneously adding sodium carbonates and calcium carbonates to the resorcinol-formaldehyde mixture. The xerogel was prepared by varying the solids content, catalyst concentration, and catalyst composition, and each was analyzed for its structural properties, including surface area and pore diameter. The results show that the role of the cation is related to the stabilization of the clusters formed in the system [8-11].

Over the past two decades, resorcinol-formaldehyde (RF) oligomer gels have been widely used due to their low density and tunable pore size. They are usually obtained by polycondensation of monomers in an aqueous medium followed by evaporation or supercritical drying. In this study, RF gels were synthesized by polycondensation in the presence of sodium dodecylbenzenesulfonate (NaDBS), followed by drying at room temperature and supercritical drying. Size measurements together with N2 sorption analysis and scanning electron microscopy (SEM) micrographs showed that the pore structure of the gel was mainly influenced by NaDBS. In all samples (xerogels and aerogels), the maximum intensity was observed at a critical NaDBS concentration, while a significant increase in pore size and a broadening of the pore size distribution were found at higher NaDBS concentrations. The highest mesopore volumes were found in the xerogels (133% for the acetone-dried samples and 67% for the water-dried samples), while for the aerogels, an expansion of the pore sizes into the macropore regime was observed at 5% NaDBS. SEM micrographs showed that very large pore volumes can be achieved using supercritical drying, in agreement with porosity analysis. However, in the case of xerogels, a denser structure with smaller pores (micro- and mesopores) is present, only a slightly modified structure was obtained when large amounts of NaDBS were used. The results showed that the addition of NaDBS had a strong effect on the RF gel pore tissue regardless of the drying technique, which should be considered when using this surfactant in gel formulation for various applications[12-13].

The researchers studied the absorption of heavy metals by airgel of resorcinol-formaldehyde oligomer modified with amine groups. Airgels of resorcinol-formaldehyde (RF) oligomer modified with amine groups were used to remove heavy metal ions from aqueous solutions. RF airgel was synthesized under subcritical conditions and then modified with 3-aminopropyltrimethoxysilane. The ability of modified RF aerogels to remove Pb(II), Hg(II) and Cd(II) ions from aqueous solution was studied by cyclic adsorption depending on the variation of pH, contact time, sorbent concentration and initial metal content.

It was found that the maximum adsorption capacity of Pb(II), Hg(II) and Cd(II) metal ions is reached in about one hour at pH 6, 6 and 5, respectively. Experimental data show that the adsorption of ions on the airgel surface is endothermic. The adsorption isotherms showed that the adsorption behavior of the modified airgel could fit the Langmuir and Freundlich models. The results of this study also showed that amine-modified RF aerogels can be used as effective sorbents for the removal of heavy metal ions Pb(II), Hg(II) and Cd(II) from aqueous solutions [14].

2. Experimental details

A new way for the synthesis of resorcinol-formaldehyde oligomer xerogels doped with controlled porous metals was found. The complex preparation method of resorcinol-formaldehyde (RF) organogels offers a number of possibilities for the preparation of metal-containing mesoporous carbon gels. However, the introduction of metal during the sol-gel step is not always negligible, as it can interfere with the polycondensation reaction. A new method was proposed to overcome this difficulty in the case of molybdenum. It was found that a sufficiently long initial polycondensation period (PP)

(in our case at least 110 minutes) before adding the metal salt gives a medium-porous oligomer monolith. Scanning electron microscopy (SEM), low-temperature N2 adsorption, and small-angle X-ray scattering (SAXS) studies reveal how the modification of PP changes the structure at different length scales. PP tuning offers a new means to tune the mean porosity of the obtained RF gels containing molybdenum [15].

In the study, tannin-resorcinol-formaldehyde-based adhesives and wood lamination were investigated by Matrix Laser Desorption/Ionization Time-of-Flight Mass Spectrometry (MALDI-TOF) at room temperature. It was found that the adhesive at the gelation point consists of resorcinol-formaldehyde oligomers, unreacted flavonoids, and resorcinol-formaldehyde oligomers interacting with tannin flavonoid compounds. The latter consists of an oligomer, which is the main part of the glue. In addition, their ratio is highest at the minimum reactivity of phenol around pH= 4 [16].

Urea-resorcinol-formaldehyde (KRF) oligomer with a small amount of resorcinol was synthesized at low temperature. While most of these adhesives exhibit waterproof properties, some also have adhesive properties as well as weather and boiling properties. A KRF oligomer with suitable adhesion properties was also obtained by inducing branching by introducing a certain amount of resorcinol or mimosa tannin polyflavonoid extract as the branching unit. With this method, resorcinol as low as 12.7% and 12.15% in the total liquid oligomer is obtained, while maintaining the adhesiveness and water resistance properties [17].

In the study of resorcinol-formaldehyde oligomer with different analytical methods, resorcinol-formaldehyde oligomer is distinguished, which differs little from the mole ratio of resorcinol and formaldehyde. The amount of monomer, dimer and trimer can be determined by gas-liquid chromatography (GLC) and high-pressure liquid chromatography (HPLC). Average chain lengths can be calculated from both gel permeation chromatograms (GPC) and 1H NMR spectra. Second, it can also be used to confirm the molar ratio of resorcinol to formaldehyde. 13C NMR spectra provide information on the structure of oligomers, the relative amount of free resource and the relative degree of condensation. It was determined that oligomers with a low ratio of resorcinol to formaldehyde contain a large amount of free resorcinol and have a low degree of condensation [18].

Gel permeation chromatography was used to study the condensation of resorcinol with formaldehyde. Gel permeation chromatography was used to study the acid-catalyzed condensation of resorcin with formaldehyde in a concentrated solution. The consumption of resorcin and the formation of some oligomeric products and the degree of change of molecular weight distribution during the reaction for condensates prepared using different reaction conditions were compared [19].

The study of the reaction of resorcinol-formaldehyde oligomer in weak solution observed by 13C NMR spectroscopy revealed that hydroxymethylated resorcinol (HMR) based on resorcinol-formaldehyde oligomer can significantly improve the bond strength of wood-epoxy oligomer in external applications. However, for HMR to be most effective, it should be prepared several hours before it is applied to the wood surface. In this study, 13C nuclear magnetic resonance (NMR) spectroscopy was used to monitor HMR composition as a function of time to characterize which chemical groups were present in solution when HMR was applied. Quantification of formaldehyde-derived groups requires the use of 99% 13C-enriched formaldehyde. First, the related hydroxymethyl groups corresponding to the fourth position of resorcinol and hemi formal groups are easily formed. Signals from the methylene bonds between the resorcinol rings begin to appear at 20 minutes of the reaction. 95% of formaldehyde was bound to resorcinol rings within 1.7 hours, 16% was converted to methylene compounds after 3 hours, and 40% was converted to methylene compounds in 8.3 hours. Another set of NMR experiments was used to monitor the pH dependence of the peak positions of the resorcinol solution. These experiments show significant effects especially between pH =7.7 and pH=9.1, which confirms the chemical shift changes observed during the HMR reaction [20].

A resorcinol-formaldehyde precursor was synthesized to produce the CO2-selective Carbon Molecular Sieve Membranes (CMS) developed in this study. The degree of polycondensation (PD) was analyzed by gel permeation chromatography (GPC) and its effect on CO2/N2 and CO2 permeability was investigated. The membrane oligomerized at 80 °C (designated as R80) was selected as the best-performing CMEC after initial testing. In order to increase the selectivity of CO2 permeability and

CO2/N2 permeability, the R80 membrane was processed after research with an oxidizing atmosphere. The results of gas permeability and pore size distribution (MPD) measurements by permporometry at polymerization temperature of 80°C, pressure of 6 bar after 100 minutes of processing and solidity of 10% 120°C with an oxygen concentration of CMSM R80T100, which exhibits an ideal CO2/N2 selectivity of 194 at °C, performed well above the upper limit for Robeson oligomeric membranes, as well as other CMMSs produced in this study [21-24].

Solid-state infrared spectroscopy, differential scanning calorimetry, and elemental analysis were used to evaluate the reactivity of the resorcinol-formaldehyde oligomer with nitric acid and to characterize the solid product. Two different reactions were identified in the temperature range of 25-55°C. The first reaction is mainly related to nitration of the oligomer, while the second one involves bulk oxidation and destruction of the oligomer compound, which leads to dissolution and outgassing. The reaction was confirmed in nitric acid as low as 3 M at 25°C and 0.625 M at 66°C. Although the nitrated oligomer can be isolated under appropriate experimental conditions, calorimetric tests have not revealed significant hazards associated with processing dry material [25–30].

Resorcinol-formaldehyde latex (RFL) adhesives based on resorcinol-formaldehyde oligomers and applications such as rubber products such as tires, hoses and belts are composite materials. They are made using a variety of natural and synthetic elastomers, reinforced with various reinforcing materials such as black ink, fibers and other fillers. With the increasing demand for durable high-performance products, reinforcement and elastomer-based materials must be constantly improved.

In the case of tire applications, stronger reinforcements can allow for thinner carcass layers, which in turn can reduce heat build-up and improve fatigue resistance in end products. These requirements have led to the development of high-strength fibers such as nylon, polyester, and steel to reinforce rubber products for tires and other applications. In general, synthetic fibers do not adhere well to rubber due to their smooth oligomeric surface and low reactivity.

The low surface activity of the fiber is related to the low polarity and reactivity of the oligomer molecules. Therefore, the formation of physical or chemical bonds between the fiber and the rubber is greatly reduced. Since direct contact between elastomer and fiber was not possible, an adhesive was needed to promote bonding between the two. The first adhesive system developed for viscose, a mixture of casein and natural elastomer latex, provided acceptable adhesion of viscose to rubber compounds. However, as reinforcing agents in rubber-like composites, synthetic fibers found that improved adhesives and adhesion promoters were needed to increase the bond between the rubber and the fibers. Improved adhesion requirements for wheels, conveyors and drive belts have led to the development of resorcinol (R)-formaldehyde (F)-latex (L) adhesives [31-32].

The researchers produced latex-type adhesives for nylon and viscose tire cords by reacting resorcinol and formaldehyde in an aqueous solution in the presence of a catalyst for a period of time and then adding butadiene-styrene-vinylpyridine latex. Ammonia improves the stability of the latex and increases its adhesion to the cord. However, if ammonia is added before the resorcinol and formaldehyde react, a white precipitate forms. This article studies the nature of this precipitate and the conditions of its formation. Information on the reaction mechanism was obtained by measuring the heat of reaction of formaldehyde and ammonia, and then of mixtures of formaldehyde and resorcinol with the addition of varying amounts of ammonia. Ammonia reacts rapidly with formaldehyde to form the unstable intermediate trimethylolamine, which then reacts with resorcinol to form trisdihydroxybenzylamine. This compound is also highly reactive and condenses with large amounts of ammonia and formaldehyde to form a low-solubility oligomer whose composition depends on the amount of ammonia and formaldehyde available for reaction. Single and double amines react with ammonia in the same way [33].

Researchers have studied the high temperature adhesion properties of melamine-urea-formaldehyde and phenol-resorcinol-formaldehyde adhesives. In order to better understand the adhesion properties of glued laminated timber (such as glued laminated timber) during fire, phenol-resorcinol was used to investigate the effect of high temperature on the shear strength of the adhesive line. -formaldehyde (FRF) and melamine-urea-formaldehyde (MKF) adhesives were used. The wood destruction mode was observed to study the heat resistance of the two adhesives. Fourier transform infrared spectroscopy (FTIQ) and

scanning electron microscopy (SEM) were used to analyze the chemical and microscopic changes at different temperatures. The shear strength parallel to the fibers of solid larch wood decreases linearly with increasing temperature. The bond strength of the wood-FRF adhesive line exposed to high temperatures was the same as that of solid wood. The wood-MKF adhesive line showed good adhesion performance at room temperature, but poor thermal resistance. The shear strength of the wood-MUF adhesive joint was 0 MPa at 280°C. The adhesion properties of PRF and MUF deteriorate linearly with increasing temperature. FTIQ analysis showed that FRF can maintain a relatively intact chemical structure at temperatures above 150°C, and the structure of MKF significantly deteriorates at temperatures above 200°C [34–37].

3. Conclusion

Resol-type phenol-formaldehyde oligomers were prepared and modified with resorcin-formaldehyde oligomer as a result. Optimum forming conditions and curing processes for obtaining modified wood adhesives characterized by high tensile shear resistance have been studied. At 80 or 25°C for 40 minutes or 100-110 days, with the presence of paraformaldehyde (10 or 15% weight) in the oligomer composition as a hardening agent, resorcinol-formaldehyde oligomers of phenol-formaldehyde with an equal weight ratio are more favorable conditions. The activation energies of solidification reactions of phenol-formaldehyde and resorcinol-formaldehyde oligomer samples were determined. Previously, metal and glass coatings from pure oligomers and their solid mixtures were prepared as varnishes or paints and evaluated [38-39].

Researchers have studied azo dyes based on resorcinol-formaldehyde oligomer. Resorcinol-formaldehyde oligomer was synthesized by condensation of resorcinol and formaldehyde in the presence of oxalic acid. The molar ratio of the used reagents was 1:0.5, respectively. By combining various aromatic diazonium salts with resorcinol-formaldehyde oligomer, a number of new oligomeric disperse dyes were obtained. As a result of dyeing polyester, nylon and wool, various attractive fibers were obtained. In this research on azo-resorcinol-formaldehyde dyes with oligomeric properties, the dyeing of fibers was completed in a short time and most importantly, no stains were observed on the fibers, but the previously reported oligomer-based dyes on the fibers formed spots. They were characterized in terms of softening point, color, solubility, visible IR and UV and thermogravimetric properties. Dyeing of polyester, nylon, and wool has resulted in yellow, orange, and brown-red shades with fastness to light and fastness to washing [40].

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Method of optimal synthesis of magnetic elements and devices based on an oriented graph

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Abstract: The article deals with the problem of optimal synthesis of magnetic elements and devices of information management systems based on topological oriented graph models. An algorithm has been developed for constructing an optimal topological model of a oriented graph. Based on this algorithm, the optimal synthesis of magnetic devices is calculated taking into account their magnetic properties and using modern types of computers in calculations.

Keywords: Magnetic element, Magnetic device, Algorithm, Topological oriented graph model.

1.Introduction

In existing information control systems, automation [1,4], various kinds of magnetic elements and devices play an important role, which is associated with their obvious advantages such as reliability, efficiency, radiation resistance, small dimensions. However, the classical methods of analysis, and even more so the synthesis of these devices, are quit complex and time-consuming and are often associated with a large error, as well as the impossibility of a sufficiently efficient use of computer systems, since requires the development of algorithms in each specific case, which is also associated with the nonlinearity of magnetic materials. Therefore, it is relevant to develop universal algorithms for analysis and optimal synthesis with the introduction of numerical topological methods [2,3].

In this regard, let us consider an algorithm for constructing an optimal topological model of the oriented graph of these magnetic elements and devices.

Let us consider the possibility of optimal synthesis of magnetic elements and devices based on the topological model of a oriented graph [1,3,5].To implement this problem, we will compose an algorithm for constructing an optimal topological model of a oriented graph in the following form:

1. We will consider as a given oriented graph $G(X,U)$, consisting of a set of arcs and vertices $X=\emptyset$, $U=\emptyset$, reflecting the set of synthesized elements and devices in such a way that each oriented graph $C_i \in C$ is an element of the i-th variant of the synthesized magnetic element under the condition of belonging to $\overset{n}{\underset{i=1}{X_i}} \in \overset{n}{\underset{i=1}{X}}$. In this case, the value a_i, for each i-th arc $U_i \in U$ of the oriented graph corresponds to the i-th element of the topological number T_{ri},, and each element $a_i \in T_{ri}$ determines the complex magnetic resistance of the i-th section of the K-magnetic element, $Z_{\mu ik} = R_{\mu ik} + jx_{\mu ik}$

2. Write topological numbers T_{ri}, for all vertices, reflecting the incidence of m-th arcs to each i-th vertex of the oriented graph and get a set of topological numbers T_{ri} ...T_{rk}...T_{rn}, where $T_{ri} = [a_1, a_2 \dots a_k \dots a_n]$ the number of m-th arcs incident to the i-th vertex of the oriented graph G .

3. Determine additional topological numbers T_{ri}^d for each number T_{ri} by writing $d_i \cdot x$ additional elements of the set of numbers not included in T_{ri} and get T_{ri}^d... T_{rk}^d ... T_{rn}^d.

4. Calculate the determinants of additional topological numbers:

$$\underset{Z_{\mu ik}}{det}\, T_{ri}^d \dots \underset{Z_{\mu ik}}{det}\, T_{rk}^d \dots \underset{Z_{\mu ik}}{det}\, T_{rn}^d.$$

5. Calculate the derivatives of additional topological numbers with respect to k...m...n,, where где i... k... n are the numbers of m edges and get:

$$\frac{\partial T_{ri}^d}{\partial i} \dots \frac{\partial T_{ri}^d}{\partial k} \dots \frac{\partial T_{ri}^d}{\partial n}.$$

6. Calculate the additional minors Δ_{ik}, equal to the sum of the values of the complements of the trees of the oriented graph $\sum_{u_k=0} D_i^d$, provided that the corresponding arc u_k is excluded by determining the determinant

$$\Delta_{ik} = \underset{Z_{\mu i}}{det}(T'_{ri} \cap T'_{rk}), \qquad (1)$$

where a_j, $a_k \in T_{ri}$ are incident to the i-th arc.

7. Define the topological transfer of the i-th path of the digraph in the form:

$$T_i = \left(t_{q-1}P^{q-1} + \cdots + t_{-(q-1)}P^{-(q-1)}\right)\left(K_qP^q + \cdots + K_{-q}P^{-q}\right), \quad (2)$$

where t_q, k_q, P^q are the topological transfer coefficients.

8. Calculate the optimality criterion for the oriented graph. As a criterion for the optimality of a oriented graph, consider the minimum number of arcs of the oriented graph corresponding to the minimum values of the required elements $Z_{\mu i}$.

9. Write the system of optimal nonlinear equations in the form [4]

$$\begin{cases} \psi_{q-1}\left(R_{\mu 1}, R_{\mu 2}, \dots, x_{\mu 1}, x_{\mu 2}, \dots\right) = t_{q-1} \\ \psi_{-(q-1)}\left(R_{\mu 1}, R_{\mu 2}, \dots, x_{\mu 1}, x_{\mu 2}, \dots\right) = t_{-(q-1)} \end{cases} \quad (3)$$

$$\begin{cases} f_q\left(R_{\mu i}, \dots, x_{\mu i}, \dots\right) = K_q \\ f_{-q}\left(R_{\mu i}, \dots, x_{\mu i}, \dots\right) = K_{-q} \end{cases}$$

where the coefficients t_i, K_i are determined according to the relation

$$T_i = \left[t_{q-1}P^{q-1} + \cdots + t_{-(q-1)}P^{-(q-1)}\right]\left[K_qP^q + \cdots + K_{-q}P^{-q}\right]^{-1} =$$

$$\det_{Z_{\mu i}}\left(T_{ri'} \cap T_{rk'}\right) \quad (4)$$

These equations are solved by the method of iterations, provided that for the initial values $R^0_{\mu i}$, $x^0_{\mu i}$ the nominal synthesized values are accepted at $i = 1,2,\dots,n$.

At the same time, the differences

$$\psi^0_s - t_s = \theta^0_s \qquad s = -(q-1), \dots, (q-1)$$

$$f^0_s - K_s = \xi^0_s \qquad s = -q, \dots, q$$

The method of successive approximations is carried out until the maximum values θ^0_s, ξ^0_s approximate to zero. When $\theta^0_s \to 0$, $\xi^0_s \to 0$, the values of $R_{\mu i}$, $x_{\mu i}$. are determined. It should be noted that it is more expedient to solve these nonlinear equations on a computer [3,4,6].

Graphene-based materials are extremely important in the development of memory devices of modern quantum computers [7-23].

2. Experimental details

Numerical example of constructing an optimal topological model of a oriented graph of magnetic elements and devices. As a numerical example of constructing an optimal topological model of a oriented graph of magnetic elements and devices, we consider a oriented graph (Fig. 1) that displays possible options for the synthesis of a magnetic element [2,5].

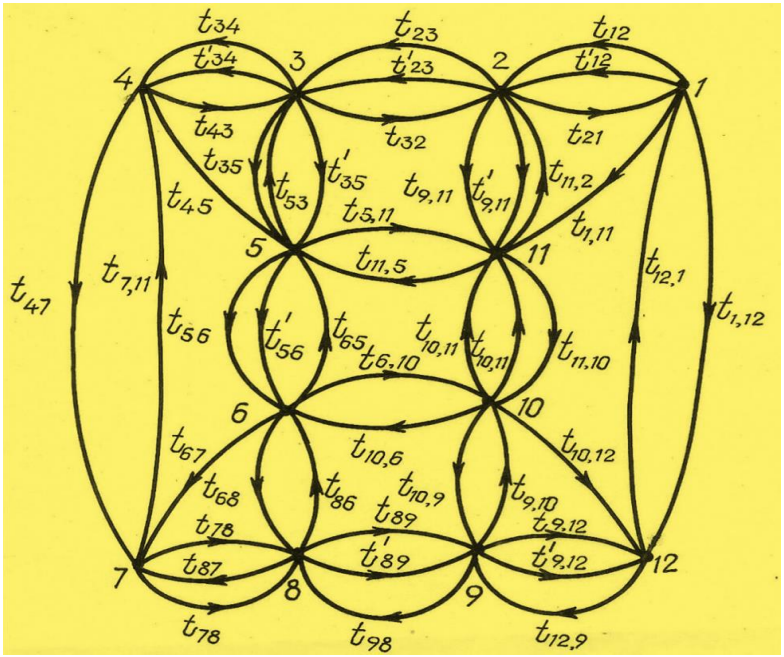

Figure 1. Oriented graph showing possible options for the synthesis of a magnetic element.

Complex transfers of arcs of the optimal digraph (Fig. 2.) are given in the Table.

Complex edge transfer notation t_{ij}	Active transmission component t_i	Reactive transmission component jt_i	Transmission module $\|t_i\|$	Transmission argument φ, degree
t_{12}	4,3	1,7	4,65	21˚35′
$t_{12'}$	2,6	0,8	2,27	17˚10′
t_{21}	3,2	1,8	3,64	29˚40′
t_{23}	3,7	0,5	3,84	7˚30′
$t_{23'}$	6,4	0,7	6,44	6˚15
t_{32}	5,6	2,5	6,14	24˚05′
t_{34}	3,3	1,2	3,51	20′
$t_{34'}$	7,1	0,9	7,18	7˚14′
t_{43}	8,1	1,1	8,15	7˚45′
t_{47}	4,3	2,1	4,8	26′
t_{78}	5,3	1,3	5,46	13˚48
t_{45}	2,8	0,7	2,88	14˚04′
t_{35}	2,2	0,5	2,26	12˚30′
$t_{35'}$	3,3	0,3	3,33	5˚12′
t_{53}	5,6	2,7	6,25	25˚40′
$t_{2,11}$	6,7	2,1	7,1	17˚25′
$t_{2,11'}$	3,3	1,2	3,5	20′
$t_{11,2'}$	2,8	0,9	2,94	17˚50′
$t_{1,11}$	1,8	0,7	1,94	21˚15′
$t_{5,11}$	4,5	3,0	5,42	33˚040
$t_{11,5}$	1,2	0,6	1,35	6˚35′
t_{56}	7,0	2,6	7,45	20˚23′
$t_{56'}$	6,0	-	6,0	0′
t_{65}	1,8	0,7	1,94	21˚15′
$t_{1,10}$	1,7	0,8	1,88	25˚10
$t_{11,10}$	4,7	-	4,7	0′
$t_{6,10}$	5,6	2,7	6,25	25˚40′
$t_{10,6}$	3,3	1,2	3,5	20′
$t_{6,7}$	7,0	2,6	7,45	20˚23′
t_{68}	4,5	1,5	4,74	18˚30′
t_{86}	1,2	0,6	1,35	26˚35′
$t_{10,12}$	2,8	0,9	2,94	17˚50′
$t_{10,9}$	2,8	0,9	2,94	17˚50′
$t_{9,10}$	9,05	3,35	9,65	20˚20′
t_{78}	5,96	2,83	6,6	25˚20′
t_{43}	1,7	0,8	1,88	25˚10′
t_{47}	1,5	0,5	1,58	18˚30′
t_{78}	1,5	0,74	1,68	26′
t_{87}	98,2	14,35	99,5	8˚15′
t_{89}	4,5	1,5	4,74	18˚30′
$t_{89'}$	1,32	0,6	1,45	24˚30′
t_{98}	5,75	2,5	6,27	23˚30′
$t_{9,12}$	5,6	2,7	6,25	25˚40′
$t_{1,12'}$	3,2	1,6	3,58	26˚30′
$t_{12,1}$	2,2	0,7	2,35	17˚40′

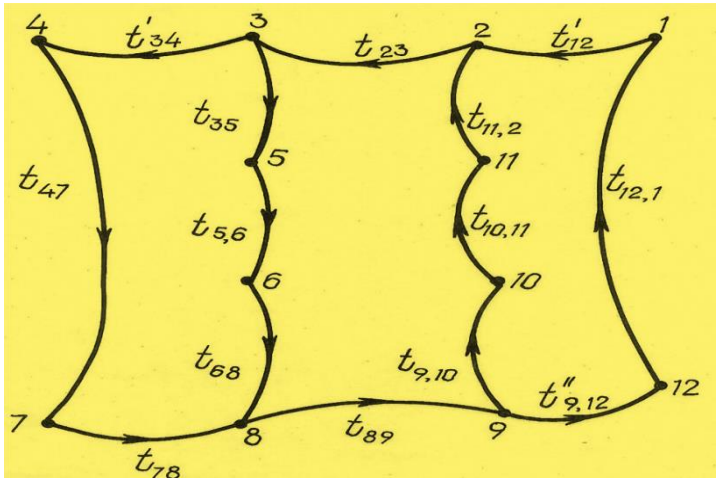

Figure 2. Optimal oriented graph.

Based on the above algorithm, the optimal oriented graph is determined and, accordingly, the device of the magnetic element (Fig. 3).

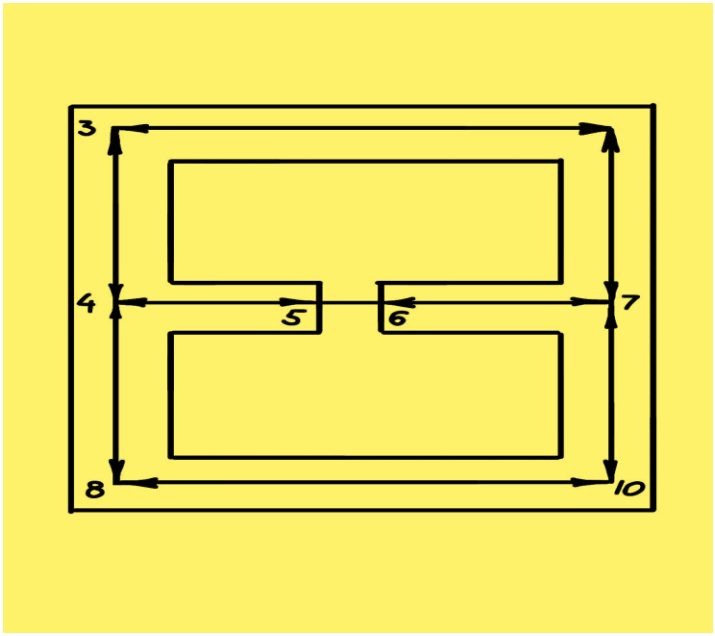

Figure 3. The device of the magnetic element.

According to the above algorithms, to build an optimal topological model of the oriented graph of magnetic elements and devices, a calculation program is compiled, which has the following values:
1. The weight codes of the oriented graph arcs t_{ij}, x_i, x_j are entered as initial data into the RAM, where t_{ij} is the weight of the oriented graph arc, x_i is the number of the initial vertex of the oriented graph, x_j is the number of the end vertex of the arc;
2. The number of arcs of the original contours are calculated sequentially $k = 2,3, \dots, n$
3. When $k = n$, control is transferred to block 10, assuming that the contour can consist of no more than n arcs. When $k \neq n$, control is transferred to block 4.
4. From the array M of the arcs of the oriented graph entered into the RAM, the arc $\alpha_i \in M$ is selected one by one. It is assumed that each of them is the i arc of the k - contour.

5. For the selected arcs of the oriented graph, an array M' is formed.
6. From the array M', the list of arcs D_i, is selected one by one, constituting the proposed i - contour.
7. The presence of the contour in the list D_i is checked. If D_i is a loop, then control is transferred to block 9, otherwise, to block 8.
8. The presence of unscanned arcs in the array M' is checked. If all arcs are selected, then control is transferred to block 2, otherwise, to block 4.
9. The found contour is assigned a serial number and it is written to the array M.
10. Formation of an array of topological numbers T_r .
11. Calculation of the product of topological numbers T_r .
12. Checking the fulfillment of the condition:

$$T_r = T_{r1}^i \cdot T_{r2}^i \cdot \ldots \cdot T_{rn}^i . \quad T_{ri} \neq T_{rj} \text{ for } i = j.$$

If "yes", then control is transferred to block 13, if "no" - to block 11.
13. Additional topological numbers T_{r1}^d are calculated for each T_{ri} number.
14. The determinants of additional topological numbers are calculated:

$$\underset{Z_{\mu i}}{det}\, T_{ri}^d \ldots \underset{Z_{\mu i}}{det}\, T_{rk}^d \ldots \underset{Z_{\mu ik}}{det}\, T_{rn}^d.$$

15. Derivatives of additional topological numbers are calculated i:

$$\frac{\partial T_{ri}^d}{\partial i} \cdots \frac{\partial T_{ri}^d}{\partial k} \cdots \frac{\partial T_{ri}^d}{\partial n}$$

16. Additional minors are calculated:

$$\Delta_i = det(T'_{ri} \cap T'_{rk})$$

17. Calculation of the topological transfer of the i path of the oriented graph G.
18. Calculation of the ratio of the determinants of derivatives of additional topological numbers to the determinants of additional topological numbers.
19. Checking the sample of all:

$$\underset{Z_{\mu i}}{det}\, T_{ri}^d \ldots \underset{Z_{\mu i}}{det}\, T_{rk}^d \ldots \underset{Z_{\mu ik}}{det}\, T_{rn}^d.$$

20. Writing and solving a system of optimal equations:

$$\psi = f\left(R_{\mu i}, \ldots, x_{\mu i}, \ldots\right).$$

21. Checking the fulfillment of the given optimality equation $q \leq m$, and $-x - 1 = d$, where n is the number of oriented graph arcs, x is the number of oriented graph vertices, q is a set of elements.
22. Printing results in the form of optimal values of complex magnetic resistances

$$Z_{\mu i \text{опт}} = R_{\mu i \text{опт}} + j x_{\mu i \text{опт}}$$

for each i arc of the resulting optimal oriented graph $G(X, U)$.

3. Conclusion

According to the proposed algorithms, based on the topological model of the oriented graph, the optimal synthesis of magnetic elements and devices of information control systems is performed.
Algorithms for constructing an optimal topological model have been developed oriented graph.

The proposed algorithms make it possible to significantly reduce the complexity and error in calculating the parameters of magnetic elements and devices of information control systems.

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Study of structure and properties of low-alloy pipe material in thermal strengthening

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Abstract: In this research work, improving the plasticity and complex mechanical characteristics with the application of thermal treatment, which is widely applied to pipe metal in the production of pipes for the extraction of oil and gas products, is considered one of the most important issues. In order to obtain the required structure and properties, the concentration of the elements specifically included in the steel was determined in advance. It has been found that chromium and vanadium included in the composition have great advantages in making pipes from low-carbon and low-alloy 13ХФА steel. In addition to forming carbides, chromium increases the depth of plating in complex alloying with manganese and silicon. Chromium dissolves in ferrite and strengthens it. At the same time, with the inclusion of a small amount of carbon, Nitrogen provides a fine-grained structure and increases fluidity by entering into strong chemical bonds. In the study, it was found that the most favorable property when using 13ХФА steel is obtaining quality properties at a low level of alloying. This prevents the valuable properties of the metal from using a large amount of alloying. The chromium element forms an amorphous coating of 3-valent chromium hydroxide that covers the surface of the steel. In short, chromium prevents the growth of grains without heating and increases the mechanical properties during static and impact loading, the depth of penetration, fire resistance, and wear resistance.

Keywords: Strengthening, Amorphous, Level, Valuable, Resistance.

1.Introduction

Currently, thermal treatment is considered the most important component in the production of various types of pipes. In the thermal treatment of pipes, provision of various operational properties, preparation of structures and properties necessary for further processing for various fields, restoring the plasticity of metals for further deformation, creating diffusion connections between different layers and balancing the structure and properties of the metal are brought to the fore. In a word, thermal processing in production is considered the most favorable complementary technological operation [1-3].

The types of products produced in metallurgical plants (pipes, various sheets, etc.) are subjected to various thermal processing methods in order to eliminate chemical and physical inhomogeneity, facilitate cutting or pressure processing, reduce stresses and prepare the steel structure for final thermal processing [4-5].

During the production of pipes of different brands and different diameters, it is necessary to take into account the factors that cause uneven heating of the metal to the heating temperature in the thermal furnace (production temperature, heating mode, heating time, burning intervals of the energy used for heating the furnace, etc.) [6].

One of the most important issues is to cut the sample and conduct structural analysis after rolling the pipe. During the analysis of the samples taken from the pipes and the tested pipe, it was found that the reason for the crack that occurred along the length of the pipe was that the correct processing mode was not selected during the thermal treatment of the pipe. Thermal treatment of such steels at high temperatures in the case of normalization, after normalization, re-stabilization should be subjected to an annealing process. Due to this, the formation of permanent austenite occurs, which subsequently leads to the formation of internal cracks. The fact that the crack is broken along the length of the tested pipe and that it is white when viewed from above is the result of improper heat treatment. allows to come [7,8,9].

Each brand of steel produced in pipe rolling should be studied and their technological map should be prepared, thermal treatment regimes should be worked out. It consists in increasing the penetration depth, fire resistance and wear resistance of the mechanical properties during static and shock loading by optimizing the thermal processing regimes for thermal strengthening of the hot-rolled low-alloyed pipe material and studying the structure and properties.

2. Experimental details

To fulfill the set goal, in laboratory and production conditions, 13ХФА (C-0.11-0.17; Si 0.17-0.4 ; Mn 0.4-0.65 ; Ni < 0.25 ; Cr 0.5 -0.7: Cu < 0.25; V 0.04-0.09; N < 0.008; Al 0.02-0.05; Fe ~ 96) and its properties are improved by thermal strengthening of the pipe material.

In order to determine the effect of heat treatment on the structure and properties of different regimes on heated 13ХФА steel, 10 x 10 x 55 mm, 20 x 20 x 100 mm samples should be prepared.

The cooling rate of the selected pastries is placed on the thermokinetic diagram by constructing the real and characteristic cooling curves for the value in 10% NaCl aqueous solution. (Figure 1)

Figure 1. Macro view of samples cut from pistah a)10 x 10 x 55 b) 20 x 20 x 100 c) pipe section

In order to compare the real and characteristic cooling curves of the specified samples, a 30 x 20 mm tube section cooled in water was taken.

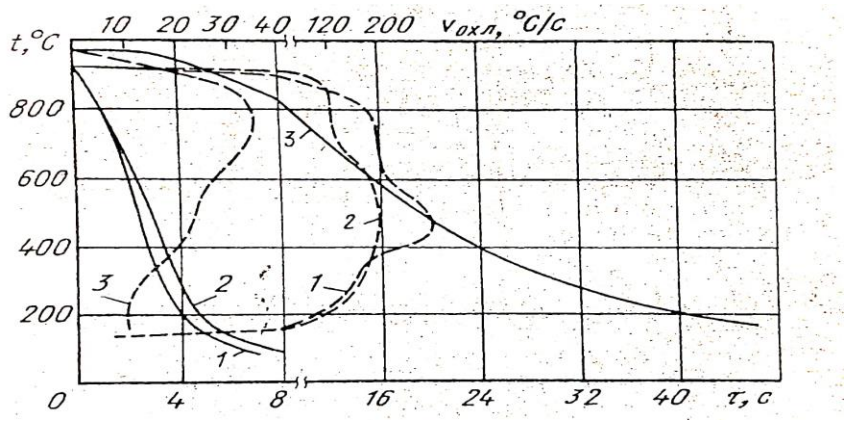


Figure 2. Real (solid line) and characteristic (dashed line) cooling curves (the thermocouple was used for the middle of the tube wall thickness.)

1,2 – 10 x 10 and 20 x 20 mm, cooled in a 10% aqueous solution of NaCl; 3- 130 x 20 mm, cooled in water.

The effect of tempering temperature on the structure and hardness of 13ХФА steel is studied (850 - 1000, holding for 5 minutes at every 50). Cooling was also carried out in a 10% solution of NaCl in water. (t=17÷23)

The effect of water temperature on the properties of pipe material is in the range of 15-75 (every 5) . For example, for 10 x 10 x 55 mm samples, 950-960 (every 50). The effect of tempering is also studied at 400-700 (every 50).

Tempering rate was 1.8-2.5 in electric oven and 0.12-1.84 in sublimation (depending on sublimation temperature and size of pastry).

The preparation of test samples was determined according to GOST 1497-84 (tensile), GOST 9454-78 (impact viscosity), hardness measurement was determined according to GOST 9013-5. is carried out in solution in water).

The real cooling curves of the tube and tube section are reflected in the thermokinetic diagram (Fig. 3.).

In this diagram, cooling on the 10 x 10 x 55 and 20 x 20 x 100 mm slices confirms the martensite structure. This corresponds to that obtained from sheet material [10].

During cooling in water, the structural constituents in the cross-section are composed of ferrite, bainite and marensite.

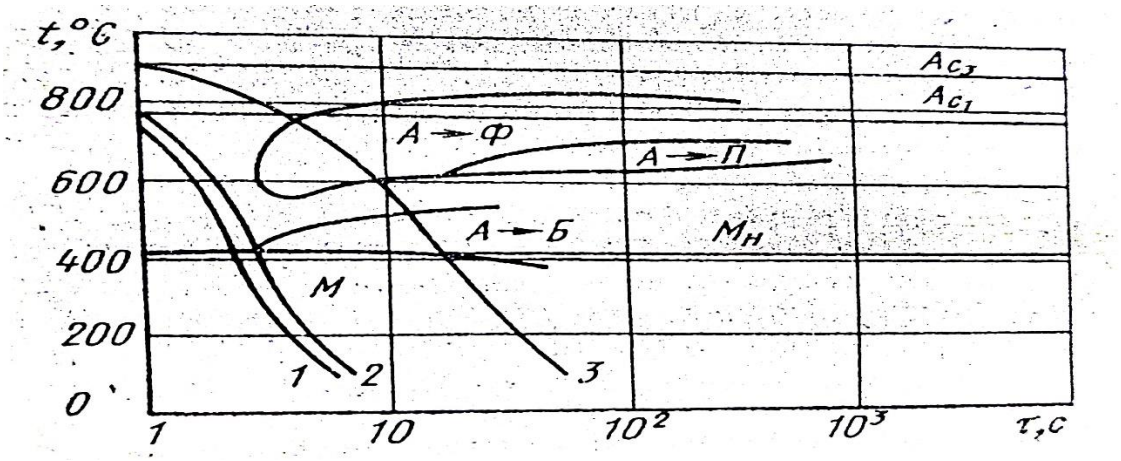


Figure 3. Thermokinetic diagram of 13ХФА steel with real cooling curve

1,2 – 10 x 10 and 18 x 18 mm cross-section pistahs, 3 – tube cross-section pistah 130 x 20 mm

Tables 1 and 2 show the chemical composition of the given pipe steel according to the GOST4543-2016 standard and the actual physical and mechanical properties according to the requirements.

Table l. 13ХФА pipe steel according to GOST4543-2016 standard

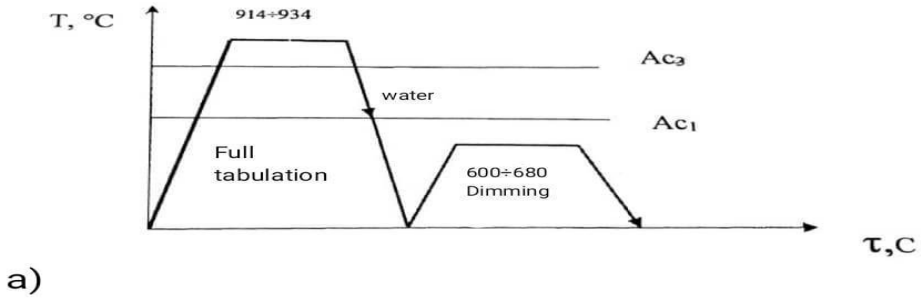
Steel Brand	Chemical composition in %											
	C	Mn	Si	P	S	Cr	Ni	Cu	Mo	V	Ti	Al
13ХФА GOST 4543-2016	0.11-0.17	0.4-0.65	0.17-0.37	<0.30	<0.025	0.5-0.7	<0.3	<0.3	<0.11	0.04-0.09	<0.03	0.02-0.06

Table 2. GOST4543-2016 standard and actual physical and mechanical properties of 13ХФА tube steel

Steel Brand	Durability class	Don't be stupid Threshold $\sigma_{0,2} MPa$	Durability Threshold $\sigma_M\ MPa$	Relative Extension $\delta_{0,5}$,%-with	Firmness HB	Impact viscosity KCU, kC/m ^{2}	Density g / cm ^{3}
13ХФА GOST 4543-2016	K45 K50 K52 K54 K56	355-472	510-628	20	< 269	34.3	7.86

Actual result	325	480	21.5	195	-	7.45

Based on the obtained real and characteristic cooling curves and the thermodynamic diagrams of the real cooling curve, depending on the thickness of the pipe, the thermal treatment mode of 13ХФА steel can be shown as follows.



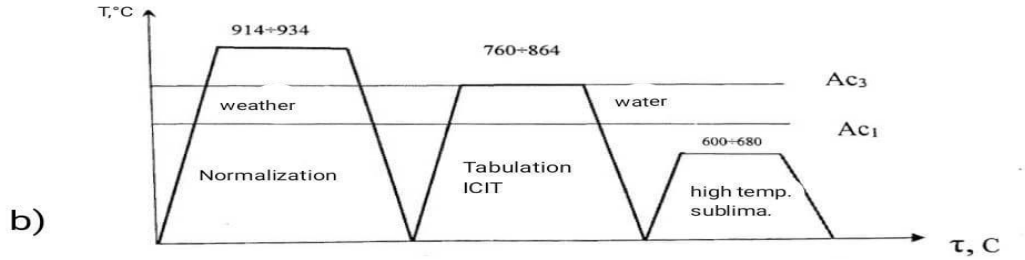


Figure 4. Modes of thermal treatment of pipes for 13ХФА steel

a) Full tabulation + dimming

b) Normalization + tabulation and inter-critical interval tabulation + high-temperature sublimation

The tabulation temperature of steels up to eutectoid is determined by the following formula.

$$t_q = Ac_3 + (50 \div 70)℃$$

then

$$t_q = 864℃ + (50 \div 70)℃ = (914 \div 934)℃$$

The principle scheme of the tabulating device is given in full in the figure.

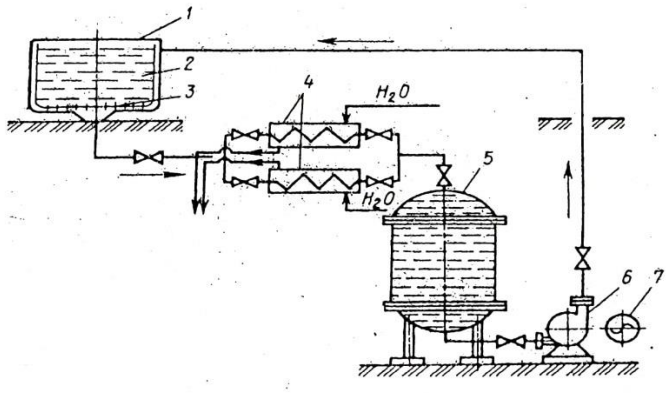


Figure 5. The principle scheme of the tabulating device

1-bath body; 2-setting medium (water); 3-grid base; 4-refrigerator; 5-a capacity filled with water; 6-pump; 7-pump electric motor.

Temperatures of the crisis points of 13ХΦА steel

Table 3.

Ac_1	Ac_3	Ar	Ar_3	M_b
760	864	-	790	270

As a result of the research, it was found that when the tempering temperature is increased from 850℃ to 1150℃, the amount of ferrite in the structure decreases and reaches the level of non-existence at 1000. The structure mainly consists of martensite. On the other hand, when the tempering temperature range (850-1000) is reached, austenite there is no change in the grains. (picture 6)

Figure 6. Microstructure of pashtos cured at different temperatures (x500)
a - 850 ^{0}C; b -950 ^{0}C; c -1150 ^{0}C.

Pastes are tempered at 1000-1050, inhomogeneity occurs in both austenite grains and structural constituents. Observing coarse-grained austenite in the structure creates the characteristic of showing it as a breakdown product of closely spaced austenites . During this process, impact viscosity decreases.

When the heating temperature rises above 1100, the steel structure becomes more homogeneous and consists of a breakdown solution of coarse-grained austenite (Figure 6).

After tempering, the hardness of pastash is (35÷40) HRC in the indicated temperature range.

It confirms that 900-950 temperature is appropriate for the effect of temperature on its properties in 13ХΦА steel plate.

Chromium and vanadium, which are included in the composition of the material, play a very important role in the formation of the structure of the material. These elements ensure the acquisition of the structure and properties required for the pipe material. Here it plays a decisive role in the formation of a kind of structure. Being a carbide forming element, it dissolves in ferrite and strengthens it (Figure 7).

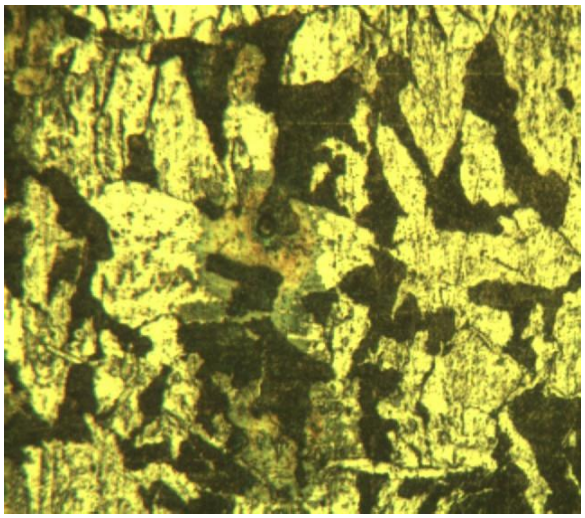
However, due to the complex composition of chromium, manganese, and silicon, they increase the depth of steel.

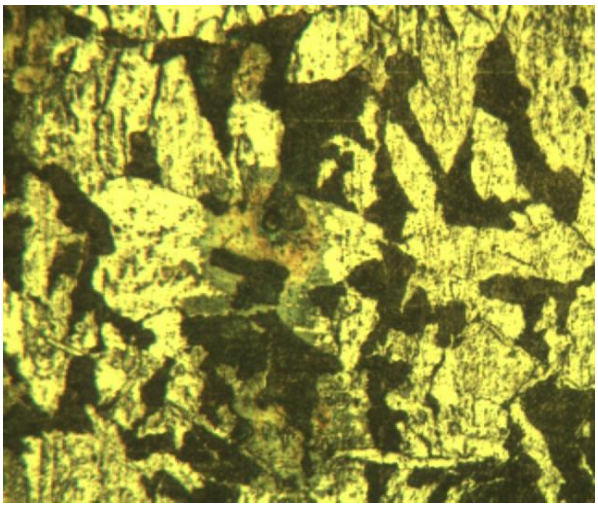
By adding vanadium in a small amount (0.04÷0.07)% in the low-carbon pipe material , forming solid chemical compounds (carbides, nitrides or complex carbonitrides) related to carbon and nitrogen austenite prevents grain growth by forming a fine-grained structure and increases impact toughness.

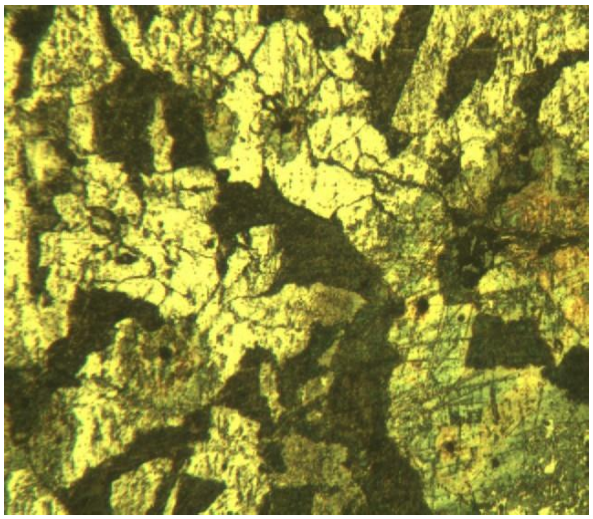
13ХΦА steel from other (32 Г2, 09Г2, 12Г2С, 17 ГС, steel10, steel20, etc.) is the creation of properties that ensure quality during low alloying. At the same time, oil and gas extraction, etc. is not widely used [11]. These advantages are largely due to its chromium content, which creates an amorphous layer of chromium trivalent hydroxide on the surface of the steel, which coats the surface of the steel [12]. At the same time, the carbonate of iron strengthens or binds the crystals together. One of the biggest advantages is that it does not allow more components to enter inside (Figure 8).

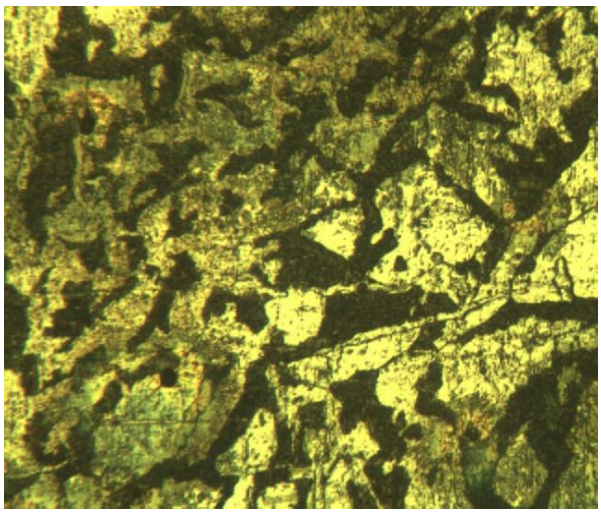
During tabulation, high internal stresses appear and as a result, cracks occur. This problem is solved by high magnification. The structure of highly tempered pipe material, apart from the ferrite-carbide mixture, has high corrosion resistance due to the granular morphology of the carbides.

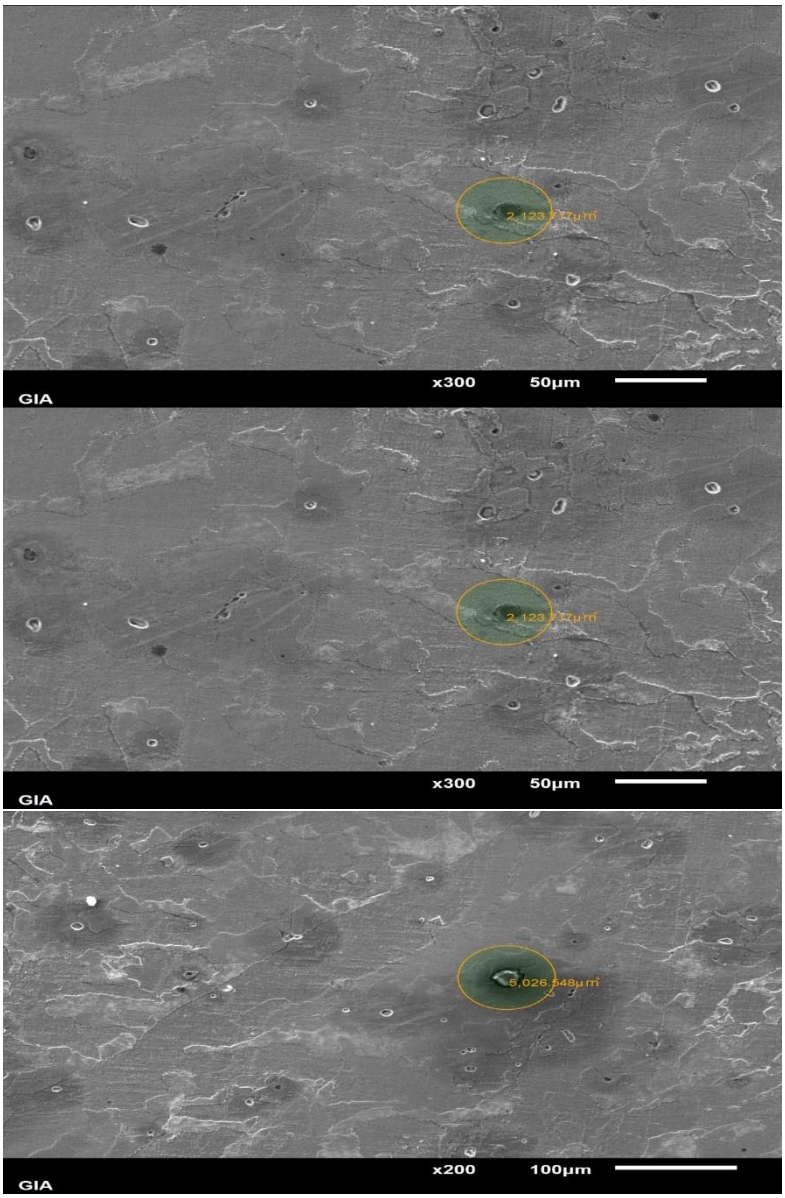
Mormalization is widely used to improve the properties and structure of low-carbon low-alloy steel by quenching austenite without high strength. During such normalization, the dispersity of the ferrite-cementite structure increaseand the amount of pearlite increases. (Picture 7)











The presence of a small amount of chromium in the composition stabilizes the structure of solid carbides.

If the pipe material is heated slightly above the critical temperature or if long holdings are allowed at the optimum temperature, austenite grains will grow at this excess temperature, resulting in the formation of large acicular martensite. At this time, the hardness decreases and the impact viscosity decreases (picture 4).

During normalization of heated pipe metal, it is heated to austenite state and cooled in calm weather. Here, due to normalization, the structure and properties are improved. During normalization, the dispersity of the ferrite-cementite structure increases and the amount of pearlite increases. At the same time, normalization ensures high cleanliness on the surface of the pipe steel and prevents brittle fracture. increases the resistance. Reduces the possibility of cold cracking [13].

the high heating temperature, the formation of oxides around the grains sometimes causes embrittlement of the steel. The volume and atomic composition of element oxides involved in the composition and the formula and composition of oxide compounds of these elements were detected with the help of an electron microscope [14]. In Figure 8, the electronic structure of such inclusions inside the grain was obtained (Figure 5). At the same time, the full scale

of the electronic spectrum of this appearance was obtained.

3. Conclusion

13ХФА steel of different thermal treatment regimes were carried out in laboratory and production conditions on samples cut from pipe material.

The amount of carbon (>0.1%) in the thermal strengthening of thick-walled pipes made of 13ХФА steel in the industrial production is limited by the application of various cooling methods in tabulation.

The analysis of the real cooling curves showed that the average cooling speed for the pastas δ_soy=245 və 170/sanis - in the temperature range of 900-400.

The thermokinetic diagram based on the real cooling curves of the pashtos, the martensite structure formed in the cooled pashtos samples is confirmed by the ones in the traditional sheet material. During cooling in water at different temperatures, the structural constituents consist of ferrite, bainite, and martensite.

It is low carbonized so that the structure of the steel is not homogeneous in the temperature range of 1000-1050. This is related to the size of the austenite grains and the structural elements. The most optimal tempering temperature is determined at 900-930.

It was determined that depending on the cooling temperature, there are great possibilities to adjust the properties of 13ХФА steel. σ_M>510 MPa ,σ_a>372-421 MPa,δ>23%,HB<92 HRB,KCV>98c/〖sm〗^2the possibility of price adjustment is obtained. Low-carbon 13ХФА steel, the presence of small amounts of vanadium and chromium leads to the formation of fine-grained structure and stabilization of solid carbides. High annealing (600-680) of σ_0,2/σ_M<0,9 tempered 13ХФА steel creates the best relationship between strength and viscosity while completely or partially eliminating internal stress It was found that if the tube material is heated a little above the critical temperature or if the storage time at the optimal temperature is long, large acicular martensite is formed as a result of the growth of austenite grains. This lowers the hardness and indicates a decrease in impact viscosity. During the normalization of the heated pipe end, the dispersity of the ferrite-cementite structure increases and the amount of pearlite increases.

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Transmission capacity of interactive television broadcast systems and increase their technical efficiency

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Abstract: By using interactivity, adjusting the parameters of communication systems can be done easily. The development of radio communication devices is related to the improvement of their quality indicators. One of the important parameters of communication and broadcasting systems is their transmission capacity. It is closely related to other important parameters of the system. In communication or broadcast systems, the signal/interference ratio, data transmission accuracy, transmission speed, spectral, energy and information efficiency are determined by the ability to transmit. Correct selection and adjustment of these parameters is of great importance. The article analyzes the relationship between the transmission capacity of the communication system and its technical efficiency. It was shown that a large selection of the extinction coefficient leads to spectrum expansion, and a small selection leads to an increase in the duration of elementary pulses, and the spectrum expansion leads to an increase in noise power. A compromise value of the extinction coefficient in TV broadcasting was selected using the "eye diagram".

Keywords: Interactive television, Digital terrestrial TV broadcasting, Emissivity, Spectral efficiency, Energy efficiency, Extinction coefficient.

1.Introduction

In recent years, LMDS (Local Multipoint Distribution System - Local multipoint distribution system) and MVDS (Multipoint Video Distribution), which are considered to be the newest technology in terrestrial interactive television (TV) broadcast and distribution network for small areas in the world and are distinguished by their high speed and high integration of services System - Multipoint video distribution system) is widely used. The well-known advantages of the considered systems have led to their wide application [1,2]. Currently, interactivity is implemented in LMDS and MVDS systems and some other digital terrestrial TV broadcasting. For example, interactivity has taken place in Japan's ISDB (Integrated Services Digital Broadcasting - Terrestrial - integrated service digital broadcasting - terrestrial) system. There are significant differences between LMDS and MVDS systems. Those differences should be taken into account during their application. Although their working frequency ranges for different countries are slightly different from each other, the considered systems work at very high frequencies up to several tens of gigahertz [1-5].

There are specific features of improving parameters of interactive communication and broadcasting systems. By using interactivity, it is possible to easily adjust parameters [6]. The development of radio communication facilities is related to the creation of new facilities as well as the improvement of the quality indicators of existing facilities. One of the important parameters of communication and broadcasting systems is its transmission capacity. Transmission capacity is one of the most important parameters of any communication system, and it is closely related to other important parameters of the system. In communication or broadcast systems, the signal/interference ratio, data transmission accuracy, transmission speed, spectral, energy and information efficiency are determined by the ability to transmit [7]. It is very important to choose these parameters correctly and adjust them during operation.

Therefore, it is important to analyze the relationship between the transmission capacity of the communication system and the aforementioned efficiencies. When designing communication systems, their other important parameters are also taken into account - accuracy of information reproduction, immunity, communication range, communication reliability, equipment reliability, electromagnetic compatibility, environmental compatibility, equipment cost, dimensions and weight, which to one degree or another affect the system. is related to the release capacity [8]. Also, the improvement of some of these parameters can lead to the deterioration of another important parameter [7]. For example, increasing the resistance to obstacles, transmission speed or information

efficiency can lead to a decrease in economic efficiency.

Throughput refers to the maximum speed of information transmission through a communication channel in the case of given restrictions. When determining the transmission capacity in communication systems, certain restrictions are placed on the strength and base of the signal. We can represent any signal that satisfies the Dirichlet condition as a sum of Fourier series. In this case, Fourier coefficients become information carriers. The presence of a statistical relationship between them leads to a certain decrease in the amount of information. In this case, using the differential entropy, we can calculate the capacity of the channel affected by the noise.

Setting the issue. If the base of the signal is not bounded, then $P_k = N_0 \Delta f_b$ we can find the maximum value of the emissivity in the channel affected by the "white" soot using the expression, where P_k – the strength of the noise, N_0 – intensity of noise, Δf_b – is the frequency passband. By expanding the frequency band for this, $\Delta f_b \to \infty$ it is possible to find the maximum value of the release capacity. By plotting the discharge capacity, we can be sure that this quantity in such a channel $\Delta f_b = P_s / N_0$ takes 70% of its maximum value when - is the signal strength [1,6]. With the further increase of the frequency band, the capacity of the channel increases very slowly. Therefore, when designing communication and broadcast systems, based on the requirements set for them, a compromise solution should be sought for the selection of parameters [2,7,9].

Transmission speed is of great importance in digital communication systems. Transmission speed is the amount of data transmitted per unit time. Energy efficiency characterizes the transmission speed at the required signal/interference ratio. Therefore, to increase the energy efficiency, on the one hand, it is required to increase the transmission speed, and on the other hand, to reduce the required signal/interference ratio. Note that there are many possible ways to improve these two parameters [2,4,5].

Transmission speed is sometimes given with its relative price. The specific bit rate is the calculated bit rate per unit frequency band. In binary digital communication systems, special transmission rate after modulation 2 bit·sec^{-1}/Hs is less [8]. For example, in QAM modulation, the specific transmission rate varies greatly depending on the code rate and the number of QAM modulation positions. By changing the code rate from 1/2 to 7/8, the specific transmission rate increases by a factor of about 1.76 in QPSK, 16-QAM, and 64-QAM modulations. At the same code rate, the specific transmission rate of 64-QAM is 1.5 times that of 16-QAM, and 16-QAM is twice that of QPSK. In general, by changing the code rate from 1/2 to 7/8 and switching from QPSK to 64-QAM, the specific transmission rate increases by 5.27 times [1-3]. It is clear from these considerations that it is possible to increase the energy efficiency of the system with the correct selection of these parameters.

However, in addition to the specific transmission speed, the modulation method has an effect on the radius of the coverage area of the stations. This, in turn, can affect the level of obstacles in the network itself. Therefore, the correct selection of the modulation method also allows to increase the release capacity.

In digital broadcasting systems, channel coding is performed in addition to source coding. In order to increase its resistance to interference, interference-resistant coding is performed during channel coding. At this time, each correction code combination consists of data symbols and check symbols. This causes the transmission speed to decrease. The extent to which the transmission rate is reduced depends on the code distance. Barriers in communication systems often appear in the form of packets. Correcting multiple errors in the same code combination requires a large code distance. Therefore, external and internal mixing is used in digital TV [9]. This allows the decorrelation of errors to be carried out.

LMDS and MVDS systems work in the cm and mm range, and in this range there are almost no extraneous interferences on the air. Therefore, the increase in the release capacity of these systems is brought to the reduction of the obstacles created by the system itself. Among those obstacles are the generation of amplitude-amplitude and amplitude-phase transitions in the transmitter-receiver tract due to the broadband of the signal, other cross obstacles, blocking of signals and obstacles related to the topology of the network where these systems are applied [1,2,10].

Apparently, the improvement of one parameter that reflects the quality indicators of the system can lead to the deterioration of other parameters. Therefore, suitable values of these parameters should be selected for each system and given reception conditions.

The purpose of the article is to choose a compromise between their release capacity and technical efficiency during the implementation of the mentioned systems.

2. Experimental details

When each system is designed, its parameters are optimized. It is clear that depending on the purpose of the designed system, the importance of its individual parameters will be different. Therefore, the weighting coefficient of the parameters is used during the evaluation of the system efficiency. The evaluated parameters should be technically important, should characterize the system well, should be effective. Calculations for efficiency evaluation should be practical. In practice, the evaluation of the system with linear functions is more applicable [9]:

$$Q = \sum_{i=1}^{n} \lambda_i \delta_i , \qquad (1)$$

here n – the number of parameters considered, δ_i – the ith parameter considered,, λ_i – *is the weight of the ith parameter.*

Let's do this evaluation for LMDS and MVDS systems used in interactive TV broadcast systems. We have investigated the working principle of these two systems and revealed the main parameters characterizing them. The main parameters characterizing these two systems are given in the table, they are compared with each other and generally with high frequency communication systems. A comparison of the parameters shows that although there are certain similarities between them, there are also differences, and these differences should be taken into account during the design and implementation of the system. This table also shows the advantages of both systems.

Determining the weighting factor for the specified parameters can be done after extensive study of the system. As you can see, there are enough parameters characterizing the considered systems, and the analysis of each of them requires extensive research. Here, only the emission capacity of the considered systems and the evaluation of the parameters related to it will be performed. The transmission capacity of the system is determined by the spectral, energy and information efficiencies and other parameters related to them (signal/interference ratio, information amount, transmission speed, frequency bandwidth).

The discharge capacity of the system can be determined by Shannon's formula. Variations of this formula for different channels are given by Shannon. Shannon's formula is universal, and most of the parameters mentioned above are directly or indirectly involved in it. In theory, it is possible to provide a transmission rate equal to the channel's capacity. Encoding methods can be used to provide emissivity close to the theoretical value of emissivity.

Let's use the well-known Shannon's formula [7], which determines the channel's release capacity for a channel affected by additive barriers:

$$C = \Delta f_b \, log_2 \left(1 + \frac{P_s}{P_k} \right), \qquad bit/s ,$$

here $C / \Delta f_b$ – The ratio represents the maximum specific speed [7].

The energy efficiency of the communication system, in turn, is a very important parameter of the system, and it is closely related to a number of other parameters, and the change of the energy efficiency seriously affects other parameters of the system. This parameter was analyzed in the scientific and technical literature on telecommunications, its expression was defined and its relationship with different types of parameters was clarified. [8].

Table.Main indicators of LMDS and MVDS systems

№	LMDS systems	MVDS systems
1.	A multi-frequency modulation method (16-QAM /QPSK)-OFDM is used as the second stage modulation	QAM (cable TV); QPSK (satellite TV) modulation methods are used.
2.	It works at extremely high frequencies (27.5...31.3 GHz - the long range of cm and mm waves)	It works at extremely high frequencies (40.2...42.5 GHz -mm waves).
3.	The frequency band is wide (1...2 QHs)	Very wide bandwidth (2 GHz)
4.	The transmission speed is quite high	The transmission speed is very high.
5.	It is a wireless communication system. Not using cables as a communication line leads to the elimination of expenses incurred on them.	It is a wireless communication system. Not using cables as a communication line leads to the elimination of expenses incurred on them.
6.	Confidentiality of information can be ensured.	Confidentiality of information can be ensured.
7.	Networking can be done in a very short time.	Networking can be done in a very short time.
8.	The cost of building a network is cheap. It can be expanded or contracted without incurring huge costs.	Building a network is simple, quick and relatively cheap. It can be expanded or contracted without incurring huge costs.
9.	It is possible to change the location of subscribers	It is possible to change the location of subscribers

	without using additional equipment.	without using additional equipment.
10.	It is possible to use passive and active repeaters to expand the reliable reception area	It is possible to use passive and active repeaters to expand the reliable reception area
11.	It is possible to use passive and active repeaters to expand the reliable reception area	It is possible to receive multi-channel television signals from the air.
12.	It is almost environmentally safe because it works on weak signals.	It is environmentally safe because it works on very weak signals.
13.	There are almost no dead zones	There are almost no dead zones

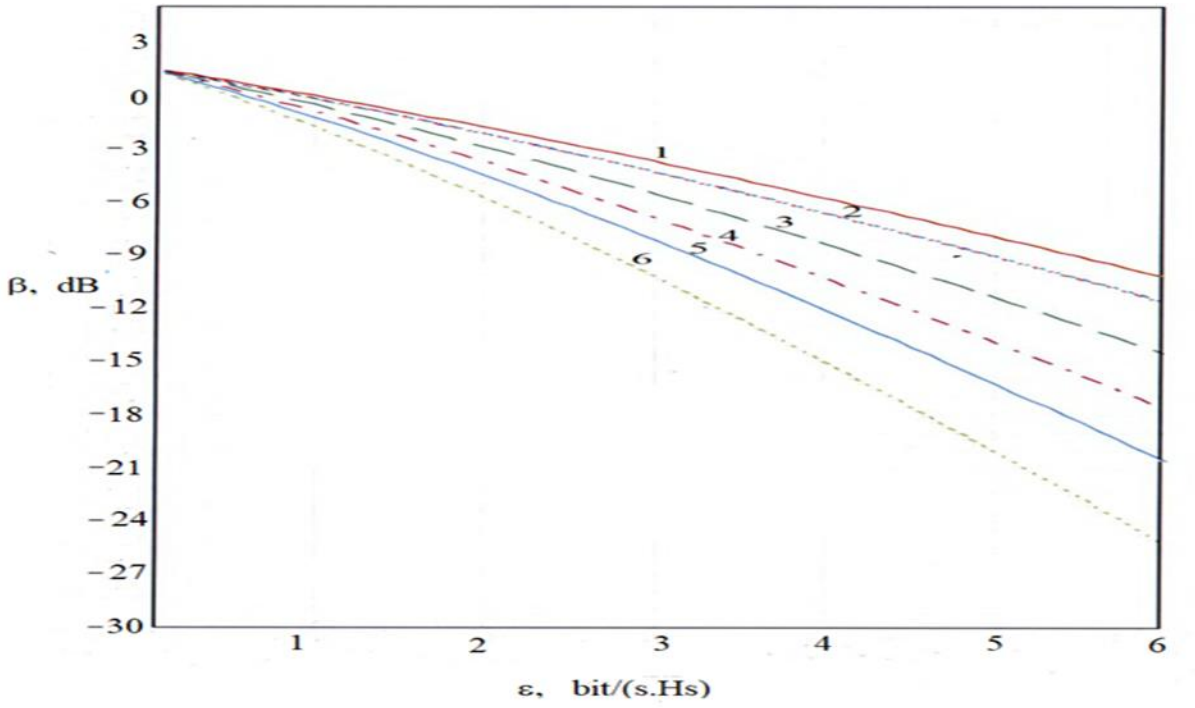

Image. Dependence of energy efficiency on spectral efficiency (α=const): 1. α1=0; 2. α1=0,2; 3. α1=0,4; 4. α1=0,6; 5. α1=0,8; 6. α1=1.

The Shannon limit between the three efficiencies mentioned above is given in the literature [7]. One of the indicators that determine energy efficiency is the power of the radio transmitter.

The figure shows the relationship between energy efficiency and spectral efficiency. It is clear from the graphs that an increase in spectral efficiency leads to a decrease in energy efficiency. Broadening the spectrum allows to increase the transmission speed, but it also leads to an increase in the noise level and a decrease in the spectral efficiency. Full use of the spectrum of communication systems is also an important issue. Nyquist strip to evaluate this Δf_N they use the concept that coordinated filtering is applied to ensure this band [7,9,10]. At this time, the noise band is equal to the Nyquist band.

Sometimes, in order to evaluate energy efficiency, the signal strength and the level of interference are not measured separately, but the signal to interference ratio is directly evaluated. There are various possibilities of increasing the signal-to-noise ratio. By increasing the energy of each bit, the signal to interference ratio can be increased.

It is necessary to adapt the width of the communication channel to the spectrum of the signal. We calculate the width of the communication channel as follows [2,3]:

$$\Delta f_b = \Delta f_N \left(1+\alpha_1\right),$$

here α_1 – is the extinction coefficient.

A large selection of the extinction coefficient leads to the broadening of the spectrum, and a small selection leads to an increase in the duration of the elementary pulses. This requires the use of more complex filters for their formation. If α_1=0 , then the duration of elementary impulses will be endless. At this time

elementary impulses $sin\,c(\omega t)$ shaped and $\Delta f_b = \Delta f_N$ will be. In this case $\varepsilon_{ef} = \varepsilon_{ef0}/(1+\alpha_1)$ using the expression $\varepsilon_{ef} = \varepsilon_{ef0}$ we find that, here ε_{ef0} – is the potential spectral efficiency. $P_k = N_0 \Delta f_N (1+\alpha_1)$ it is clear from the expression that the power of the noise increases with the expansion of the spectrum. Increasing the extinction coefficient leads to a decrease in spectral efficiency.

Therefore, it is necessary to choose a compromise value of extinction coefficient for each communication system through appropriate experiments. Using the "eye" diagram given in the literature, we can say that the extinction coefficient in TV broadcasting α_1= 0,15...0,35 choosing between can be considered favorable.

3. Conclusion

When designing any communication or broadcast system, there is a need to choose a trade-off between throughput, transmission rate, signal-to-interference ratio, bandwidth, and their associated spectral, energy, and information efficiencies. A small selection of the extinction delay leads to the reduction of the spectral efficiency to its potential value, but to a decrease in the energy efficiency, and an increase in the duration of the elementary pulses. In this case, it is required to use more complex filters to form elementary pulses. The "eye" diagram can be used as a compromise value of the TV broadcast loudness factor α_1= 0,15...0,35 selection can be considered.

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Design and implementation of RFID based manufacturing automation system: metal industry

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Abstract: In the globalized world, it has become necessary to develop and implement efficiency strategies in terms of production speed, cost and quality in order to increase the competitiveness and ensure the sustainability of enterprises operating in the production and service sectors. In this context, enterprises must constantly update their products and services, management technologies and business models to use their resources more efficiently, create more efficient work environments by synchronizing their process-oriented systems with existing systems. In this study, an RFID (radio frequency information transfer and identification system) based on the automation of production tracking was developed to adapt to changing competitive conditions, to re-plan and manage the work processes of a manufacturing company operating in the metal sector. In this study, RFID technologies applied in many fields, such as identification reading systems, product information reading systems, which can make the data flow faster, more reliable and controllable, have been developed and applied in order to improve the transportation performance. As a result of the application, it was observed that the speed of product transportation increased, the problems arising in the transportation process were minimized and more comfortable working conditions were provided.

Keywords: Automation, RFID, Metal industry, Efficiency, Manufacturing.

1.Introduction

As the fourth industrial revolution began to manifest itself in both the manufacturing sector and the service sector, advanced technologies such as cloud technologies, the Internet of Things, and artificial intelligence technologies began to take their place. Among these technologies, RFID technologies, which ensure a faster, reliable and controllable flow of information, are used in many fields, such as ID reading systems, product information reading systems, payment systems, warehouse management, logistics management, personnel tracking. The purpose of using RFID systems, which are one of the most suitable solutions for accurate, fast and reliable data transmission, is to transmit information to the user in the most accurate and fastest way, to detect the information placed on the label according to the purpose for which the product is used, and to ensure faster implementation of processes. Today, purchasing, production-distribution processes, which play an important role in the competitive advantage of production and service enterprises, and the planning, management and efficiency of these processes are of great importance. With RFID systems, in addition to final products, raw materials, spare parts, vehicles, construction equipment, business personnel, etc. it is possible to monitor, analyze and manage all the current data related to objects [1]. The aim of the study is to develop, implement and evaluate a new production tracking automation system using RFID systems to improve transportation performance in a small enterprise operating in the metal industry. The research aims to improve the process performance by automating the production process and automating the currently manual "product identification" system after the design and implementation of the RFID system. Carrying out such a study on automation in a small-scale manufacturing enterprise is important in terms of pioneering automation projects in this context. It is also assumed that the use of new technologies will be the beginning of new projects to be implemented in the enterprise, as it facilitates the speed, quality improvement and systematic work spiral of research, reduces the error rate and increases customer satisfaction. In the design process of the RFID system, the RFID reader is converted into a handheld terminal using an LCD screen, and the commands are made in the form of buttons. C++ programming language was used for the software of the terminal. After the verbal data collected on the shipping processes, a time study of pre- and post-shipment

operations was conducted to support the research with numerical data and the gains after implementing the developed RFID system were evaluated. Through the literature review, it has been seen that the RFID system is applied in many different fields, from the production and service sector to the education and health sector [2].

An RFID-based system was designed and implemented on an axis to minimize delays and errors during material handling in a small enterprise operating in the metal industry. In an R FID system, the electromagnetic waves emitted by the reader meet the antenna and activate the circuits on the tag. The waves are modulated and sent back to the reader, and the reader converts the new wave into digital data. Technologies that identify all kinds of animate or inanimate entities through radio frequency waves and tags (RFID Tag) placed on assets are called RFID technologies (Figure 1). The radio frequency data transmission and identification system is an automatic system consisting of a microchip (tag) and a reader (RFID Reader). Antennas are the units that provide communication between the tag and the reader. The RFID system consists of 2 components: an antenna reader and a tag. Tags are units that carry information and readers. A component that receives coded information via radio frequencies [3].

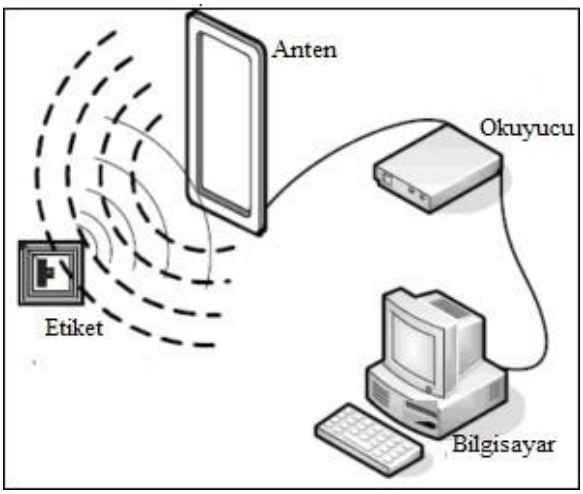

Figure 1. RFID working principle.

RFID tags can be placed directly on or inside all objects to be identified in the RFID system. Thus, the product is recognized when it enters the scope and the information mentioned on the label is easily accessible. The RFID reader is the brain of the RFID system and is essential to the operation of any system. RFID readers are devices that transmit and receive radio waves to communicate with RFID tags. Today, RFID systems are used in many areas such as OGS (active RFID), HGS cards and tags (passive RFID), Akbil (passive RFID), parking automation, warehouse counting systems. RFID systems used for the automation of production tracking have been widely used in various applications in manufacturing enterprises in recent years and provide advantages to the enterprise in many areas, such as data collection from the field in factories, production planning, costing, and correct calculation. With RFID tags, information can be collected about where the product or personnel are in the factory area or at any moment of production, where they passed and when, and how long they stayed in the same place. This information is sent to decision support software that allows managers to use their time more efficiently. The RFID system shown in Figure 2 for the applied metal plant was designed and commissioned to automate production tracking. In this regard, the test software was implemented in the enterprise where the design application of the RFID system was implemented [4].

Figure 2. RFID system design

2. Experimental details

In the process of putting the designed RFID system into practice, the RFID cards to be placed in the boxes are identified separately, and the RFID product cards to be placed in the products are identified separately and called "product code". The RFID reader is converted into a handheld terminal using an LCD screen, and the commands are designed as buttons. C++ programming language was used for the software of the terminal. The production area of the enterprise where the application is made is "metal" production. In the proposed new system, when the order planning officer prepares the list of products to be sent, he determines the information of the products to be sent to the codes of the cards without entering new information into the RFID cards for each order. The design of the product label and box label at the time of shipment is shown in Figure 3.

Figure 3. Product label and box label reading system design.

It was observed that product identification processes were carried out in the form of one-by-one labeling in the applied enterprise before the introduction of the RFID system, and it was a process entirely dependent on the employees. In addition, it was determined that control operations are performed visually, are completely dependent on the worker, there are postures during vehicle loading operations,

and there are ergonomic deficiencies. It was observed that the workers bent down to pick up the products from the pallet and loaded them into the machine. After the RFID system design, it was decided to load the boxes with forklifts to reduce handling operations and avoid unnecessary stops. In addition, some improvements have been made to the in-car product range. After the design and implementation of the RFID system, when the products are placed in the transport vehicle after passing through the boxes, this situation has disappeared, the sequence of the product has been protected from damage and has become standard. In addition, the delays experienced in the transportation processes during the delivery of the product to the client company were prevented [5].

3. Conclusion

It can be predicted that the size of this profit will increase with the integration of the developed RFID system into other types of products. By putting the design of the RFID system into practice, numerical improvements as well as increased efficiency have resulted in non-quantifiable process quality improvements summarized below:

Instead of attaching a label per product, grouping all the products in one box and giving a single identity for the variety has reduced the workload and minimized the costs of the labels. In this sense, RFID cards that can be used continuously instead of disposable tags reduce cost and reduce resource costs.

The manual operations and data that the employee has to keep in his memory have been reduced to a minimum, and the error rate has been reduced by tracking the data through the system.

Control processes not only reduced the burden of the master, but also eliminated the fear of making mistakes, placing the workload of the system and software on the person.

Both product development processes and control processes can be reviewed in the system and converted into a backward-controlled format.

Significant ergonomic improvements were made when loading products into the vehicle. Workers' bending and load-carrying work has been greatly reduced.

During the loading operations, while 4 personnel were carrying out the transportation process, it was determined that only one person assigned to use the forklift after the introduction of the RFID system was sufficient for the transportation.

A standard order for placing the product in the car is ensured and the possibility of damage to the product due to incorrect placement is minimized.

In addition to simplifying vehicle loading operations for the facility where the RFID implementation is implemented, the same improvements have been made for the customer company in terms of product unloading, contributing to reducing the workload of the customer company's employees.

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Environmental protection during operation of offshore pipelines

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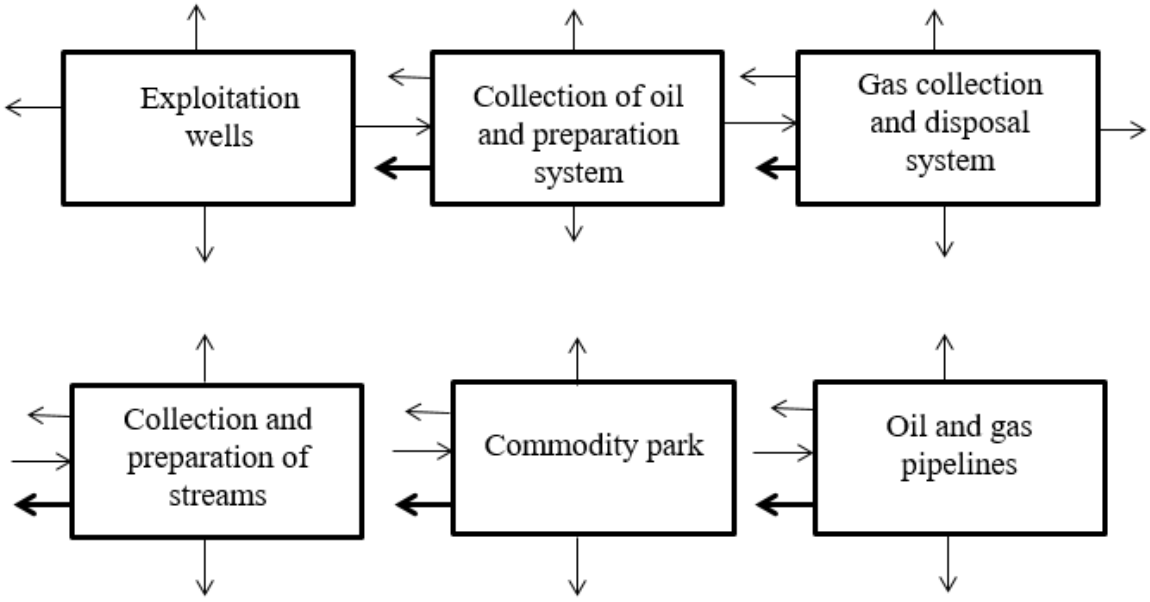
Abstract: The factor that most affects the environmental performance of oil and gas pipelines is the release of hydrocarbons from pipelines into the environment due to accidents. In addition to disrupting the normal working regimes of pipelines, accidents cause significant operational difficulties and financial losses, seriously damage the ecological balance of the environment, and create a fire and explosion hazard. One of the important factors affecting the ecological environment of the Caspian Sea is the leakage of oil and gas from the pipelines into the sea as a result of accidents and damage during the operation of offshore pipelines.

Keywords: Offshore pipelines, Water basin, Environmental damage, Polluted water, Caused damage, Accidental spills, Hydrocarbons.

1.Introduction

It is known that main pipeline systems that transport oil and gas belong to the category of dangerous objects. From this point of view, offshore pipelines, as well as pipelines that collect and transport hydrocarbons from export and land deposits can have a significant impact on the environment in Azerbaijan. Even though offshore pipelines are built using modern technology, they are still a potential threat to the environment. Leaks that may occur in pipelines laid in marine conditions are a source of greater danger for a unique water basin such as the Caspian Sea. For one reason or another, hydrocarbons leaking into water basins form material damage, expressed by the reduction or destruction of the material value of the environment.

Damage to the environment, oil and gas losses, as well as the restoration of efficient operation modes of the pipelines greatly depend on the location and degree of accidents, as well as the time of their detection and elimination. The consequences of spilled oil on the marine environment are greater, and the elimination of the consequences of such accidents can require a lot of money and be time-consuming.



Conditional signs: ↑ Emissions into the atmosphere; ← Pollution of surface water basins; ← Soil pollution; ↓ Groundwater pollution

Therefore, it is of great importance to promptly detect and prevent oil leaks in order not to create major interruptions in the operation of pipelines, quickly restore their normal working regimes, and improve their ecological and economic indicators [1].

2. Experimental details

If to take into account that environmental damage is caused during the search, construction and operation of the pipeline route, then the full material damage can be expressed as follows.

$$Z = Z_a + Z_t + Z_I \quad (1)$$

Here,

Z_a, Z_t , Z_i are damages during search, construction and operation, respectively.

The water basins through which the pipeline passes are mainly affected by the route search and construction of pipelines. During operation, practically all components of the environment are affected to one degree or another. However, at this stage, the main load falls on water basins and groundwater. As the earth's atmospheric layer, the animal world are in an inextricable relationship with other components of the environment, they are also affected during exploration and construction works, as well as during operation. Because the impacts during exploration and construction of pipelines are of a similar nature they can be expressed as $Z_a + Z_t = Z_{at}$ [2].

Direct material damage is expressed by the violation of the soil-plant, water basin complex, and the removal of areas from use in accordance with the existing regulations during the search and construction. This part of the damage is estimated by the costs (S_i) incurred for the restoration of the initial condition of Z_{at1} water basins and the soil-plant complex

$$Z_{at1} = KS_i \quad (2)$$

K is the coefficient that takes into account the number of operations to be performed. In order to prevent river channels and coastal areas from being washed away at pipeline crossings, the works mainly consist of shore strengthening measures. The evaluation of these works ($Z_{s.b.}$) can be evaluated analogously as Zat1.

The direct damage caused to water basins as a result of accidents happened in underwater pipelines is calculated by the following formula

$$Z_{s1} = B_Z + S_T + T_q \quad (3)$$

Here, B_Z – damage to fisheries; S_T - costs incurred for cleaning water bodies; T_q - additional costs incurred for the treatment of contaminated water for use.

In the case of contamination of groundwater used as a water source with hydrocarbons, direct material damage can be determined by the costs incurred for the construction of Z_{s2} water collection facilities or the creation of new water sources.

Thus, the damage caused by the pollution of surface and underground water can be calculated by the following formula:

$$Z_s = Z_{s1} + Z_{s2} \quad (4)$$

As a result of accidents in gas and oil transportation systems, due to the release of hydrocarbons into the environment, the decrease in the productivity of the natural ecosystem, the deterioration of the health of the population, the loss of working time, and the decrease in the cost of natural resources determine the damage to the economy, not only to the industrial area itself, but also the population who used polluted natural resources refers to the loss of the oil and gas industry itself: the cost of the product (oil or gas) lost, the cost of repair work to eliminate the accident, the loss caused by equipment downtime. The loss of other areas are: loss in industry and agriculture, in fisheries, in forestry. The cost of the lost product is calculated by the following formula:

$$S_i = G_{ex} V + G \quad (5)$$

here: G_{ex} - selling price of 1000m^3 of gas or one ton of oil;

V - the actual amount of oil or gas spilled as a result of the accident;

G - additional income that can be received if the spilled oil and gas are processed.
The cost of repairs to eliminate accidents can be calculated as follows.

$$D_g = M_c + A + T + A_d \quad (6)$$

M_c - the cost of materials and fuel used during the elimination of the accident;
A_d - depreciation (amortization) of fixed assets;
A - additional wages and mandatory social insurance fees not provided for in the plan; T - travel expenses.
The use of hydrocarbon-contaminated water by industrial enterprises leads to the stoppage of equipment, the formation of rust and corrosion in them, the reduction of the period between repairs, and the deterioration of the quality of the released product. Discharge of groundwater and hydrocarbons into water basins leads to fish poisoning, destruction of small fish, and deterioration of the quality of fish products. When using poisoned fish products, there is also a danger for the human body. So, some components accumulated in the body of poisoned fish have carcinogenic properties.
From this point of view, the rapid corrosion and erosion of the pipelines that make up the collection and transport system in sea conditions causes the emergence of environmental problems and the consumption of additional funds to eliminate them. Protective coatings, galvanic anodes and cathodic protection are used to protect pipelines from external corrosion. One of the most effective methods of internal corrosion protection is the use of inhibitors. The main function of inhibitors is to reduce the corrosion aggressiveness of the transported liquid. The effect of the inhibitor varies depending on the environment and changes in operating conditions. Thus, the temperature of the aggressive environment, the speed of movement of the liquid and many other factors affect the effectiveness of the inhibitor. Therefore, the development of new complex-acting inhibitors is relevant. The high viscosity of the liquid transported through pipelines is one of the main factors that lead to a decrease in the efficiency of the transportation process and an increase in transportation costs. In this regard, reducing the hydraulic losses caused by the viscosity of the transported liquid is one of the main issues.
BFTF-1 reagent with complex effect allowing to solve the indicated problems has been developed. As a result of laboratory studies, this reagent is dissolved in hydrocarbons based on benzoguanamine-phenol-formaldehyde oligomer and technical phosphatidine. As a corrosion inhibitor, BFTF-1 reagent has the property of hydrophobicizing the metal surface, reducing oil viscosity and hydraulic losses due to the presence of surfactants.
Some of the physicochemical properties of BFTF-1 reagent are as follows.
Appearance (color) - brown
Density, at 20°C, kg/m³ - 890
Freezing temperature, C - 25
Kinematic viscosity, mm²/s - 20
pH at 20°C, in 1% water solution – 8.
In order to determine the corrosion rate of steel plates on the mass ratio, researches have been conducted in laboratory conditions for 6 hours, at a temperature of 25°C and different consumption rates of the reagent.

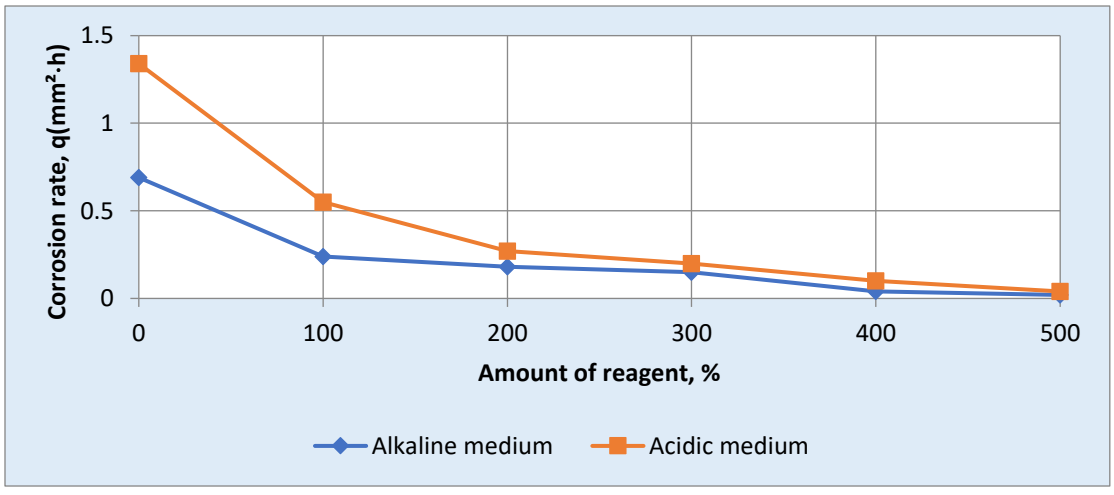


Figure. 2. Dependence of the corrosion rate on the amount of reagent.

As it can be seen in figure 2, the corrosion rate of steel samples in non-regent aggressive environments was 0.6994-1.3567 g(m²·h). When different amounts of the reagent were added to aggressive environments, the corrosion rate of the metal decreased and the protection efficiency was 68-97% depending on the consumption amount of the reagent in the environments of 0.392-0.0252 g(m²·h).

The surface of metals is heterogeneous and characterized by the presence of centers with different activity. The reagent neutralizes the corrosion process by shielding active centers with high energy on the surface of the metal, isolating them from the aggressive environment. The analysis of the obtained results shows that it is appropriate to take the optimal consumption of the applied reagent at 400-500 mg/l. In this case, the corrosion protection effect is 94-97%.

At the next stage of research, the effect of different concentrations of the new reagent on the viscosity of oil at a temperature of 20°C has been studied (Figure 3).

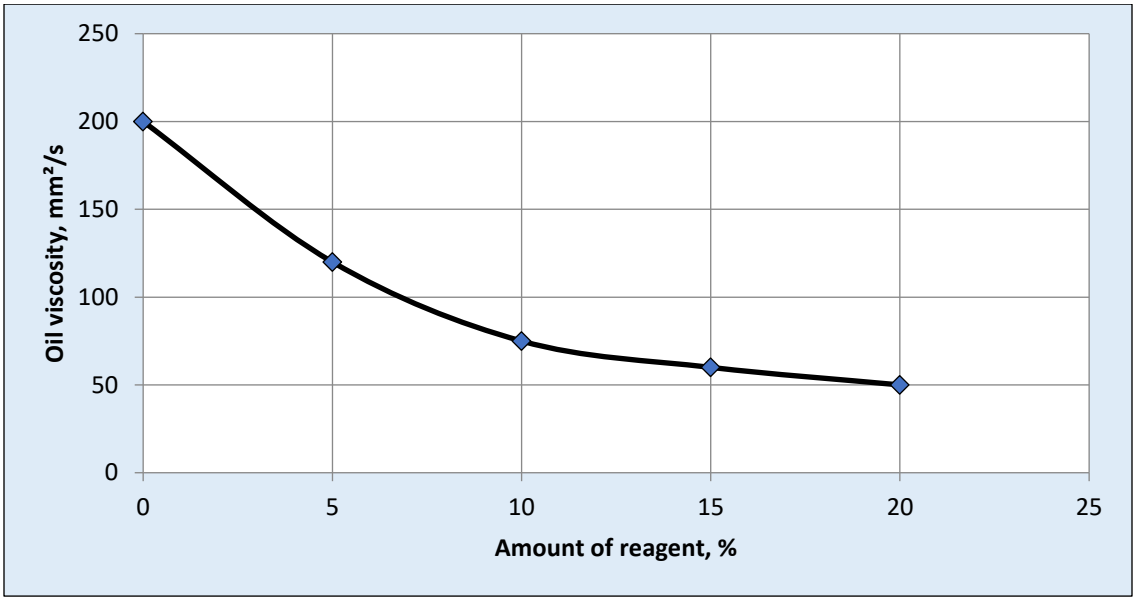


Figure 3. Dependence of oil viscosity on the amount of reagent

Figure 3 shows that the amount of regent added to the oil increases, its viscosity decreases sharply. When the amount of reagent is above 15%, the rate of reduction of oil viscosity weakens. When it is 20-30%, it decreases to about 3-4 times. Therefore, in order to reduce the viscosity of oil, it is suggested to take the optimal consumption of the reagent in the range of 10-20%.

If to take into account the fact that most of the wells operated in the last stage of development are watered, then the rate of consumption of the anti-corrosion reagent is 400-500 mg/l, which corresponds to the rate of consumption (10-20%) for reducing oil viscosity and hydraulic losses. Therefore, the reagent used against corrosion has a positive effect on reducing the viscosity of oil.

The application of the reagent not only reduces the number of accidents caused by corrosion in pipes, minimizes the costs of their elimination, but also ensures the environmental safety of objects [19].

Non-observance of the laying technology and ensuring the durability during the construction and operation of offshore oil and gas pipelines, are indicated as important factors for environmental protection.

Benzoguanamine-phenol-formaldehyde oligomer - a new reagent developed on the basis of technical phosphatide, not only protects the collection and

3. Conclusion

During the operation of oil extraction the impact of oil spills and the displacements of offshore oil and gas pipelines on the ecology of the Caspian Sea, including its fauna, atmosphere and coast, has been highlighted.

transport pipeline system against corrosion, but also reduces oil viscosity and hydraulic losses. In order to protect against corrosion, the optimal consumption of the reagent should be 400-500 mg/l, and the optimal concentration should be 10-20% to reduce the viscosity of oil.

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A signals in digital TV broadcasting systems enhancement of frequency spectrum and energy efficiency

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Abstract: It is known that the lack of free frequencies in the radio frequency spectrum does not allow the creation of new communication service areas. For this reason, the methods of increasing the frequency spectrum and energy efficiency of signals in digital TV broadcasting systems have been analyzed in the presented article.

Keywords: Broadcasting systems, Frequency spectrum, Frequency band, Communication systems, FM-radio broadcasting, Digital TV broadcasting, AM radio broadcasting.

1.Introduction

Historically, the presence of free frequencies in the radio frequency spectrum used in the communication system has been shown to be an urgent issue as one of the main conditions for the development of radio systems. Thus, the lack of free frequencies both hinders the creation of new communication service areas and leads to their operation by interfering with each other in a narrow frequency band [1,5].

Currently, the range of free frequencies suitable for most communication means falls in the range of 100kHs 15GHz, but there are useful frequency ranges both below and above these limits. AM radio broadcasting, international radio broadcasting, FM-radio broadcasting, digital TV broadcasting, microwave satellite communication, remote control, radiolocation and radionavigation are mainly carried out in the mentioned frequency band.

Several frequency bands of this range are currently occupied. Therefore, there are difficulties in allocating new frequencies for AM, FM, microwave radio broadcasting in big cities.

For this reason, the use of antennas with a narrow directional pattern for microwave communication results in a difference between antennas with the minimum necessary beam width used for separate radio communication lines operating at the same frequencies [2,4,5]. However, when the use of spectrum and geographical area does not work, users have to use expensive antennas with precise directional pattern.

The main characteristic feature of radio wave propagation is the occurrence of various losses and fluctuations during radio transmission. The effectiveness of barriers depends on how large their value is compared to the useful signal. Therefore, it depends on the distribution distances of the receivers and the prediction of the possible interference level and the length of time that the interference signal exceeds the specified level.

One of the main requirements for the transmitter is to maintain the stability of the radiation power within the given frequency band, which depends on the modulation method and the width of the frequency band of the given information.

Out-of-band emissions determine the minimum frequency shift of the receiver operating on channels adjacent to the transmitter. Limitation of out-of-band radiation in the past and at present has allowed this problem to become secondary. It should be noted that the results of this phenomenon occur in mobile radio communication systems operating in duplex mode, because there is a need to use both transmitting and receiving antennas at the same time [5].

In order to overcome these difficulties listed above, it is first necessary to analyze the frequency spectrum of the signals. However, traditional administrative methods, scheduling, regulation, etc., which are used to solve this kind of problem are considered outdated in modern times.

In order to solve the problem from a modern point of view, it is necessary to expand the used frequency spectrum to the high frequency area. Since the number of frequency channels used in this area is small, it is easier to develop new usage rules than to rework the old range.

However, this range, the frequency range above 15 GHz, is difficult to apply as it is broadcasted directly on the earth's surface, and moreover, the signal at these frequencies is weakened by rain and snow deposits in the atmosphere. The main noticeable

difficulty is that the equipment used at these frequencies is expensive [3,4]. Thus, taking into account the above-mentioned difficulties, it is necessary to focus on the intensity of use of lower frequency ranges. In this range, both the equipment released is more convenient from the point of view of operation, and the propagation of radio waves allows the organization of wide-band communication at greater distances.

In other words, it is necessary to increase the effectiveness of the use of these ranges. Such intensification ultimately leads to an increase in the number of operators using each channel. This means that the performance of individual systems will be determined by the interference caused by other devices using the same channel.

Therefore, the following technical factors that determine the effectiveness of using the frequency spectrum can be listed: antenna orientation diagram; signal propagation conditions; transmitter characteristics; receiver characteristics; modulation techniques.

2. Experimental details

Effective utilization factor as a parameter is not yet standardized. In general, this parameter can be found as the ratio of the information at the output of the communication system to the volume of the spectral band at its input [1,4].

Then we can write:

$$E = \frac{J_{tr}}{V_f}, \qquad (1)$$

Here: J_{tr} - is the amount of information given, V_f - is the volume of the spectral band. This volume is found as the product of frequency bandwidth Δf, t - time, S_0 - volume of physical area. The size of the physical area depends on the type of communication.

According to the requirements of the ITU, the effective use factor of the orbit for fixed satellite communication providing discrete signals is determined as follows [1,4]:

$$E_n = \frac{J_{tr}}{\Delta f \gamma \Delta t}, \qquad (2)$$

Here: J_{tr} - is the amount of data, Δf - used frequency band, γ - is the satellite's drift angle, Δt - is time.

The effective utilization factor for analog modulation is defined as [1,4]:

$$E_n = \frac{J_{tr}}{F_{\max} \Delta f \gamma}, \qquad (3)$$

Here: F_{max} - is the maximum modulation frequency. Since the size of the spectral band is reduced, it allows more effective use of the band for the given amount of information. The effective use of the spectrum is related to the characteristics of the communication system. The parameters determining this characteristic include data transfer rate R, frequency band width Δf, signal strength P_s, obstacle strength P_{sh}, error probability P, delay time τ_z and extraneous factors.

The amount of information provided in a unit time is called the information transfer rate. The R/Δf ratio indicates the transmission bandwidth of the communication system at the same time, that is, it indicates the effective use of the channel. It is clear that in order to increase the effective utilization, it is necessary to increase the data transfer rate, and this should be done without increasing the frequency band used. However, it should be done in such a way that the characteristics of the communication system do not decrease. Otherwise, the effective use of the spectrum may not increase [1,4]:

$$S = \frac{P_c}{P_m}, \qquad (4)$$

the ratio is called the signal/noise ratio.

They try to increase this ratio in order to reduce the impact of obstacles and noise. For this purpose, the strength of the signal could be increased, but in this case the radio station will create an obstacle for other stations. For this reason, it is advisable to minimize the levels of impact noise.

In general, the analysis of the effectiveness of the use of the spectral band in communication systems is one of the actual problems. Therefore, it is appropriate to use the following expression to determine the spectral efficiency [4,6].

Then we can write:

$$\varepsilon_{\text{ef}} = \frac{R}{\Delta f_n}, \qquad (5)$$

The expression of spectral efficiencies for some systems shows that the area of the service area is also taken into account in broadcast systems. This is a parameter taken into account when planning a

broadcast network. Although the frequency band allocated to each program or package in a TV broadcast network is specific, in practice it is also possible that it is not expected. Energy efficiency in digital TV broadcasting systems is found by the well-known expression [1,4]:

$$\beta = \frac{R}{P_c/N_0}, \qquad (6)$$

Here:
R - is data transfer rate, P_c - signal strength, N_0 - intensity of fluctuating noises.
In addition to these indicated quantities, it is convenient to use information efficiency. Note that energy efficiency, frequency, information efficiency, channel bandwidth and signal strength are related parameters. Information efficiency can be found from the following expression [2,6]:

$$\boldsymbol{i} = \frac{\boldsymbol{R}}{\boldsymbol{C}}, \qquad (7)$$

$$R_{eqv}(\omega) \cong \left(\frac{\omega_2}{\omega}\right)^2 \left(R_1 + R_2\right), \qquad (8)$$

Here: C - is the transmission capacity of the communication channel.
The interaction between energy, frequency and information efficiency is determined by the well-known expression given in the literature [2,6]:

$$i = \frac{\varepsilon_{ef}}{\log(\varepsilon_{ef}/\beta + 1)}$$

Note that increasing the energy efficiency depends on the correct selection of other parameters.
The frequency of spectrum usage depends on many factors. The most important of these are the distribution characteristics of the antennas used in space communication and the level of interference that can be emitted at the receivers, which is related to the radiation of other transmitters.
Except for antennas used for terrestrial broadcasting and similar services, most antennas have directional properties. In the second case, it causes an increase in the power of the transmitter and the sensitivity of the receiving stations in a given direction or within a given angle. However, the side lobes of the transmitting and receiving antennas in the remaining directions cannot be completely terminated.
The ratio of the radiation power or the sensitivity of the receiver in a given direction to the corresponding quantities in other directions characterizes the selectivity of the antenna. This characteristic decreases monotonically as the angle of deviation of the antenna's head leaf from the given direction increases. To reduce the obstacles between the transmitting and receiving stations, it is necessary to adjust the opening angles of the head petals of the antennas (directional diagrams).
To adjust the level of obstacles in terrestrial systems, it is necessary to correctly choose the distances between stations that are not connected to each other. During the propagation of radio waves in space, the signal is weakened depending on the distance. However, in geostationary communication systems, since the distance changes very little and the effect of the earth's surface layer is very weak, only the angles of the antennas' directional diagrams play a major role in limiting the obstacles. The antenna head of the satellite antenna is directed to the service area on the earth's surface and, in turn, the directional pattern of the antenna of the earth station, that is, the signal of the antenna head is directed to the receiving satellite.
High allowable levels of interference allow to reduce the selectivity between the stations of different networks and, accordingly, increase the placement density of such stations. This, in turn, leads to the reuse of the spectrum as the number of stations increases and, therefore, increases the real spectral efficiency.
In the theory of communication, the speed of information transfer is determined by the amount of information given and received at the same time [2,6]:

$$R = \lim_{T\to\infty} \frac{J_n(n_1, n_2)}{T}, \qquad (9)$$

We calculate the signal strength [6]:

$$\boldsymbol{P_c} = \boldsymbol{E_b R}, \qquad (10)$$

Here: E_b - is the energy of the bit.
To make it clear that more than the allocated frequency band is used, let's consider the issue of spreading the spectrum of the signal. They find the width of the spectrum of each elementary pulse as follows [3]:

$$\Delta f_{nk} = \Delta f_n(1 + \alpha_1), \qquad (11)$$

Here: Δf_{nk} - Nyquist band, α_1- is the extinction coefficient of the spectrum of the signal. $\alpha_1 = 0$ and $\Delta f_{nk} = \Delta f_n$ we obtain the potential frequency efficiency when:

$$\varepsilon_{ef0} = \frac{J_n}{\Delta f_n S_{ob} T} \tag{12}$$

Considering (10) and (12), we find:

$$\varepsilon_{ef} = \varepsilon_{ef0} / (1 + \alpha_1) \tag{13}$$

The value of the data transmission speed calculated for a single frequency is called the specific transmission speed [2]:

$$r_0 = \frac{R}{\Delta f} \tag{14}$$

If the spectrum of the elementary symbol is aligned with the passband of the channel, then we get: $r_0 = \varepsilon_{ef}$. For a binary system:

$$r_0 = \frac{2}{1 + \alpha_1}. \tag{15}$$

Therefore, the specific transmission rate in a binary communication system is always less than
2 bit.s -1/Hs. From (8), (10) and (14) we find:

$$\frac{R}{C} = \frac{R}{\Delta f_n \log(\varepsilon_{ef} / \beta + 1)} \tag{16}$$

After simple conversions, we write:

$$\varepsilon_{ef} = \beta\left(2^{\Delta f_n C} - 1\right) = \beta\left(2^{(1 + P_c / P_{u})} - 1\right) \tag{17}$$

3. Conclusion

Effective use of the radio frequency spectrum is directly related to the characteristics of the communication system.

In order to increase the frequency spectrum and energy efficiency of signals in digital TV broadcasting systems, data transfer speed, frequency band width,

If negotiated filtering is performed in the modem of the receiver, then we can write the energy efficiency expression as:

$$\beta = RN_0 \Delta f_n / P_c \tag{18}$$

In such filtering, the noise band of the receiver is equal to the Nyquist band. Therefore, in this case, we write the power of fluctuation barriers as follows [3]:

$$P_n = \Delta f_n N_0 \tag{19}$$

In concerted filtering, R = S, so the potential transmission rate is guaranteed. Let's use the well-known Shannon's formula [4], which determines the channel's transmission capacity for a channel affected by additive barriers:

$$C = \Delta f_n \log\left(1 + P_c / N_0 \Delta f_n\right) \tag{20}$$

In this case, we can write the following expression [6]:

$$\frac{R}{\Delta f_n} = \log\left(1 + P_c / N_0 \Delta f_n\right) \tag{21}$$

Taking into account (7), (8), (18), we find the energy efficiency for concerted filtering from (17):

$$\varepsilon_{ef} = \frac{1}{E_b / N_0 \Delta f_n}\left(2^{(1 + E_b R / N_0 \Delta f_n)} - 1\right) \tag{22}$$

Expressions (19) and (22) show the analytical relationship between the specific speed and energy efficiencies.

The effective use of the spectrum is related to the characteristics of the communication system. The parameters determining this characteristic include data transfer rate R, frequency band width Δf, signal strength Ps, obstacle strength Pn, error probability P, delay time τz and extraneous factors.

signal strength, obstacle strength, probability of errors, delay time parameters should be taken into account.

By considering the proposed methods and applying mathematical expressions, it is possible to achieve an increase in the frequency spectrum and energy efficiency of signals in digital TV broadcasting systems.

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Information security in industrial facilities

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Abstract: When investigating defects related to the security and reliability of information systems, attention is paid to the existing aspects of information security, which is considered the primary component of the development, implementation and operation of information systems and is a very important issue. For many years, industrial security has been content only with the denial tolerance of the technological network without paying attention to information intrusions (especially unauthorized ones) and assumed that corporate information systems are not interconnected with the utility network, cannot connect to public utility networks such as the Internet, and besides, technological processes can be accessed from the outside. It is almost impossible to intervene. Today, management systems with developed information and communication technologies are widespread in every branch of industry, and the level of automation and intellectualization of very important infrastructure systems is also developing rapidly. The concept of critical infrastructure, society is also understood as the management systems of critical facilities for national domains, along with which national security threats arise in order to prevent attacks and disable computer networks. The infrastructure important for national security is considered vital when the termination or failure of its operation leads to emergency situations or undesirable consequences for the economy, defense, international relations, as well as other economic sectors of the country, as well as the lives of the population living in the relevant area.

Keywords: Information, Security, System, İndustry, Threat.

1.Introduction

Industrial systems instructions, operational requirements, types of information processing, etc. they differ according to other characteristics. Therefore, a different approach to information security research of such systems is required. In order to determine such approaches, it is necessary to assess the importance of problems, analyze the specifics of deficiencies and threats, and finally create a selected regime for research and provision of information security of important infrastructures. Important infrastructures always include telecommunications, energy, transport, finance, water supplies, emergency services, etc. includes. One of the most important components of industrial systems leading this type of infrastructure is the information field. These types of fields include information, information infrastructure, subjects of information viewing, as well as their regulation system. It is required to have a direct cybernetic (management) system on the issue of regulating information relations, and along with that, a cyber field is created in the information field itself. This field is also composed of selected management information, executive part (subject), communication channels and information processing tools and algorithms for the implementation of the management process. Although the cyber and information fields form a whole, there are elements that separate threats against them, and besides, it is important to take these issues into account during the study of information security of industrial systems [2]. Computers that meet IBM standards in industries are modernized with advanced operating systems, a number of protocols, browsers, Internet technologies and other software tools. As a result of the widespread use of the open norms and technologies that we consider, the number of cyber threats to these systems increases as a result of the increase in the number of connections between corporate and technological network elements. Cyber-threat is an act, process, environment, factor that creates a threat to management data, subjects, structure and requirements. By danger, failure of any of the specified elements may lead to malfunction of the control. In today's era, there is an increasing number of dangerous programs that can damage the automated control systems of industrial or other important structures. Cyber threat management is an activity aimed at disrupting the field. According to the results of the researches of different research institutes, massive security measures have been

created against all cyber-attacks, with the exception of cyber-terrorism aimed at industrial systems covering important infrastructures. Looking at the results of the analyzes of those studies, it is clear that more than 100 attacks on industrial systems occur every year, and that the dynamics of constant growth of attacks is kept under control [5]. Departments and organizations with critical infrastructure do not rely on their own measures against cyber attacks. The internal scheme of the system is very well investigated and studied for the convenient organization of cyber attacks. The most important targets of cyber attacks are critical information infrastructure systems that run critical enterprises. Technical failure of these types of enterprises can lead to chaos or disaster.

2. Experimental details

Corruption of the state of information can be represented by three large classes, which are related to the complete and partial disappearance of the advantages characteristic of preserved ISs.

• breach of confidentiality of stored and processed information;

• violation of completeness of information;

• corruption or loss of system availability. There should be a subsystem of security measures of the IS initiated by the attacker due to the classification of violations in the nominal work process. Data storage is the ability to move or change data at the moment of mutual transmission between servers, which is necessary for the distributed processing of data. We can list the following attack, starting with the corruption of the state of the system:

• changes in data during transmission, for example, increasing the amount of money deposited into the account during a legal transaction;

• transferring data in transit to distinguish confidential information, for example, copying packets in a channel and network to distinguish consumer identifiers and corresponding passwords of several encryption systems or credit card serials;

• redoing a legitimate transaction. The way to combat such corruption is to use cryptographic methods to protect data during its transmission. It is possible to choose the following methods of attack that lead to corruption of the system's state of operation:

• using fake servers to collect confidential information; • arbitrarily using authenticated information, for example, keystrokes, password or secret key discovered through the keyboard for self-signing of electronic documents: • automatic discovery of passwords with a dictionary, for example, nicknames or pet names and passwords in other forms; • detection of the password based on the examination of a certain consumer information of the system.

3. Conclusion

Thus, the listed considerations indicate that different approaches are needed in the study of information security of critical infrastructure systems. In addition to template security measures, the protection of critical infrastructure systems, the identification and prevention of possible gaps in the composition is required to be seriously considered. At the end of the research work, it became clear that one of the important tasks of the builders of information devices and information systems from the time the computer was created to this day was the provision of security measures. No large commercial or government electronic system can continue to operate without safeguards against unauthorized access to its information. Since the 70s of the 20th century, different concepts and methods of information security measures have been developed in the world, which resulted in the formation of a general approach to this issue in a short period of time. And the first security policy format was developed. Today, as a result of the emergence of security and robustness of information technologies and systems, the clauses of laws and legislative acts have largely determined several requirements imposed on the mechanisms of security measures in automated systems.

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Schematic representation of the preparation of graphene oxide

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Abstract: Due to its properties (electrical conductivity, optical and magnetic properties and metallic or semiconductor conductivity depending on the geometric parameters) and their combinations, carbon nanotubes have the widest application potential: ultra-strong fibers, yarn, fabric, composite materials, memory chips, logic circuits, nanosensors, field emitters.

Keywords: Nanotechnologies, Nanoclusters, Graphene, Film, Crystal.

1.Introduction

Materials science is now thanks to nanomaterials and nanotechnology has evolved from an engineering discipline into a core fundamental and applied interdisciplinary science, where scientists in many fields. The future of information technology, energy, transport,space technology medicine and chemical technology depend on inventions of new materials.

Another authors practice have synthesized numerous new forms of carbon nanomaterials, including fullerenes, carbon nanotubes, and graphene layers. [1,2,4,6] They are promising materials for many branches of the nanoindustry, as they have unique electronic, electromagnetic, thermal, optical, and sorption properties.

For example, Graphene has a new electronic system with unique characteristics due to charge carriers behaving like massless relativistic quasiparticles (massless Dirac fermions). Graphene is a giant molecule suitable for chemical modifications [3,10,17]. Its applications range from electronics to composite materials.

In connection with the significant influence of the graphene synthesis method on its final physical properties, it seems appropriate to consider in detail the most common methods for forming samples of this material [8,9,11,19].

A new stage in the development of graphene began with the production of single-layer and double-layer samples we through repeated use. After the demonstration of the unique electronic properties of graphene in these works, the rapid development of graphene research began. In parallel, various properties of graphene [20,23,24], which had previously been only theoretically predicted, were studied, and new methods for obtaining experimental samples were investigated.

The chemical exfoliation method consists in treating graphite with acids to obtain graphene oxides called (grafon) [13,14,16]. It is graphite intercalated with oxygen groups, which turn it into a hydrophilic material that easily disintegrates in water. These graphite oxide flakes, sometimes single layered, are reduced to low quality graphene.

Samples had content and 76.59, 21.61 and 1.8 mass. %, respectively (Table 1).

Table 1. Elemental composition, mass. %, and the ratio of synthesized GO/sulfur [6].

C	O	S	O/C	O/S
76.569	21.62	1.8	3.54	42.54

Such samples are ideal for conducting experiments to study the electronic properties of graphene, measure its conductivity, or create prototypes of graphene-based devices.

The advantage of our material is that it can be synthesized more economically by oxidizing large amounts of graphite crystals. Because of these oxygen-containing groups, this material is hydrophilic and can be dissolved in many solvents[19,21,22,24]. The main feature of the materials obtained as a result of experiments is their ability to be uniformly deposited on various substrates and thin films, which has great potential for wide application in the field of microelectronics,

integrated circuit elements, transparent conductive films, and integrated circuits. elements. and composite materials. materials. solar energy and biomedicine (due to their more sensitive properties) make them useful. As a result of our numerous experiments, we came to the conclusion that the use of the Hammer method helped us get better material. We have prepared high-quality, large, thin, transparent GO flakes using the Hammer method[17,18,23-27]. There are three methods for synthesizing GO: the Brody method, the Staudenmeier method, and the Hammer method.

2. Experimental details

In our practice, GO was synthesized by the Hammer method. First, 96% H2SO4 (10 ml) was taken into the beaker. As a starting material, 1 gram of dispersed graphite 99.9995% was used. 1 g of dispersed graphite was mixed with 0.5 g of NaNO3 in a Petri dish and added to sulfuric acid. The remaining sulfuric acid (13 ml) was also added and the system was stirred by adding a magnetic stirrer to the bowl. KMnO4 (3 g) was slowly added to the system over 2 hours. During this process, the system is placed in an ice bath and the temperature is controlled so that it does not exceed 20°C. After the system was placed in a hot bath to maintain the temperature at 35°C during stirring. After this process, a brownish gray pasty material was obtained. 46 ml of distilled water was added to the system and after about an hour it was immediately boiled, 250 ml of distilled water was added and mixed. After some time, 100 ml of 30% H2O2 was added and mixed. During this process, the color of the system changed slightly. Brown-yellow color is a sign of GO synthesis. The final product is filtered [5,7,12]. The resulting material is dried in a vacuum container at 50°C for 2 hours.

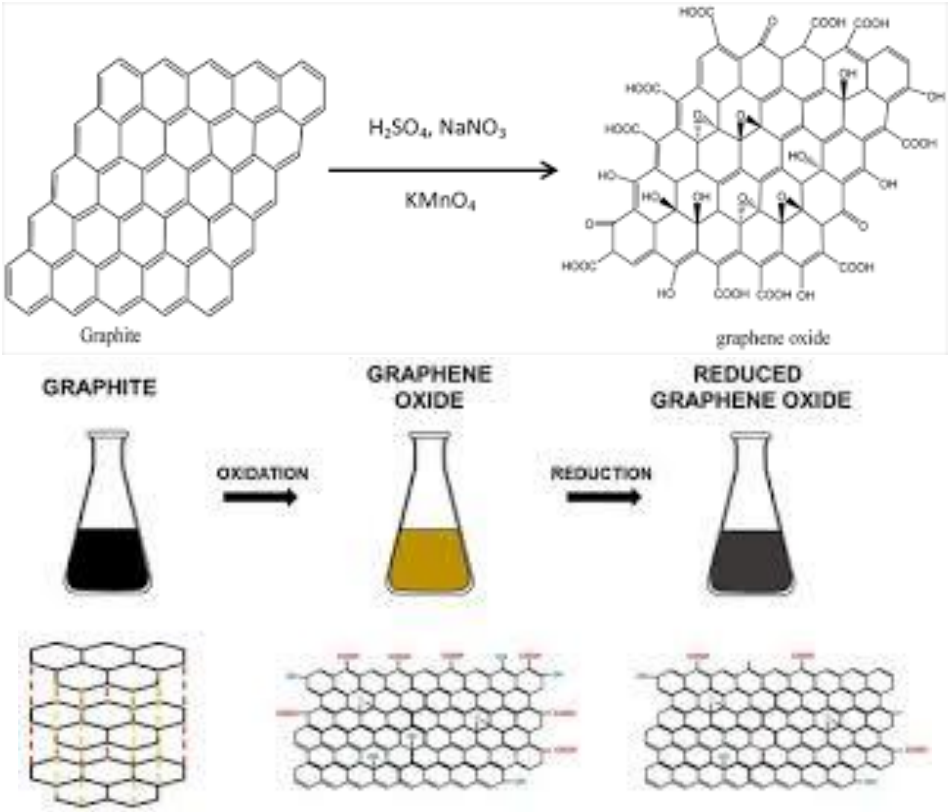

Figure 1. Schematically, the process of converting graphite into graphene oxide is carried out according to the following schemes (a and b).

3. Conclusion

The solubility of the synthesized GO is one of the first indications that high quality GO has been synthesized, since GO is a very efficient soluble material due to the oxygen-containing groups formed

on the graphene plane during the synthesis[2,. Compared to other allotropes of carbon such as carbon nanotubes[2,12,15,20], GO is soluble in all solvents, including deionized water. For example, CNTs can only form suspensions in various solvents and are insoluble. This property makes this material very useful for the production of thin, transparent and optically transparent polymer nanocomposites.

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Investigation of the influence of the protective coating on the surface of the shell on the durability of the crystallizer shell and the quality indicators of the final product.

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Abstract: The article includes the construction and design processes of crystallizing shells in adjusting the quality indicators of the cast paste, which is a product of the continuous casting process. It has been shown that in improving the quality of the cast paste, the design of the casing, the correct selection of the material and the optimal working parameters are put in the foreground. In addition, the type size of the casting, the setting and solution of various casting speed issues are justified as the basis of the casing design. On the other hand, it has been found that ensuring optimal operation is directly dependent on maintaining long-term starting characteristics and good thermal conductivity of the casing at average operating temperatures. Comparative studies were conducted on the coating of alloys selected for the base of the article and layers on the surface of the copper base. It has been shown that the inner wall of the casing must be resistant to the pressure of the liquid steel. Therefore, in the selection of casing materials, their physical and mechanical characteristics are mixed and their longevity is put in the foreground. In the operation of shells, it was found that its deformation was removed under the crystallizer and brought the ovality of the cast paste. Therefore, before starting each casting process, it is recommended to check the state of the crystallizer shell for scratches, cracks, local surface erosion, contaminations and mechanical defects that affect the work of the crystallizer.

Keywords: Continuous casting, Crystallizer, Shell, Casting paste, Casting speed, Working mode parameters, Coefficient of linear expansion, Endurance, Physical-mechanical properties, Microstructure, Quality indicators.

1.Introduction

In modern technology, the scientific works and technical solutions used in the research works aimed at increasing the accuracy and quality characteristics of the manufactured product, including the realization of the results of the research conducted in the industry, or the saving of such material and energy resources, are aimed at the creation and improvement of new technologies, methods, processes, methodologies, facilities [1,2].

It is known that the final product of the continuous steel casting process is cast iron, and according to the processing technology of these irons, they are square, round and flat, and these irons are regulated according to quality requirements. Geometric dimensions , micro- and macrostructure, chemical composition, demand for non-metallic compounds, N_2 H_2 and O_2 adjustment of their quantity to the steel grade form the basis of quality requirements. . Here it is appropriate to say that the main element of the continuous casting process is the crystallizer. Here, the liquid steel acquires the properties, geometrical shape and internal structure of the final product. Practically all manufacturers of casings in the world use similar materials and alloys based on copper. Currently, the most widespread product of casings in the CIS and foreign metallurgical plants are the casings of "EM Moudulus" firms due to the high quality and longevity of the manufactured casings, which is the main quality indicator.[3,4,]

The development of continuous steel casting technology and its global application help transform crystallizers from simple molds for liquid steel into a fundamental technological component necessary to achieve the required production volumes and high product quality. The choice of constantly improved materials that increase the service life of the products and improve the heat exchange properties, knowing their optimal forms, made the crystallizer a high-tech product. As data, the characterization of the crystallizer is different for each individual PFTM and thus must be designed and operated in close collaboration with the end customer [5].

The main detail of the crystallizer of the type PFTM is undoubtedly the copper sleeve. The flow of liquid steel falls into it, and it is there that the steel begins to crystallize (harden), the material of the crystallized shell of the pastry acquires its properties: geometric (cut, surface, crust), physical-chemical (macro and

microstructure, homogeneity and segregation). Designing clay is a very responsible process. It starts with setting the issue with the final designer : type, size, brand assortment, productivity (speed of pouring).

Having solved these issues, the construction of PFTM is selected: in rare cases horizontal and vertical, in most cases curvilinear and radial. The type of the structure is determined, the type of the crystallizer, and the type of the shell is determined along with it. Among the main characteristics of the shell construction, the following can be distinguished: its geometric dimensions and external structural features, internal geometry (profile).[6,7]

In order to ensure optimal operation, the shell of the crystallizer must maintain its starting characteristics as long as possible at average operating temperatures and, most importantly, it must have good thermal conductivity.

Thermal stress, which is exposed to the heated surface of the crystallizer in the meniscus zone, leads to more or less rapid and permanent deformation, which significantly reduces its service life. These deformations are directly related to the temperature levels inside the crystallizers, the temperature difference between the hot and cold surfaces, and between the meniscus zone and the lower zone of the shell. A valid solution for every possible condition of use depends on the right choice of material. Solving this kind of scientific problem raises a number of questions in front of the research paper. Their solution indicates the urgency of the work.

2. Experimental details

The aim of the research work was to study the characteristics of the shell material and the linear expansion coefficient of the coating layer on the final quality indicators of the tolerance of the cast paste, which is a product of the continuous casting process, on the final quality indicators. Practically all manufacturers of casings in the world use similar materials and copper-based alloys. At present, the most common product of shells in the CIS and foreign metallurgical plants is mainly high-quality (long-life) shells. The chemical composition of clays is shown in table 1.

Table 1.Chemical composition of clay materials

Materials	Chemical composition %					
	P	White	Cr	Mrs	Ni	Cu
MM1	0.015-0.040	-	-	-	-	
MM2	0.004-0.012	0.008-0.12	-	-	-	
MM3	-	-	0.03-1.20	0.03-0.3		
MM8	0.09-0.015				0.47-0.53	

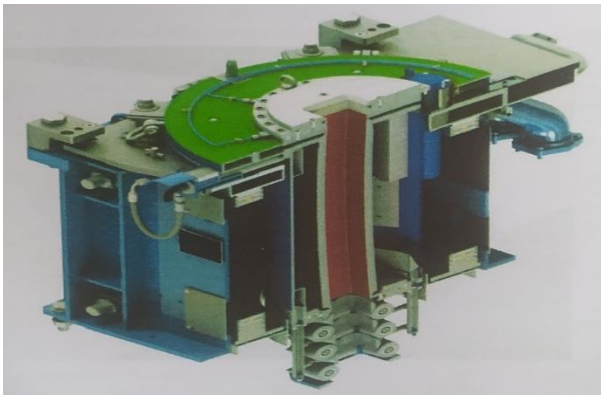

Figure 1. Also shows the general view of the crystallizing shell in cut form. [8]

125x125 mm square pashto of 3 сп and 5 ср brands was $C_T$cast for research in the crystallizing shell and

the final pashto product was received before crystallization.C_T the used C_T3сп and C_T5сп brand steel was not shown in table

Table 2. C_T3с р and composition as C_T5с п grade steel

Steel brand	Standards	C	Mn	Si	P	S	Cr	Ni	Cu
C_T3	Guest 380-2005	0.014-0.22	0.40-0.22	0.15-0.3	0.15-0.3	<0.03	<0.3	<0.3	<0.3
C_T5	Guest 380-2005	0.28-0.37	0.5-0.8	<0.035	<0.04	<0.04	<0.3	<0.3	<0.3

The description of the copper-based materials used for the casings of the crystallizers depends on the physical and mechanical properties of the surface smooth casings, as well as the quality of the castings. Therefore, comparative studies should be conducted to choose the most optimal of them. Casting of different types of pashtos of each material is widely used.

For example, the quality of phosphorous non-oxygenated copper material is well known. The most widely used material for the production of crystallizer shells for continuous casting of pastes is DHP copper, because the thermal currents are moderate and the thickness of the shell wall is not large. This is typical for the pouring of small varieties of pasta, where the pressure of the shell wall of the liquid plate is not so high.

Adding 0.15 wt% silver to copper increases the recrystallization temperature by approximately 100°C. Due to its special qualities, this alloy is used in the production of shells for casting medium pashto, where the meniscus temperature reaches and exceeds 300°C. Such a high temperature is explained by the highly active heat currents inside the crystallizer and the thick walls capable of maintaining the high pressure of the molten steel. The fact is that this material retains its initial hardness, HB>80, for a long time at a temperature of 300°C, it can be widely used for cases used in special conditions. These special conditions are long series of melts, high casting speed, suboptimal cooling conditions, high superheating of steel above the liquidus temperature and gigas.

In order to improve the mechanical characteristics of copper alloys with high thermal conductivity at high temperatures, experts suggest the use of more structurally compacted copper-chromium-synchronium.

The main elements used in these alloys are the following: Be, Cr, Co, Cu, Fe, Mg, Mn, Ni, Nb, P, Si, Sn, Ti, Zr. Their amount in the alloy depends on the possible operating temperature. There are many alloys available, which can be obtained when copper is saturated with these elements, but the results do not always match the requirements of real production conditions, such as environmental cleanliness, cost of the final product, and high losses of heat transfer. Thus, the number of alloys used in practice is quite limited. The percentage of useful alloys is also limited by the necessary balance between hardness and thermal conductivity. An alloy of copper, chromium, and synconium meets all these requirements, most importantly, it is used because it retains its hardness for a long time at high temperatures. Such conditions are encountered above all in the casting of large cuts, in which case it is difficult to achieve optimal cooling conditions due to the highly active heat currents inside the crystallizer and the thick wall of the casing, which holds the very high pressure of the liquid steel.

The copper-nickel-phosphorus alloy provides the right combination of thermal conductivity and mechanical resistance at high temperatures, which allows to minimize the problem of temperature drops along the entire perimeter of the crystallizer. This is an indisputable advantage for solidification without excessive thermal stress occurring both in the solidifying shell and in the crystallizer itself. The moderate thermal conductivity of the above-mentioned alloy significantly lowers the crisis phase of the cooling phase, which is usually related to three factors: the thickness of the oil layer, the thermal flow and the accumulation of the hard shell. As a result, the possibility of a thermal shock and a crack on the surface is eliminated. Such material is the most widespread for the production of casings designed for casting special steels.

The presence of a protective coating on the surface of the shell shows the great importance of the crystallizer to the endurance of the shell and,

obviously, the quality of the final product. Traditionally, chrome is used for such coating. The thickness of the coating of different manufacturers varies from 0.1mm to 1.0mm. However, the thickness of the chromium layer does not guarantee the improvement of operational properties. If we compare the coefficient of thermal expansion and thermal conductivity of chromium and any base material , then it can be seen that the chromium layer is subjected to mechanical influence not only from the liquid steel side, but also from the expanding copper side. The chromium layer is mechanically affected by the expanding copper. Increasing the thickness of the chromium layer induces a greater internal stress of the layer and worsens its relative thermal conductivity, which leads to the activation of chromium oxidation.

The nickel-chromium coating for the copper shells of the crystallizer consists of two layers: a nickel layer and a chromium layer. A nickel layer is applied to the copper surface of the shell, which heats up during the casting process, and a chromium layer is applied to this layer. This new coating warns against the formation of cracks in the chrome coating, especially in the meniscus zone. In fact, nickel has twice the thermal expansion coefficient of chromium. Therefore, the nickel layer of the coating can withstand a large expansion of copper, which occurs in the meniscus zone during casting. Several comparative operational tests have confirmed a significant increase in the mean tolerance of the crystallizer coated shell compared to another conventional chromium coated shell.

Decommissioning of the crystallizer shell is mainly due to the corrosion of the inner surface. Eating the clay can lead to problems with hardening or defects in the final product. It is also well known that the corners of the crystallizer shell are the first to be corroded, because there the solidification process is most active. The unique geometry of the cover ensures the least corrosion of the shell on the corners and the heat transfer necessary for the curing process on the flat surfaces of the shell. In-house testing has proven that this new and unique coating geometry significantly reduces the problem of coating corrosion at corners.

The mechanical properties of the samples were determined by P10 and WDW-1000E porosity, and the microstructures were determined on a PME olympus Tokyo microscope .

The correct selection of clay ensures the quality of the final product, the continuous operation of the PFTM and the required productivity. The shell of crystallizers has a certain final period of operation. Selection of optimal operating parameters does not allow to increase the service life of the shell as an important component of the crystallizer.

From the research conducted above, it is known that each material has its advantages depending on the type of final product range. For example, although materials from structurally compacted alloys have great advantages, in real conditions environmental cleanliness, the cost of the final product does not meet the requirements such as high losses of heat conductors. However, it retains its hardness for a long time at high temperatures. (table 3)

Another key parameter is thermal conductivity and thermal expansion coefficient. Characterizing these parameters, the nickel-chromium layer on the casing surface is considered optimal. The chromium layer formed in the clay is mechanically affected not only by the liquid steel but also by the expanding copper. For this reason, a chromium layer is created after a nickel layer is applied to the surface. Such a double coating warns against the formation of cracks in the meniscus zone. It is known that nickel chromium has twice the thermal expansion coefficient.

The temperature-dependent graph of the linear expansion coefficient of Cr, Ni and the base material copper in the layers of the materials is shown.

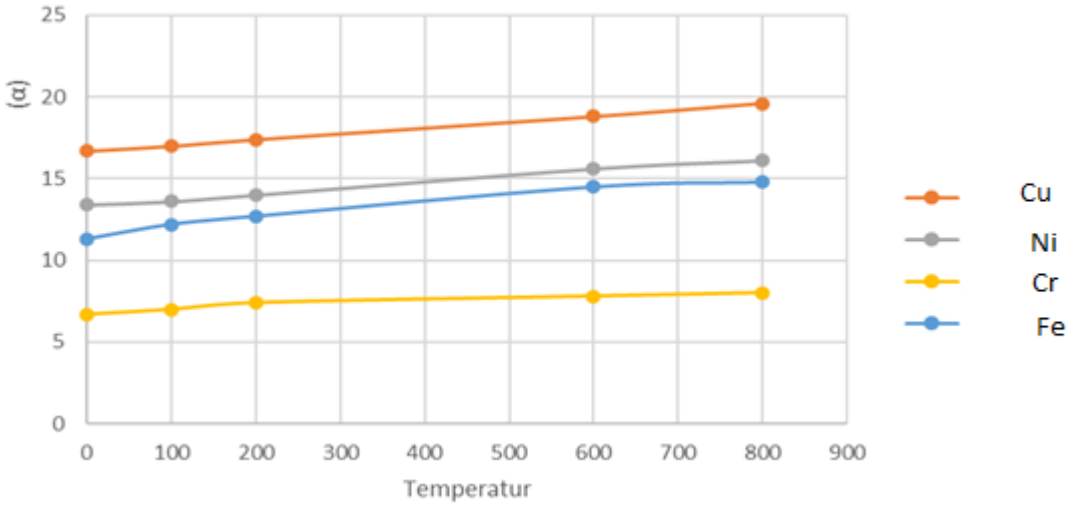

Figure 2. Temperature dependence graph of linear expansion coefficient of some materials.

In the working condition of the shell (alpha= 1.67 $\times 10^{-5}\ K^{-1}$) the maximum temperature variation (T_t=750K) in the reported quantities (alpha) is 15%. After that, the practical solution of the problem is performed only by calculation methods .

In the environment where the clay works, the temperature diaposon depends on alpha = f (T). It keeps the linear state of the lower limit of the temperature coefficient of the copper sheath in the temperature range of 100 - 750 K. 873 - 1073 K is calculated for the copper sheath and shown in the figure as a dependent lattice parameter at the experimental temperature. According to our calculations, good results were obtained between the calculated CTE and the experimental measurements for about 30K cases shown as points (every 30K). The calculated CTE (coefficient of thermal expansion) of 873 – 1073 K for the copper sheath here is significantly higher than the experimental values as the temperature approaches the melting temperature. [9,10,11]

We can express this dependence by accepting the linear dependence of the copper line expansion and expressing it with the following dependence by making a report adjustment in such changes $alpha_t$.

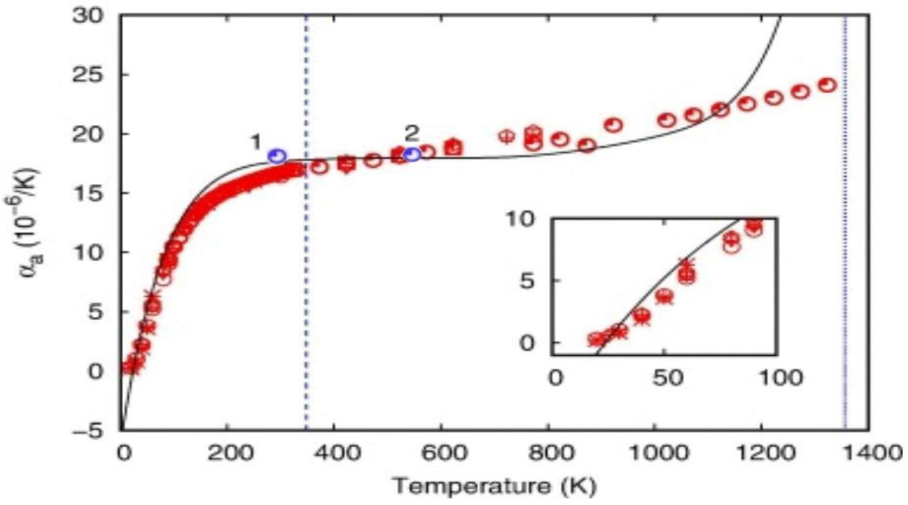

Figure 3 . Dependence of linear expansion coefficient of MM3 casing material on temperature

.

$$alpha_t = \frac{\alpha_2 - \alpha_1}{T_2 - T_1}(T_t - T_1) + \alpha_1 \quad (1)$$

Here α_1 T_1 and T_2 α_2 - linear expansion coefficients and temperature corresponding to points 1 and 2 (reference) on the graph (alpha=f(T) appears).

The dependence on clay materials is shown in figure 4 and table 3.

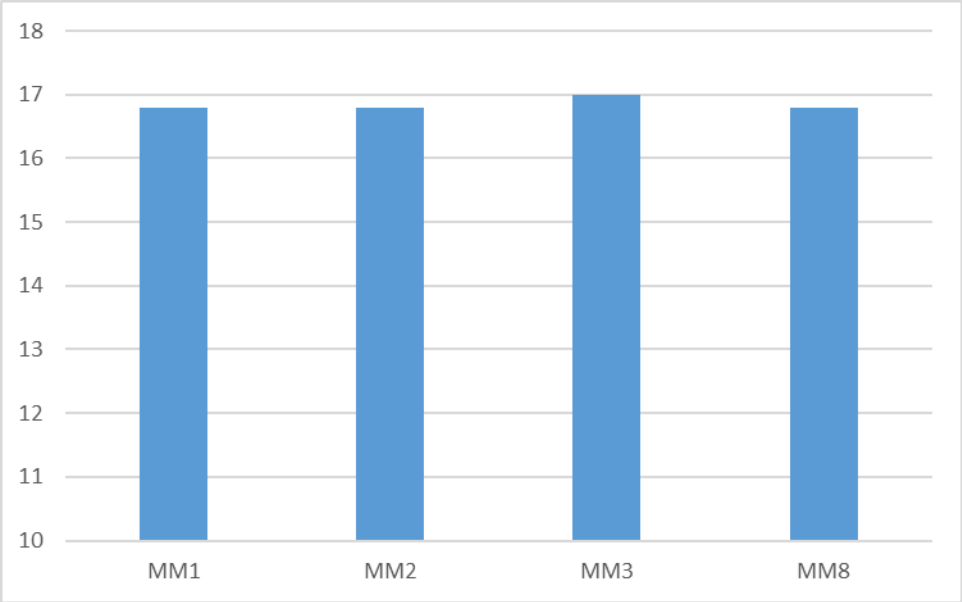

Fig. 4 Comparative dependence of the coefficient of linear expansion of clay materials.

Table 3.Physical properties of crystallizing sheath materials

Physical properties	Materials			
	MM1	MM2	MM3	MM8
Technical expansion coefficient (K^{-1})(20^0in)	1.68×10^{-5}	1.68×10^{-5}	1.70×10^{-5}	1.68×10^{-5}
Thermal conductivity [W/(m *K)](at 200°)	340	377	325	284
Electrical conductivity [% IACS]	83	93	80	70
Recrystallization temperature (°C)	330	370	700	600
Softening temperature (°C)	-	-	500	400
Young's modulus (Mpa)	1.2×10^{-5}	1.2×10^{-5}	1.3×10^{-5}	1.2×10^{-5}

Table 4.Mechanical properties of crystallizing sheath materials

Mechanical properties	Materials			
	MM1	MM2	MM3	MM8
Tensile strength [MPA] (at 20°C)	295	300	415	335
Tensile strength [MPA] (at 20°C)	-	245	385	310
0.2 Elda point [MPA] (at 20°C)	270	275	340	320
0.2 Yield point	-	230	320	280

[MPA] (at 200°C)				
Elongation[%](at 20°C)	20	18	20	18
Brinell hardness [HB] (at 20°C)	93	95	125	115

As can be seen from the table, the coefficient of linear expansion for each shell material is the same in MM1, MM2 and MM8, but it is dominant in MM3. In these materials, the crystallization temperature, softening temperature and wicking temperature are superior. explained by structured metal. The mechanical properties of MM3 materials are superior to other materials in all parameters. Also, depending on the brand of steel, the pouring rate of liquid metal in PFTM is regulated by the following volume parameters. [12]

The linear speed of continuous casting is calculated by the following formula.

$$V_t = \frac{K(1+\frac{a}{b})}{q} \qquad (2)$$

Here, K is a coefficient depending on the brand of the cast plate, a and b are the thickness and width of the cast plate, respectively. Square and round pies

The pour speed in PFTM is determined by the following formula:

$$V_l = 2\ K_1 / a \qquad (3)$$

where that K_1- are the coefficients according to the brands of steel, a - is the side of the square pistah.

Considering that the linear speed of PFTM does not have any normative coefficients, it is determined by calculation methods. Today, mainly in modern metallurgical plants in the world, the principle of casting in PFTM is carried out by pouring alloys on top of each other. This, in turn, prevents the increase of production volume and the reduction of additional liquid metal loss. Thus, in non-overlapping castings, the cutting of the head parts of each first poured paste, the loss remaining in the intermediate ladle at the end of each casting, and the loss of liquid metal left in the emergency bath for adjustment before pouring are not during overlapping casting, and thus the output percentage of liquid metal as a finished product is high (average 99 -99.5%).[13]

Table 5"" coefficient for selecting the speed of a square steel pist in PFTM K_1.

Brand of steel		" K_1" coefficient
1	Ordinary carbon steels	0.14
2	Carbon and low-alloy structural steels	0.13
3	Carbon, boiling structural steels	0.11
4	High alloy steels and alloys	0.11
5	Tool steels and roller bearing steels (ШХ)	0.10

In Table 5, the square steel pistah is included in the determination of the coefficient for selecting the speed in the PFTM in ordinary quality steels. Determination of the crystallization interval in the pouring of liquid steel in continuous casting C_T3сп According to the casting temperatures of 125×125 and 150×150 mm square pashtos of C_T5сп brand, during the melting process in the Electro-Arc furnace, the limits of measurement were determined as the pouring temperature during the pouring of the liquid metal in the Continuous Pashto Casting machine.

1) The first casting temperature – in the intermediate furnace – 1565 °C

2) Intermediate furnace at the second temperature - 1550°C

3) At the third temperature in the intermediate furnace – 1540 – 1535°C

Along with the temperature, the rate of casting - 2.8 - 3.5 m/min can change depending on the roads.

The adjustment of the copy can vary depending on the level of liquid metal in the intermediate furnace and the size of the dispensers used for pouring liquid metal: the size of the dispenser for pouring 125 ×

125mm paste - Ɵ17-15mm; The size of the dispenser for pouring 150x150mm pasta is set to Ɵ17-17mm.

The water pressure (0.7 - 0.85 Mpa) used in cooling in the Continuous Pastry Casting Machine (FPTM) is required, as well as the condition of the water and the temperature difference (outgoing and entering the crystals).

Casting Time In a Continuous Pastry Casting Machine (FPTM), the casting speed and time can vary depending on the lanes. That is, it is adjusted according to the casting ways (1, 2, 3 and 4 ways). In terms of time, it was possible to pour 60 tons of metal in 50-55 minutes without cooling the liquid metal.

The improvement of properties by the thermal treatment process is considered the most effective method of increasing these properties. Unlike hot-rolled steel, after the rolling process is complete, the structure here consists of low-temperature fractured austenite obtained by rapid cooling of the austenite.

During heat treatment, the decomposition temperature of austenite decreases. As a result, the formation of ferrite takes time, which ends with the acquisition of small-grained pearlite (sometimes bainite is formed). As a result of heat treatment, a martensite structure is obtained in the form of a thin layer in the surface layer of steel [14,15,16]. However, since the Mb transformation temperature is between 400 and 450 °C, the obtained structure undergoes self-degradation. Thus, as a result of rapid cooling of the rolls, the temperature on the surface is subsequently balanced by the internal heat, and self-reflection takes place in the obtained improved structure. After that, there is no need to repeat the application. In the end, during thermal treatment, the tabulation of the surface layer of the rolling is caused by the low durability of austenite and the high rate of crisis (500 - 1000°C/second).

As a result of heat treatment, a needle-like structure is obtained around and inside the ferrite grains. Due to the increase of mechanical properties of this structure and decrease of cold fracture, it leads to 20-60% metal saving and high reliability of constructions.

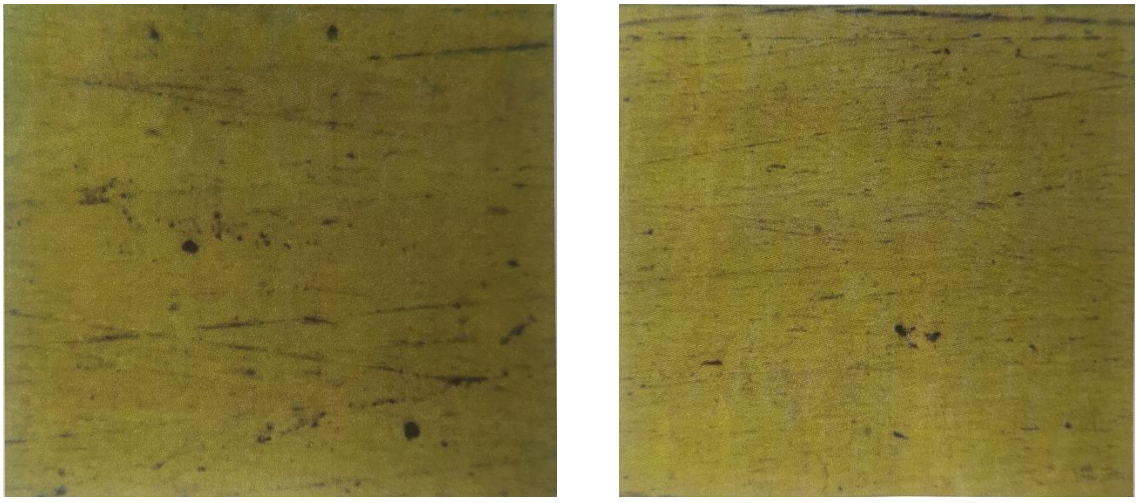

Fig. 5. Unetched microstructure of C_T3cn C_T5sp grade steel ×1000

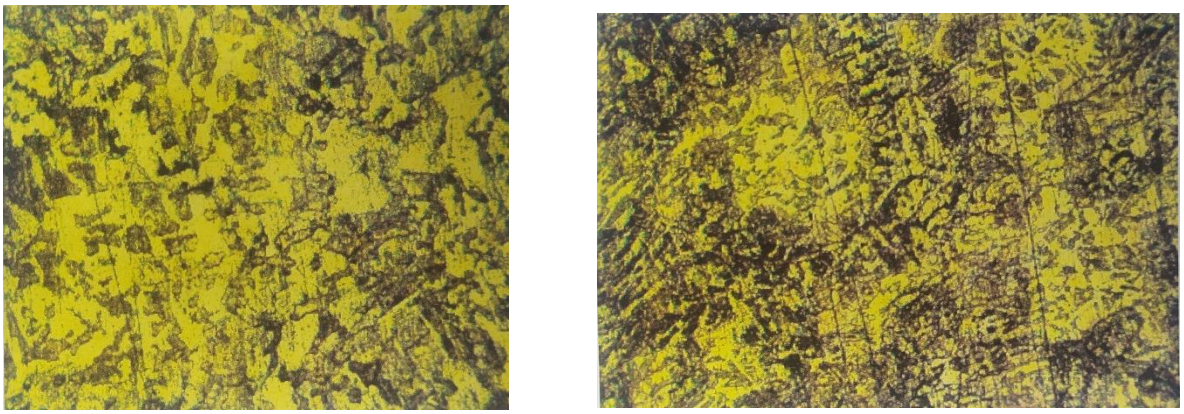

Figure 6. Annealed microstructure of C_T3cn C_T5cn brand steel ×1000

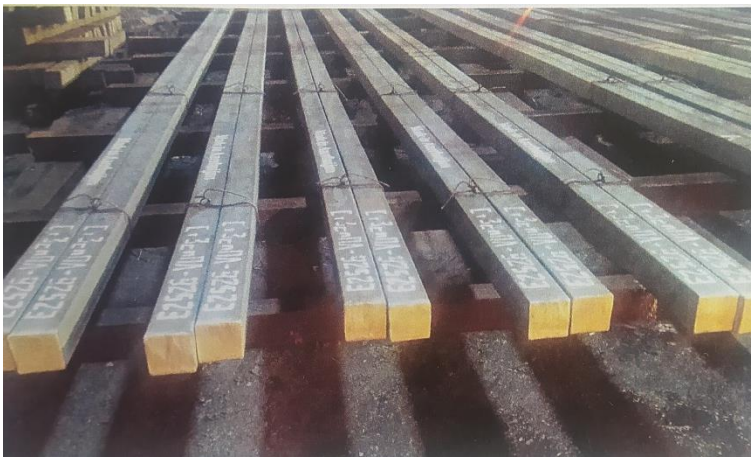

Figure 7. General view of 125×125mm square pistahs.

3. Conclusion

The final product of the continuous steel casting process is the square shape of the cast pashto.

The type of construction was defined, the type of crystallizers and the type of shell were determined, and the beginning of setting the type of temperature, shell and casting speed in the projects was clarified.

It has been determined that in order to ensure optimal operation, the crystallizer should maintain its starting character for a long time at the average working temperature and have good thermal conductivity.

Clay (Cu Cr Ni) composite material surpasses other materials in terms of mechanical properties. Thermal conductivity, which is a physical property, is intermediate to electrical conductivity.

It was found that the corners of the crystallizer shell are exposed to corrosion. Brushed chrome coating provides less corrosion on corners and increased hardness on flat areas and increases thermal conductivity.

Since there are no normative coefficients, the regulation of the parameters of the pouring speed of ordinary quality steel was determined by calculation and formulas were used of ordinary quality C_T3сп and C_T5сп casting pastes have been shown to increase mechanical properties around the obtained grains and reduce cold fracture.

The temperature dependence of the linear expansion coefficient of the clay material and coating layer metals should be studied.

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Control process of tomato paste production

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Abstract: The food industry has been one of the major sectors to embrace automation technology in the last decade. Automation in tomato paste production has become increasingly important as manufacturers seek to improve the quality of their products, reduce costs, and enhance productivity. This article will analyze the impact of automation in tomato paste production.

Keywords: Tomato paste, Automation technology, Automated processes, Control process, Product quality.

1.Introduction

Modern automated process control systems are used in almost all production processes - both in industry, energy, transport, hazardous industries and enterprises (chemical, petrochemical, oil refining), etc. [1-4]. This article deals with the control problem the production of an important strategic agricultural product - tomato paste.

Tomato paste is a highly demanded food ingredient in many parts of the world. Tomato paste is a concentrated tomato product used as a flavoring agent in many culinary recipes. It is made by cooking tomatoes for an extended period and then straining out the seeds and skins to create a smooth, thick paste. The production of tomato paste involves several stages, including sorting, washing, chopping, cooking, and packaging [7]. Traditionally, tomato paste production was a labor-intensive process that required a significant amount of time, manpower, and resources [9]. However, with the advent of automation technology, tomato paste production has become more efficient and cost-effective. Automation technology involves the use of modern machines and software to automate various stages of tomato paste production, packaging, and labeling. The use of automation technology in tomato paste production has several advantages, such as improved product quality, increased productivity, reduced costs, and enhanced safety. However, it also poses several challenges, such as high initial investment costs, technical complexity, and job losses. Despite these challenges, the application of automation technology in tomato paste production is expected to increase in the future, driven by the need for more efficient and effective production methods to meet the growing global demand for tomato paste.

2. Experimental details

Automation technology has impacted various stages of tomato paste production, including processing, packaging, and labeling. In the processing stage, automation technology is used to chop, cook, and strain the tomatoes to create a smooth paste.

Modern machines such as automatic tomato washers, tomato crushers, and steam peelers have replaced manual labor, resulting in improved efficiency and reduced labor costs. Additionally, automation technology has improved the quality of the tomato paste by ensuring that the tomatoes are cooked at the optimal temperature and time to preserve their flavor and nutrients. Figure 1 illustrates the tomato paste processing line. In the packaging stage, automation technology has eliminated the need for manual labor in filling and sealing the tomato paste in cans or pouches.

Machines such as automatic filling machines, sealing machines, and labeling machines have improved the accuracy and speed of the packaging process, resulting in increased productivity and reduced costs.

The use of automation technology in packaging has also enhanced the safety of the tomato paste by minimizing the risk of contamination.

Figure 1: Tomato paste processing line

Table 1 compares the manual and automated processes involved in tomato paste production. Automation has replaced several manual processes, increasing efficiency, reducing the risk of errors, and improving product quality.

Table 1: Comparison of manual and automated tomato paste production

Process	Manual	Automated
Sorting and washing	Hand sorting and washing	Automated sorting and washing
Grinding	Manual grinding	Automated grinding
Heating	Manual heating	Automated heating
Concentration	Manual concentration	Automated concentration
Filling and packaging	Manual filling and packaging	Automated filling and packaging

Figure 2 shows the increasing adoption of automation in tomato paste production over time. As technology has advanced and become more affordable, more companies have implemented automated processes in their production lines [6].

Automation technology also increases productivity and reduces labor costs. Machines can operate for extended periods without the need for breaks, resulting in increased production capacity. Automation technology also eliminates the need for manual labor in many stages of tomato paste production, reducing labor costs and improving efficiency.

Additionally, automation technology reduces the risk of injuries and accidents associated with manual labor, enhancing workplace safety [10].

Assuming a tomato paste production facility previously employed 100 workers who each earned an average of $20 per hour and worked 8 hours per day, automation may lead to a reduction in the number of workers needed to produce the same amount of tomato paste. If automation resulted in a 50% reduction in labor costs, this could represent a savings of $800,000 per year.

Additionally, automation could lead to improvements in efficiency, such as reducing the time required to sort and wash tomatoes, increasing the amount of

tomato paste that can be produced in a given time period. Assuming a 25% improvement in efficiency could result in a savings of $200,000 per year.

Figure 2: Adoption of automation in tomato paste production

Finally, automation could reduce waste by allowing for better control of the production process, resulting in a reduction in the amount of tomato paste that is discarded due to spoilage or other issues. Assuming a 10% reduction in waste could result in a savings of $50,000 per year.

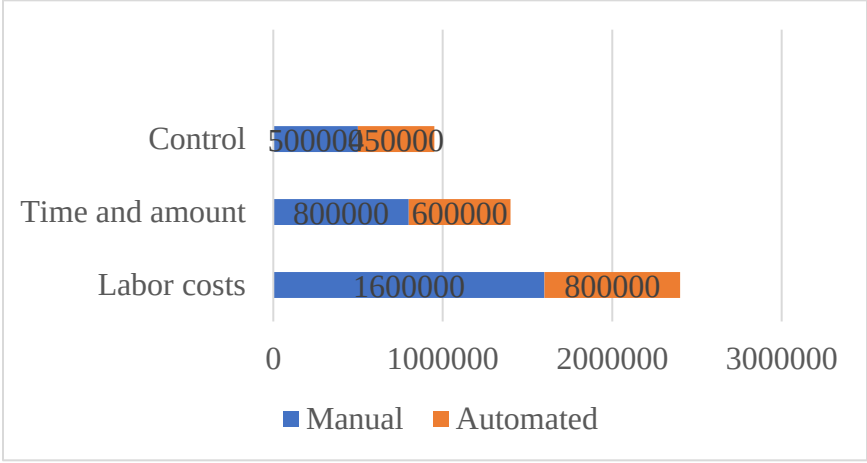

Figure 3: Cost savings from automation in tomato paste production

Table 2 highlights the impact of automation on tomato paste quality. Automation has resulted in more consistent color, flavor, and texture, and improved shelf life due to better temperature control during the production process.

Table 2: Impact of automation on tomato paste quality

Quality metric	Manual	Automated
Color	Inconsistent	Consistent
Flavor	Inconsistent	Consistent
Texture	Inconsistent	Consistent
Shelf life	Short	Longer

Despite the benefits of automation technology in tomato paste production, it also poses several challenges. One of the primary challenges is the high initial investment costs. Automation technology requires a significant investment in modern machines and software, which may be prohibitively expensive for small manufacturers. Additionally, automation technology requires specialized expertise to operate and maintain, adding to the overall cost of implementation [5].

The use of automation technology in tomato paste production may also result in job losses. Machines have replaced manual labor in many stages of tomato paste production, reducing the need for human workers. This may have negative implications for the labor market, particularly in regions where tomato paste production is a significant source of employment.

Furthermore, automation technology can improve the traceability and accountability of tomato paste production, which is essential for food safety and quality control. Automated systems can track and monitor every step of the production process, from the sourcing of raw materials to the packaging and distribution of the final product. This enables manufacturers to identify and address any quality or safety issues quickly, reducing the risk of contamination and ensuring product consistency [8].

3. Conclusion

In conclusion, automation technology has had a significant impact on tomato paste production, offering several advantages such as improved product quality, increased productivity, reduced costs, and enhanced safety. However, it also poses several challenges, such as high initial investment costs, technical complexity, and job losses. Nonetheless, the use of automation technology in tomato paste production may have positive environmental implications, improving sustainability and reducing waste and energy consumption. As technology continues to advance, it is likely that automation will play an increasingly important role in the food industry, leading to a more efficient, safe, and sustainable production process.

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Evaluation of the economic efficiency of the manufacture of the high-pressure pump valve from powder steel

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Abstract: The high-pressure pump НП-720x105 is used in various liquid media, oil and gas transportation, cement slurry pumping equipment, hydro-sand equipment and other high pressure conditions. The valve is the main working part that determines the working parameters of the pump (power, pressure, productivity, reliability, longevity, etc.). For this reason, the part that causes the pumps to fail quickly in working conditions is the valve seat of the pump and the valve tray. These parts are easily damaged due to high wear in working conditions. It is economically more convenient to make parts exposed to corrosion from abrasive steel.

Keywords: powder steel, valve, pump, high pressure, wear

1.Introduction

Theoretical and experimental results should solve the most modern problems of the industry using all the possibilities of science and technology. Implementation of the obtained results in production is one of the most important issues. At the same time, the solution to the problem of production is significantly dependent on economically efficient indicators. The following operations should be performed in order to develop an economically efficient technology during the purchase of a high-pressure pump valve from ПК80Х4Н5 grade abrasive steel (4):

1. It is necessary to try that the material balance and labor capacity during the purchase of details (pump parts) should be as low as possible.
2. It is necessary to ensure the longevity of the valve and reduce the demand for spare parts
3. To reduce labor capacity during replacement and repair of worn parts

As mentioned in works [1] and [2], the following expression (1) can be used to evaluate the economic efficiency during the development of new technologies.

$$İ_E = (C_1 - C_2) + E\Delta K) \quad (1)$$

Here, $İ_E$ is the economic effect, cent

Costs spent until the preparation of C_1-detail, manat

C_2- costs incurred after the preparation of the detail, manat

Additional costs during the implementation of ΔK m-technology, manat

E=0.15 is the coefficient of comparison with the effective standards used in the industry

2. Experimental details

The calculation of the financial costs incurred during the preparation of the details has been carried out. The expenses spent on details made with modern technologies were recorded and their statistics were conducted.

Table 1 shows the price of 1 kg of abrasive slag used for the production of bimetallic corrosion-resistant parts (pump parts). According to the proposed technological schemes, the residual porosity of the final parts (pump parts) was as follows: after dynamic hot pressing, the value of the residual porosity was 16-20% throughout the entire volume of the parts, and during cold static pressing (5).

Since the price of each of the materials used during the preparation of details is different, it does not affect the cost of the purchased details. This, in turn, affects the price of the applied technology.

The amount of sandblasting used for the production of 1000 parts is determined as follows (2).

$$M = ((m_{yey} \cdot X_{yey} \cdot 1000) + (m_{esas} \cdot X_{esas} \cdot 1000)) \cdot k_{id} \cdot k_{ti} \quad (2)$$

Here, m_{yey} and $m_{əsas}$ are the mass of the food-resistant and base material, kg/detail

X_{yey} and $X_{əsas}$ -resistant and basic material costs for the preparation of the ruby block, man/kg

k_{id} -year costs incurred on the details produced

coefficient that takes into account losses during k_{ti} - technological processes

The results obtained after all these processes are given in table 1.

Table 1. The price of 1 kg of non-edible powder

The name of the material	Mass fraction, kg	Wholesale price, manat/kg	Price, rubles
Abrasive chip for base material			
ПЖВ 3.160.26 stamped iron crumb	0,99	2.25	2.22
ГК -3 stamped graphite crumb	0,01	1.91	0.01
TOTAL		2.23	
Transportation and purchase costs (3.65%)		0.08	
TOTAL		2.31	
Inedible powder crumb			
ПЖВ 3.160.26 stamped iron crumb	0,734	2.25	1.65
ГК-3 stamped graphite crumb	0,01	1.91	0.01
ПВ-Х18Н15-056 stamped crumb	0,2	44.94	8.98
ПНК 1Л5 stamped nickel crumb	0,05	11.8	0.59
Zinc stearate	0,006	2.81	0.16
TOTAL			11.39
Transportation and purchase costs (3.65%)		0.41	
TOTAL		11.8	

The cost, labor costs, and energy costs of the abrasive chip used to make the main part and the corrosion-resistant coating are listed in Table 2-6.

Table 2. Materials used during the preparation of parts obtained by dynamic hot pressing (DQP) and cold static pressing (SSP) processes

Technology	Type of detail	Main cover			Non-edible coating			Costs incurred on the details produced annually, K_{id}	Coefficient that takes into account losses during technological processes K_{ti}	Material used for the preparation of the detail, manat/kg
		Cover weight, kg/det	The price of the cover sheet is ruble/kg	The price of the cover, AZN/detail	Cover weight, kg/detal	The price of the cover, AZN/kg	The price of the cover, AZN/detail			
DQP	Saddle	2,1	2.33	4.89	0,2	11.67	2.33	0.04	1,05	10.84
	plate	1,4	2.33	3.26	0,15	11.67	1.75	0.04	1,05	7.51
SSP	Saddle	1,7	2.33	3.96	0,16	11.67	1.86	0.04	1,05	8.74
	plate	1,1	2.33	2.56	0,11	11.67	1.28	0.04	1,05	5.77

Table 3. Report on the production of valve parts (saddle and tray) by dynamic hot pressing

N	Operation name	Costs incurred for 1000 parts, manat	
		Saddle	plate
1	Preparation of Shikhta Mixing operation	$\frac{2,3 \cdot 1000}{12,5} \cdot 60,6 = 11150,4$	$\frac{1,55 \cdot 1000}{12,5} \cdot 60,0 = 11150,4$

	Productivity-12.5 kg/hour, mixing time 3 hours		
2	Cold pressing Productivity-200 pieces/hour, pressing operation-4 hours	$\frac{1000}{200}\cdot 67=335$	$\frac{1000}{200}\cdot 67=335$
3	Cooking in a chamber oven Productivity-14 kg/hour, cooking time 4 hours	$\frac{2,3\cdot 1000}{14,5}\cdot 60,6=9612,$	$\frac{1,55\cdot 1000}{14,5}\cdot 60,6=6477,9$
4	Dynamic hot pressing Productivity-Stamping process 120 units/hour, 4 hours	$\frac{2,3\cdot 1000}{14,5}\cdot 60,6=9612,$	$\frac{1000}{200}\cdot 67=558$
5	Mechanical processing Productivity - preparation of 50 pieces/hour tray, 6 hours	$\frac{1000}{60}\cdot 82=1366,6$	$\frac{1000}{50}\cdot 82=1640$
6	Thermal processing Productivity-30 kg/hour, for 4 hours	$\frac{2,3\cdot 1000}{14,5}\cdot 60,6=9612,$	$\frac{1,55\cdot 1000}{30}\cdot 60,6=3131$
7	Control of defects and dimensions	670	760
8	Total 25% all factors considered	35423	30552,8

Table 4. Report on the manufacture of valve parts (saddle and tray) by cold static pressing

N	Operation name	Costs incurred for 1000 parts, manat	
		Saddle	plate
1	Preparation of Shikhta Mixing operation Productivity-12.5 kg/hour, mixing time 3 hours	$\frac{1,7\cdot 1000}{12,5}\cdot 60,6=8141,6$	$\frac{1,1\cdot 1000}{12,5}\cdot 60,0=5332,8$
2	Cold pressing Productivity-200 pieces/hour, pressing operation-4 hours	$\frac{1000}{200}\cdot 67=335$	$\frac{1000}{200}\cdot 67=335$
3	Cooking in a chamber oven Productivity-14 kg/hour, cooking time 4 hours	$\frac{1,7\cdot 1000}{14,5}\cdot 60,6=7104,8$	$\frac{1,1\cdot 1000}{14,5}\cdot 60,6=4597,2$
4	Dynamic hot pressing Productivity-Stamping process 120 units/hour, 4 hours	$\frac{1000}{80}\cdot 67=837,5$	$\frac{1000}{110}\cdot 67=609$
5	Mechanical processing Productivity - preparation of 50 pieces/hour tray, 6 hours	$\frac{1000}{60}\cdot 82=1366,6$	$\frac{1000}{50}\cdot 82=1640$
6	Thermal processing Productivity-30 kg/hour, for 4 hours	$\frac{1,7\cdot 1000}{30}\cdot 60,6=3434$	$\frac{1,1\cdot 1000}{30}\cdot 60,6=2221$
7	Control of defects and dimensions	670	760
8	Total 25% all factors considered	27486,7	19368

Table 5. Energy loss report during dynamic hot pressing of valve parts (saddle and tray).

N	Operation name	Costs incurred for 1000 parts, manat	
		Saddle	plate

1	Preparation of Shikhta Mixing operation Productivity-12.5 kg/hour, mixing time 3 hours	$\frac{2,3 \cdot 1000}{12,5} \cdot 3 = 552$	$\frac{1,55 \cdot 1000}{12,5} \cdot 3 = 372$
2	Dynamic hot pressing Productivity-200 units/hour, pressing operation, Press power-8 kW/hour	$\frac{1000}{200} \cdot 8 = 40$	$\frac{1000}{200} \cdot 8 = 40$
3	Cooking in a chamber oven Productivity-14 kg/h, oven power-30 kW/h	$\frac{2,3 \cdot 1000}{14,5} \cdot 30 = 4758,6$	$\frac{1,55 \cdot 1000}{14,5} \cdot 30 = 3206,8$
4	Dynamic hot pressing Productivity-120 pieces/hour, Press power-6 vW/hour	$\frac{1000}{120} \cdot 6 = 50$	$\frac{1000}{120} \cdot 6 = 50$
5	Mechanical processing Productivity-making 60 pieces/hour of saddle, 50 pieces/hour of making tray. Power-3 kW/h	$\frac{1000}{60} \cdot 3 = 50$	$\frac{1000}{50} \cdot 3 = 60$
6	Thermal processing Productivity-30 kg/h, Power-10 kW/h	$\frac{2,3 \cdot 1000}{30} \cdot 10 = 766,6$	$\frac{1,55 \cdot 1000}{30} \cdot 10 = 516,6$
7	Total	6217,2	4245,4

Table 6. Energy loss report during static cold pressing of valve parts (seat and tray).

N		Costs incurred for 1000 parts, manat	
		Saddle	plate
1	Preparation of Shikhta Mixing operation Productivity-12.5 kg/hour, mixing time 3 hours	$\frac{1,7 \cdot 1000}{12,5} \cdot 3 = 408$	$\frac{1,1 \cdot 1000}{12,5} \cdot 3 = 264$
2	Dynamic hot pressing Productivity-200 units/hour, pressing operation, Press power-8 kW/hour	$\frac{1000}{200} \cdot 8 = 40$	$\frac{1000}{200} \cdot 8 = 40$
3	Cooking in a chamber oven Productivity-14 kg/h, oven power-30 kW/h	$\frac{1,7 \cdot 1000}{14,5} \cdot 30 = 3517,2$	$\frac{1,1 \cdot 1000}{14,5} \cdot 30 = 2275,8$
4	Dynamic hot pressing Productivity-120 pieces/hour, Press power-6 vW/hour	$\frac{1000}{80} \cdot 6 = 75$	$\frac{1000}{110} \cdot 6 = 75$
5	Mechanical processing Productivity-making 60 pieces/hour of saddle, 50 pieces/hour of making tray. Power-3 kW/h	$\frac{1000}{60} \cdot 3 = 50$	$\frac{1000}{50} \cdot 3 = 60$
6	Thermal processing Productivity-30 kg/h, Power-10 kW/h	$\frac{1,7 \cdot 1000}{30} \cdot 10 = 566,6$	$\frac{1,1 \cdot 1000}{30} \cdot 10 = 366,6$
7	Total	4656,8	3171,4

During the preparation of the valve detail (saddle and tray) of the high-pressure PN-720x105 pump from scrap material, the areas where technological processes will be implemented are determined. 15.2% depreciation is accepted in the prices of the equipment required for the implementation of the technology (A1525 brand mixers, press-molds, chamber oven, mechanical processing press, etc.).

The process of making the details of the press-molds is considered an important operation and has implemented this process. With the help of designed press-moulds, the "valve saddle" worth 1.57 manats and the "valve tray" worth 1084.23 manats were prepared and put into production. The number of cycles to prepare 1000 parts in the designed press-mould was 50000, and the costs were 535.37 manats.

Currently, 535.37 manats were spent on the production of 1000 valve parts, but 17240.58 manats were spent on the production of 1000 valve parts by dynamic hot pressing (DHP) method. It was also clear from here that 20% savings were achieved during the production of 1000 valve parts. When calculating the economic efficiency of new technologies in factory conditions, the costs incurred in auxiliary departments are not taken into account.

Currently, the production of 1200 pieces of pump valve parts (saddle and tray) is carried out according to the annual program from the given project. The price of these parts is 42618.57 manats. In this case, with the application of new technologies, we can calculate the economic efficiency during the development of parts of the high-pressure pump valve:

1. During dynamic hot pressing

$E_q = (42618.57 - 35486.26) - (0{,}15 - 5336.87) = 12469.03$ manat

2. During cold static pressing

$E_q = (42618.57 - 20035.18) - (0{,}15 - 5336.87) = 27920.11$ manat

During the preparation of valve parts, the amount of costs incurred for the production program is determined based on the data of the conducted laboratory tests. As mentioned in the study [3], we can use the following expression (4.3) to determine the economic efficiency of corrosion-resistant materials.

$$E_y = N_e C_d - N_{ds} C_{ys} \quad (3)$$

Here, the serial number of N_e -spare parts

C_d -number of details per series

N_{ds} - the number of details that cannot be eaten

C_{ys} - price of inedible details

As can be seen from expression (3), the number of spare parts ensures that the seat and tray part of the valve part can be replaced with a new one during impact-abrasive wear. As can be seen here, the N_e/N_{ds} ratio ensures the longevity of the valve parts. In addition, it was found that the longevity of valve details (saddle and tray) made of 40XH2MA steel is slightly lower than that of ПК80Х4Н5 steel and is mainly determined by the ratio (4) below.

$$\frac{N_e}{N_{ds}} = \frac{L_{40XH2MA}}{L_{ПК80Х4Н5}} = \frac{\Delta m_{40XH2MA}}{\Delta m_{ПК80Х4Н5}} \quad (4)$$

Here, $\Delta m_{40XH2MA}$ and $\Delta m_{ПК80Х4Н2}$-samples are the absolute wear of abrasive steels of the 40XH2MA and ПК80Х4Н5 grades, respectively, during impact-abrasive etching.

As mentioned in the third section, the absolute wear of samples made of 40XH2MA steel during the impact-abrasive etching process is $\Delta m_{40XH2MA}$ =0.012 grams, and the absolute wear of samples made of ПК80Х4Н5 abrasive steel is $\Delta m_{ПК80Х4Н2}$=0.004-0.006 grams. If dynamic hot pressing and cold if we make a valve detail from PK80X4H5 steel using static pressing methods, then ΔmПК80Х4Н2=0.005 grams. In this case, we will obtain the following expression (4).

$$\frac{N_e}{N_{ds}} = \frac{L_{40XH2MA}}{L_{ПК80Х4Н5}} = \frac{\Delta m_{40XH2MA}}{\Delta m_{ПК80Х4Н5}} = 24 \quad (5)$$

Based on the result obtained from expression (4), we can note that for 1200 spare valve parts made, we will get N_e =750. In this case, we can define the cost-effectiveness to ensure the corrosion resistance of the valve seat and tray as follows.

1. By dynamic hot pressing method

$E_{is} = (1200 - 355.18) - (750 - 20.75) = 115.57$ manat

2. By cold static pressing method

$E_{is} = (1200 \cdot 355.18) - (750 \cdot 20.75) = 410652.5$ manat

3. Conclusion

The value of residual porosity in chrome-nickel abrasive steels with high corrosion resistance was 5-6%, and this result was obtained by applying a force of 300-350 Newtons by dynamic hot pressing (DHP) and cold static pressing (SSP) methods. It was found that the impact-abrasive corrosion resistance of the samples obtained after the dynamic hot and cold static pressing process was approximately 3 times higher than the details obtained by conventional methods. In

order to increase the resistance of the samples to impact-abrasive corrosion, surface strengthening was carried out by the method of surface plastic

deformation (with spheres). A new technology was developed for the preparation of valve parts (saddle and tray) of the high-pressure НП-720x105 brand pump. The unique technology was applied to the impact-abrasive corrosion process. made it possible to manufacture durable valve parts, including the valve seat and tray. With the application of various technologies, the material consumption and labor capacity have been significantly reduced, and the longevity of the valve parts has increased.

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Monitoring of the composition of produced water used in the process of oil extraction

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Abstract: In the article, the composition of produced water used in the process of oil extraction in the SOCAR Drilling well was studied by physical and chemical methods, parameters such as - pH, conductivity, TDS, TSS, turbidity, ions, and metals, COD and organic composition were determined. The values of the measured parameters were compared with the normative values. Obtained UV spectra allow determining the quality parameters of organic compounds dissolved in water - absorption (abs) coefficients corresponding to the compounds.
Keywords: produced water, chemical compounds, GS/MS, UV spectroscopy

1.Introduction

Petroleum is a major source of energy and profit for numerous countries moment, and its product has been described as one of the most important artificial conditioning in the twenty-first century [1]. Roughly fact is estimated that the world's diurnal petroleum consumption would increase from 85 million barrels in 2006 to 106.6 million barrels by 2030 [2]. Produced water results from two processes in oil painting and gas assiduity. First, during birth, this gives an admixture of water and oil painting; the source of which is generally seawater girding the oil painting well. Second, the water fitted into the oilfield to bring the deep oil painting to the face also eventually becomes part of produced water or wastewater [3]. When hydrocarbons are produced, they come to the surface as a liquid mixture. The composition of these produced fluids depends on the production of crude oil or natural gas and is generally a mixture of water produced by mixing either liquid or gaseous hydrocarbons, dissolved or suspended solids, sand and clay mechanical mixtures, various chemicals injected into the wells, and produced as a result of production activities. The main composition of formation water consists of: Salt content (salts, total soluble solid salinity, electrical conductivity), Oil and oil products (this is a measure of the amount of organic chemical compounds), Various inorganic and organic compounds, Hydrogen sulfide, etc. [4, 5].

Produced water it has a simple to complex composition that's variable, and it's considered as an admixture of dissolved and particulate organic and inorganic chemicals. Chemical and physical parcels of produced water vary vastly which depends on several factors including, geographic position of the field, age and depth of the geological conformation, hydrocarbon-bearing conformation geochemistry, birth system, type of the produced hydrocarbon, as well as its chemical composition in the force. The toxic of produced water discharged from gas platforms is 10 times advanced than the toxic of the oil painting wells discharge. Still, the volumes from oil painting product are much advanced than gas product [6]. The major ingredients that are present in produced water include swab content(measured as saltness), total dissolved solids (TDS) or electrical conductivity; oil painting and grease(O&G); polyaromatic hydrocarbons(PAHs), benzene, toluene, ethylbenzene, and xylenes (BTEX), phenols, organic acids, natural organic and inorganic composite that cause hardness and scaling(e.g., calcium, magnesium, sulfates, and barium); and chemical complements similar as biocides and erosion impediments that are used during drilling, fracturing and operating process of the well.

The purpose of the work is to study the composition of produced water injected into wells during oil extraction in the SOCAR Drilling well by modern physical and chemical analysis methods were used.

Measuring pH and temperature is carried out using the pH110 device. This method involves determining the pH of the water using a glass electrode. This method allows measuring the pH in the range of 1-14 in laboratory conditions. Determination of pH and temperature is done with a pH meter. The device consists of 2 electrode tips. The iron tip is for temperature determination and the glass tip is for pH determination.

Conductivity, salinity, TDS, and TSS parameters are measured by the Conductometer CO310. The electrode tip of the device was washed and cleaned

with distilled water. Then the electrode was immersed in produce water. From the menu section of the device, we select various functions in order, and the value of each indicator is reflected on the screen separately. The extraction of mineral and energy resources has the potential to increase both total suspended solids (TSS) and total dissolved solids (TDS) loading to an adjacent waterbody [7,8,9].

Estimation turbidity is based on measuring the intensity of the light emitted by the suspended particles of the substance by the nephelometric method. The intensity of emitted light is an indicator of turbidity. Coming to the sample tray the distance between the scattered light and the passing beam should not exceed 10 cm. For this reason, in order to remove particles larger than 0.1 μm, to pass pure water through a filter with a very small pore size. turbidity was performed with a turbidimeter model HI 93414

The Ultraviolet Spectrophotometric Screening Method (UV-1600PC Spectrophotometer) was used to measure the ions and metals concentration via the colorimetric method with the procedures given below for the respective ions: Ca^{2+} (SM 3500-Ca), Mg^{2+} (SM 3500-Mg), Fe^{3+} (SM 3500-Fe), NO_2^- (SM 4500-NO_2^- B), NH_3/NH_4^+ (SM 4500-NH_3-A), NO_3^- (SM 4500-NO_3^- B), SO_4^{2-} (SM 4500-SO_4^{2-} E), Cl^- (ASTM D512-04 C), $CaCO_3$ (2340 C), HCO_3^- (2320 B), K^+ (SM 3500-K) Na^+ (SM 3500- Na). The organic components were identified by UV-Spectroscopy (Cary 50) at a wavelength of λ=200-800 nm. A quartz cuvette (width 1 cm,height 4 cm, volume 4cm^3) was used in the dies.

COD analysis was performed by adding 2.5 ml of sample 1.5 ml of solution A and 3.5 ml of solution B and placing it in a thermoreactor for 2 hours at 150 °C. Then, having reached room temperature, the sample was analyzed in the spectrophotometer at a wavelength of 660 nm. Solution A was prepared by adding to approximately 500 mL of distilled water 10.216 g of $K_2Cr_2O_7$, primary standard grade, previously dried at 150 °C for 2 h, 167 mL of H_2SO_4 concentrated and 33.3 g of $HgSO_4$; once all the reagents were solubilized, the solution was allowed to cool and after it is completed with distilled water until it reaches 1 L. The solution B was made by adding 10 g of Ag_2SO_4 and 50 ml of H_2SO_4 concentrated and completed with distilled water until it reaches 1 L.

A GS-MS device (GC/FID chromatogram, test method Madep 2019) was used to measure the collective concentrations of extractable aliphatic and aromatic petroleum hydrocarbons in aqueous matrices and soil/sediment. The extractable aliphatic hydrocarbons were collectively quantified in two carbon number ranges: C_9 to C_{18} and C_{19} to C_{36}. Extractable aromatic hydrocarbons were collectively quantified in the range from C_{11} to C_{22} and also THC (total hydrocarbon) are reported. These ranges of aliphatic and aromatic hydrocarbons correspond to a boiling point range of about 150 °C to 500 °C.

2. Experimental details

In the study, parameters characterizing the composition of produced water - pH indicator and temperature, electrical conductivity, TDS, TSS and salinity, turbidity, ions, metals, and the number of organic compounds were measured. Moreover, the absorption bands characteristic of organic compounds were identified by the spectroscopic method.

It was established that the pH indicator in wastewater samples is equal -7.45 and the temperature 23.1 ^{0}C. measured Total Dissolved (TDS) and Total suspended solids (TSS), conductivity and salinity results in table1

Table 1. Total Dissolved (TDS) , Total suspended solids (TSS), conductivity and salinity of samples.

№	PARAMETERS	RESULTS	NORMS
1	Conductivity	29.53 mS	136,000-586,000 mS [10]
2	Salinity	17.7 ppt	0-300 ppt [12]
3	TDS	20.13 g/l	100-400,000 mg/L [12,13,14]
4	TSS	13 mg/l	1.2-1000 mg/L [13]

The analysis of the literature data shows that the permeability of produced water varies in a wide range - 136,000-586,000 mS/cm. The conductivity of the water sample, based mainly on the results of the analysis, is many times smaller than the values shown in this interval.

It has been determined that there are different intervals for the occurrence of TSS. Based on literature data, this parameter is in the range of 14-800 mg/l in some samples and 8-5484 mg/l in others. The results we get correspond to the minimum price of these results. TSS norm of produced water is equal to 1.2- 1000 mg/l [15,16,17,18,19].

Higher salinity results cause the presence of dissolved chloride and sodium mainly as the concentrations of calcium, magnesium, and potassium are usually low [11].

During the experiment, the value of turbidity was determined to be 28.3 NTU.

The COD parameter was equal is 1240 mg/l. The norm of produced water is 1200-2600 mg/l [19-21]. Our results are in line with the norm.

The concentration of ions and metals in the given samples was determined and the values are given in the table below.

Table 2. The ions and metals concentration

№	IONS AND METALS	CONCENTRATİON, mg/L	NORMS, mg/l
1	$CaCO_3$	3600	-
2	HCO_3^-	4178.50	0.15,000 [15]
3	CO_3^-	3600	-
4	OH^-	2040	-
5	Cl^-	11839.25	0-270,000 [16]
6	SO_4^{2-}	65.84	0-15,000 [17]
7	NO_2^-	0.002	-
8	NO_3^-	18.0	-
9	NH^+_4	30.0	-
10	Ca^{2+}	175.0	0-74,000 [18]
11	Mg^{+2}	213.0	0.9-6000 [19]
12	Fe^{+3}	0.15	0.1-1000 [20]
13	Na^++K^+	8668.05	0-150,000 ,24-4300 [21]

As shown in the table, Na^++K^+ , Mg^{+2} , Ca^{2+} , Cl^-, OH^-, CO_3^-, HCO_3^-, $CaCO_3$ says these in a large interval. SO_4^{2-} , NO_2^- , NO_3^-, NH^+_4, Fe^{+3} It says in a fairly small interval.

Extractable aromatic hydrocarbons are collectively quantitated within the C_{11} through C_{22} range. These aliphatic and aromatic hydrocarbon ranges correspond to a boiling point range between approximately 150 °C and 500 °C.

The result of the produced water analysis is shown in Table 3.

Table 3. Amount of identified hydrocarbons

Sample ID	Results	Sample ID	Results
	ug/l		ug/l
(C_9-C_{14})	896	FLT	18.8
(>C_{14}-C_{18})	654	Pyrene	0.0
(>C_{18}-C_{24})	899	B(a)ANT	0.0

(>C_{24}-C_{36})	1894	Chrysene	0.0
Aliphatics (C_9-C_{18})	1550	B(b+k)FLT	55.4
Aliphatics (C_9-C_{18})	1550	B(a)Pyr	0.0
Aliphatics (C_{19}-C_{36})	2793	IND+D(ah)ANT	0.0
Aliphatics (C_9-C_{36})	4343	B(ghi) Perylene	0.0
THC (C_9-C_{36})	**12991**	(C_{11}-C_{22}) Aromatic	8647

As shown in the table, the total oil products in the above samples, he summed up (C_9-C_{14}), (>C_{14}-C_{18}), (>C_{18}-C_{24}), (>C_{24}-C_{36}), Aliphatic (C_9-C_{36}) . The crime rate is much higher than the norm. The norm is the produced water is equal to 2-560 mg/l. [22,23,24]

This shows that the produced water mixes with the extracted oil in a certain amount. It was determined that there are aromatic and polycyclic aromatic compounds in the determining components, and as shown in the table (C_{11}-C_{22}), the concentration of aromatic compounds is 8647 ug/L.

The quality analysis of seamless joints in the mentioned samples showed that absorption bands corresponding to various connections from 200-280 nm were observed. Figure 1 shows the distribution of absorption (abs) values at different wavelengths.

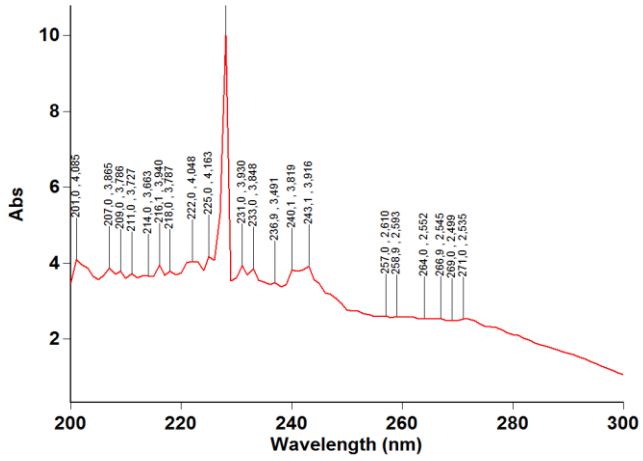

Figure 1. UV spectrum of produced water

It is clear from the graph that the intensity of the peaks is higher at the wavelength of 200-300 nm and the absorption values of the peaks correspond to aliphatic and aromatic compounds such as hexane, benzene, amin groups, toluene, naphthene, chlorobenzene and so on [25].

3. Conclusion

The main compounds in samples were aliphatic (C_9-C_{36}) , aromatic compounds , cyclical aromatic compounds PACs were identifed.

As a result of the chemical analysis of the water sample taken from the SOCAR drilling well, it was shown that the chemical parameters were not exceeding the world standards. The Total among of aliphatic (C_9-C_{36}), PAHs and PAKs were equal 12991 ug/l, 8592 ug/l and 55.4 ug/l , respectively.

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