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Articles

Logical Sequences

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Abstract

The article analyzes logical sequences used in logic and computing. The main objective of the research is to show the relationship between logic, computing and functional expressions. Existence of such connection allows to make a comprehensive analysis of formulas and analytic descriptions. Comprehensive analysis simplifies consistency check of formulas. Existence of relationship between three types of descriptions allows to analyze semi-structured information. The article reveals the contents of a logical sequence used for research. In this article, logical sequence is a general concept related to logic and mathematics.

Keywords: artificial intelligence, logic, logical sequences, linear logical sequences, parallel logical sequences.

1. Introduction

Construction of logical sequences or logical chains (Raev, Tsvetkov, 2018) is commonly used in compiling algorithms and in scientific projects. Construction of logical sequences is used in preparation of doctoral dissertations. When performing research projects, the aim is to conduct sound research and to achieve outcome studies, which refute or prove initial theses. This task is accomplished by constructing and applying logical sequences. When preparing doctoral dissertations, the aim is to conduct sound research and to rationalize new scientific solutions to tasks. Validity of conclusions also requires the use of logical sequences. The essence of logical sequences construction is summarized in this article.

2. Materials and methods

Numerous publications and scientific reports on logic and scientific analysis are used as materials. Mathematical logic and system analysis are used as methods.

3. Results

General Formulation of Research

Logical sequence is a general concept that incorporates a sequence of computations, a sequence of functional transformations and logical chains. Logical consequence (Tarski, 1936) is the most simple logical chain. For this reason, logical consequence is the basis of a logical

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sequence. There are simple and complex logical consequences.

Simple logical consequence is a relation between one premise *A* and one conclusion *B*. Implication (Ebbinghaus et al., 2013) describes a simple logical consequence.

$$A \to B. \ (1)$$

or

$$A_1 \to A_2 \ \ (2)$$

Expression (2) describes information situation (Tsvetkov, 2012), in which state A_1 implies state A_2. Complex logical consequence describes set of transitions of type (2). The simplest logical sequence is expressed with a complex logical consequence. Logical sequence can describe not only transitions, but states as well. In actual practice the system or algorithm can be consistently in different states. Such situation or logical sequence is shown in Figure 1.

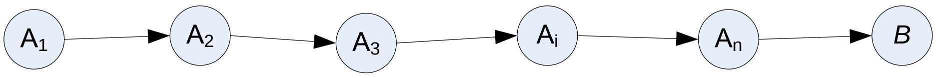

Fig. 1. Logical Consequence

Figure 1 shows a complex logical consequence or a simple logical sequence. Complex linear logical consequence (logical sequence) is a set of relations between a chain of premises A_i and one conclusion *B*. Figure 1 describes expression (3).

$$A_1 \to A_2 \to A_3 \to A_i \to A_n \ \to B. \ (3)$$

Expression (3) describes a logical sequence, or logical chain, or information construction (Tsvetkov, 2014). Expression (1) describes a link of logical consequence or logical sequence.

Practical formation of logical sequence in research includes several steps. The first step is to formulate the objectives of study "*B*". The second step is to define key points of the study. Key points of the study form key states "A_i", which are included in expression (3). These key states are shown in Figure 1 as vertices.

The third stage is the most important one. It involves finding relations and state transitions in expression (3). Here we should emphasize the difference between logical relation and functional transformations. If expression (3) is considered as a logical construction, all transitions between "A" states therein are the same and correspond to relation of implication. If expression (3) is considered as functional consequence, all transitions between "A" states can be different. Each transition can correspond to a specific function. Expression (3) can be written using universal quantifier

$$\forall A_i \,(A_{i-1} \to A_i) \ \ (4).$$

Diagram in Figure 1 has a dualinterpretation. One interpretation exists in the area of mathematical logic, the other lies in the area of functional analysis. In the area of logic diagram on Fig. 1 and expression (3) describe the classical Tarski logical consequence (Tarski, 1936). Semantic notion of logical consequence was introduced by Tarski in 1936.Formal definition of the logical consequence has the following form:

$$(A1, \ldots, An) \models B \ (5)$$

Semantic definition of logical consequence (5) reads as follows: statement B logically follows from premises (A1, ..., An), if it is impossible that statements A1,..., An are true, and statement B is false (i.e. if B is true in any model where A1,..., An are true). The distinctive feature of a logical consequence lies in the fact that it leads from true statements only to true statements.

In the area of computational analysis this means correctness of computations in transition from one function of chain (3) to another function.

$A_i$can be seen as logical formulas in expression (5). In such case there are three conditions for them. 1. There is a set Γ of derivable formulas. 2. There is a subset Δ of derivable formulas. 3. There is a set of formulas *Fm*, which can be either derivable or non-derivable. These conditions are expressed formally as follows:

$$\Gamma, \Delta \subseteq Fm \ ; A, B \in Fm \ (6)$$

If there are initial conditions (6), then there are three properties (7-9) for logical consequence (5).

$$A \in \Gamma \Rightarrow \Gamma \models A \ \ \text{(reflexivity)}, (7)$$

$$\Gamma \models A \text{ and } \Gamma \subseteq \Delta \Rightarrow \Delta \models A, \text{ (monotonicity), (8)}$$
$$\Gamma \models A; \Gamma, A \models B, \Rightarrow \Gamma \models B \text{ (transitivity or separation). (9)}$$

Logical consequence allows to introduce a definition of paraconsistent logic.

Assume that $\models$ is a relation of a logical consequence. Consequence is called explosive, if it meets the condition that for any formulas *A* and *B*, *B* follows from *A* and *not-A*.

$$\{A, \neg A\} \models B. \text{ (10)}$$

Classical logic, intuitionistic logic, multi-valued Łukasiewicz logic and most other logics are explosive. Logic is called paraconsistent (da Costa et al., 1991), if and only if its relation of logical consequence *is not* explosive.

Logical sequence shown in Figure 1 is linear and sequential. There are parallel logical sequences. Parallel logical sequence consisting of two chains is shown in Figure 2.

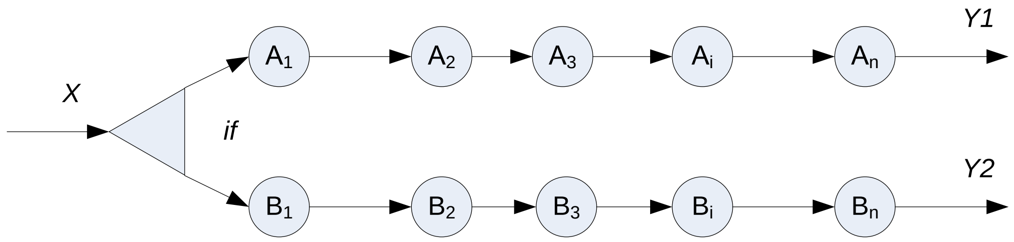

Fig. 2. Parallel logical sequence

There can be any number of parallel chains. Such sequence (Figure 2) is called *acyclic* (Skulrattanakulchai, 2004; Gebremedhin et al., 2007), since there are no cycles in this scheme.

$$X \rightarrow [(\forall A_i (A_{i-1} \rightarrow A_i) \rightarrow Y1) \oplus (\forall B_i (B_{i-1} \rightarrow B_i) \rightarrow Y2)] \text{ (11)}$$

In expression (11) *X* is an array of input data; *Y*1, *Y*2 are arrays of output data. There can be more than two arrays of output data.

There are no such strict requirements for parallel logical sequences as compared to functional sequences. If we consider the diagram in Figure 2 as an example of parallel computations, then additional conditions emerge for it in computing area: synchronization, data race, deadlock (Boyapat et al., 2002). There are no such conditions in the area of logic (Figure 3).

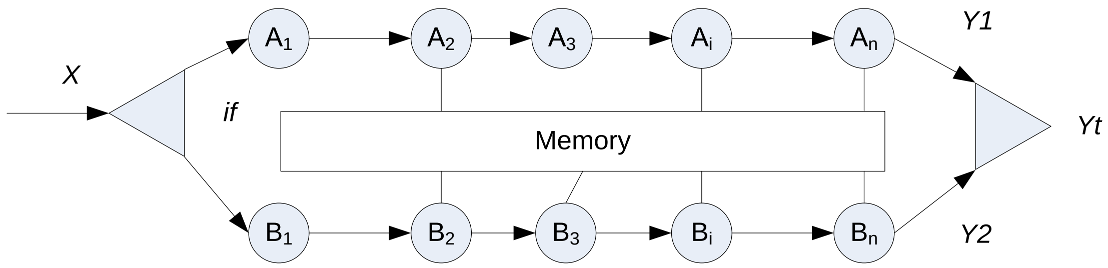

Fig. 3. Logical sequence in parallel information processing

Nodes *A, B* in Figure 3 can be seen as computation modules. Each branch in Figure 3 characterizes each individual processor. If multiple modules of the same program are run on different processors, the need for synchronization of operations emerges. For example, *Y*1, *Y*2 must be obtained simultaneously for transformation into a common array *Yt*.

Therefore, operation of chain *A* must be synchronized with operation of chain *B*. Parallel computing requires careful synchronization of program modules executed by different chains of computations.

Initial branch of input data *X* is called Fork, while aggregation of data is defined as join. There must be Fork/join (Lea, 2000; Lebrecht, Knottenbelt, 2007) sequence for parallel computations. There is no such sequence in logical consequences. This can be explained by impossibility of solving tasks, where uncertainty arises, by means of binary logic. These situations require the use of ternary logic or additional logical sequences. Fork/join sequence eliminates incompleteness of binary logic.

"Data race" (Narayanasamy et al., 2007) problem emerges for multiprocessor computers with shared memory. If processors operate in parallel, they can access the same data simultaneously. These data are stored in shared memory (Figure 3) for both reading and recording. Processors operating in parallel can simultaneously access the same data stored in shared memory. Simultaneous reading does not cause any problems, while recording two different values into the same memory cell is impossible. Recording must be executed on one-by-one basis. Attempt of simultaneous recording of different values into one memory cell causes data race. Computer memory in Figure 3 creates a branch from logical chains *A*, *B*. These branches are directed from each vertex perpendicular to the direction of common logical consequence. Data race problem is one of the most serious problems for parallel programming, because in case of incorrectly organized resource blocking program can be completed with incorrect results.

Deadlock situation (Piroddi et al., 2008). Locking and barring of access to resource for competitors are required in order to cope with data race problem. Competitors mean parallel computing processes. They must interrupt their operation and line up, waiting for release of the resource. Locking is a useful mechanism, which can not be ignored. But locking is also a very dangerous mechanism, which can result in suspension and termination of the program. This situation is called deadlock.

All three problems are not described by binary logic. Therefore, they require additional information structures and expansion of binary logic to ternary logic.

Initial information set X is transformed into a system of interconnected facts, patterns, rules, inferences Y on the basis of logical sequence.

A qualitative difference between input set X and output set Y should be noted. Input set X can be unstructured and unsystematized. Output set Y is structured and systematized. Application of logical sequence structures and systematizes input information.

Eventually, logical sequence creates a knowledge system.

$$Y \rightarrow Kn\ (C, E)$$

This knowledge system includes connections (C) and elements (E). But this system has an area of trueness, which is also determined in the course of research.

Input set is only partially included in the knowledge system. A part of input set falls into "non system". In scientific research, output information is divided into reliable information and information uncertainty. "Non system" is divided into "antagonism" and uncertainty. Antagonism designates the part of information, which refutes research task or is contrary to it. Uncertainty requires further analysis. The area of uncertainty is the source of solutions to new tasks and scientific novelty. As a result, initially formed knowledge system expands with new knowledge resulting from solving new scientific tasks.

Basic logical chain or logical sequence is called a forming chain or sequence. It serves as the ground for evidence base. In addition, there are indirect logical chains with support functions.

For example, in scientific research indirect logical sequence includes a set of figures and diagrams. A set of figures and diagrams is an additional logical sequence, which supports and clarifies the logic of presentation and the logic of evidence.

Indirect logical chain is linked to the construction of semantic space of research area or definitions system. Semantic space generally means a set of organized indicators, which describe a certain content area (Raev, Tsvetkov, 2018). Semantic space of a scientific research means combination of keywords, categories and relations between them, which describe content of the research area.

There is a verbal logical sequence in addition to formal logical sequences. This sequence is called discursive logical sequence.

Discursive logical sequence is conditional upon loss of relevance of the research topic during the period of study. New ideas may appear refuting or changing the author's hypothesis until research is complete. Errors in presentation may occur. This conditions discourse as situational evidence and requires introduction of discursive logical sequence as evidence of hypothesis in the light of new facts.

4. Conclusion

Relevance of scientific research and reliability of the results is related to sets of logical sequences. Logical sequences connect logic, mathematics and computing. Logical sequences have different qualities and perform different functions. Some sequences address structuring and systematization problems. Other logical sequence create substantiation of hypothesis. Still other logical sequences serve as support for the hypothesis. In general, the method of logical sequences can be named as a means of mandatory creation of substantiated scientific research. Set of logical sequences is used for conduct of a comprehensive analysis. The method of logical sequences is the developing area requiring further research and development.

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Information Monitoring of Transport

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Abstract

The article analyzes the information monitoring of transport facilities. Information monitoring is integrated monitoring, which includes geo-information monitoring, geodesic monitoring, space monitoring and mathematical modeling methods. Information monitoring also includes digital and information modeling. The article gives a classification of monitoring objects of transport. It is proved that modern information monitoring of transport facilities should be comprehensive. It is shown that the development of information monitoring is fully consistent with the Transport Strategy of the Russian Federation for the period up to 2030 and is included in the objectives of the development of the transport system of Russia.

Keywords: informatics, transport, management, infrastructure, monitoring, information monitoring, space monitoring.

1. Introduction

Development of the unified transport space of Russia on the basis of balanced development of transport infrastructure is one of the objectives of development of the Russian transport system. This objective was approved by the Transport Strategy of the Russian Federation for the period up to 2030.

The unified transport space of Russia must solve a variety of tasks. These tasks include: functioning of the balanced system of transport utilities; functioning of the integrated infrastructure of all means of transport; application of uniform standards of technological compatibility of various means of transport; harmonization of standards for technical compatibility of various means of transport; creation of the information environment of interaction of various means of transport. Creation of the information environment of interaction of various means of transport increases the value of information methods and technologies. The unified transport space will provide the growth of the Russian economy. It will strengthen the connections between the regions by removing structural imbalances in the transport sector. The unified transport space adds new territories to the economy through establishment of additional transport connections. Information space is the basis of the unified transport space. Information space is created technologically and technically. The information space status is supported by monitoring. Information monitoring is the most important thing for information space.

Information space is created through application of integrated technologies. Such integrated technologies include ground-based and space observation methods. Space technologies are currently contributing to development of various industries (Barmin et al., 2014; Bondur, Tsvetkov, 2015b). This is due to the fact that space monitoring is able to obtain information throughout the

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entire range of electromagnetic waves. Space monitoring technologies allow not only to receive information about objects on the Earth's surface, but also serve as the basis for monitoring and validating of ground-based data. It is important to stress that monitoring technologies are not fragmented, but are a complex, holistic technological system. Technological monitoring system has the property of self check, since it can duplicate information, obtained via different channels. Space methods are essential in global transport control and in support of intelligent transport systems (Wen et al., 2011). Space technologies contribute to creation of the spatial data infrastructure (Coleman, 2010). Development of state-of-the-art transport control is impossible without the use of space technologies and space monitoring. This is due to the space monitoring capabilities, which include (Bondur et al., 2015) greater visibility of space resources and prompt obtaining of information. One space image can replace up to 1,000 images, obtained during the aerial imaging (Savinykh, Tsvetkov, 2001). Space monitoring enables monitoring of the Earth's surface up to 24 times per day. Such space monitoring provides an opportunity for observations in any hard-to-reach areas. Space monitoring enables transmission of information in a wide range of electromagnetic waves to any users. Users of space-based information can be located anywhere in the world. Remote sensing methods are the basis of the space observation technology. Earth's remote sensing methods have proved to be effective over the past decade. Their evolution and adaptation to different tasks and different consumers led to creation of diversified space technologies of observation and research of the Earth's surface. Information monitoring combines space and ground-based technologies.

2. Results

Characteristics of Information Monitoring. Space monitoring has many advantages. However, space monitoring, as a means of information collection, obtains only aggregated, survey and generalized information. Generalized information is a summary survey information of a large volume, but not of a high accuracy. Ground-based methods provide collection of highly accurate information. High accuracy is provided by geodetic methods and photogrammetric methods. Combination of methods of geodesy, geoinformatics and photogrammetry has resulted in the emergence of an integrated geomonitoring (Wagner, 2016). Application of information and mathematical modeling methods has led to the integration of the geomonitoring with the information monitoring. Modern information monitoring is an integrated monitoring, including methods of ground and space monitoring, combined with digital and mathematical modeling methods.

Monitoring includes technological, technical and information factors. Technological factors of space monitoring include the following characteristics: monitoring object, monitoring purpose; monitoring field, monitoring methods, monitoring technologies and monitoring object models. The most important factors are: monitoring purpose; monitoring field; monitoring object; monitoring methods.

There are two types of monitoring object models: a priori model and a posteriori model. A posteriori model is built after conducting monitoring. A priori model is built prior to monitoring, if information about the monitoring object is available.

Monitoring object is located in the area, which affects it (Figure 1). It is the field (not the space) that changes the state of the monitoring object. Different technologies, selection of which depends on the monitoring object and purpose, are used during the monitoring.

Monitoring field is the type of information field (Tsvetkov, 2014b). The set of models, which are used in space monitoring, is large.

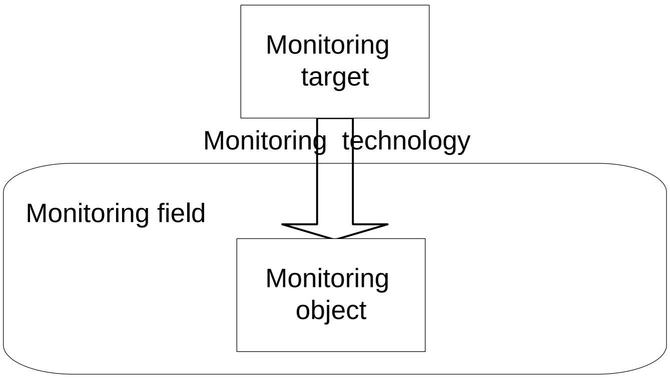

Fig. 1. Monitoring field and object

Information models of objects, processes and situations (Tsvetkov, 2014a), information construction (Rozenberg, 2016) (generalized models of objects and processes), communication models, models of information units, correlative models, models, opposition models and dichotomous models are used during the monitoring.

Figure 2 shows the result of space monitoring, namely railway junction as a fragment of transport infrastructure. This image was obtained in the visible spectrum.

Fig. 2. Fragment of railway station in Burgas, obtained during the satellite imagery
Source: http://earthexplorer.usgs.gov/

This image provides information about the state of the monitoring object. The combination of images allows to identify trends of the state. The combination of images allows to evaluate the results of control over the infrastructure objects.

Information monitoring includes space monitoring. It is used to address a variety of application tasks. It includes: research of the ecological condition of the soil; control of vehicle movement; control of real estate objects; analysis of fire hazardous situation; control of pipelines; control of transport infrastructure.

Monitoring can be considered as three types of complex systems – technological, technical and complex organizational and technical systems. Monitoring, being the complex technological system, provides not only observation, but also systematization of data and results of processing. Information monitoring provides integrated processing and representation of information. Such a possibility is created through the application of geoinformatics methods, which offer data integration.

The generality of monitoring allows to select the channel of electromagnetic waves for an active task. For example, when monitoring a fire hazardous situation, the infrared range is applied (Pereira et al., 2011). For this task, it is a key indicator. Other indicators are applied during the study of the Arctic or Antarctic Territories. Polar night or polar day are typical for low-latitude territories. In the latter case, the bright white background fills in the visible spectrum (Savinykh, 2012). This makes the transition from the visible spectrum to the radio range and the use of high-resolution radar images. The same channel is used in case of intense cloudiness above the surface (Zatyagalova, 2012).

Many transportation problems require the use of integrated monitoring, which includes infrastructure monitoring and monitoring of mobile objects. Technological diagram of diversified (Bondur, Tsvetkov, 2015a) integrated monitoring is shown in Figure 3.

Figure 3 shows that information is obtained in different ranges, for which purpose different types of satellites are used.

Integration of tasks of information transport monitoring results in the need for integration of methods. Special mention should be made of the remote sensing and geoinformatics, combined into a single system.

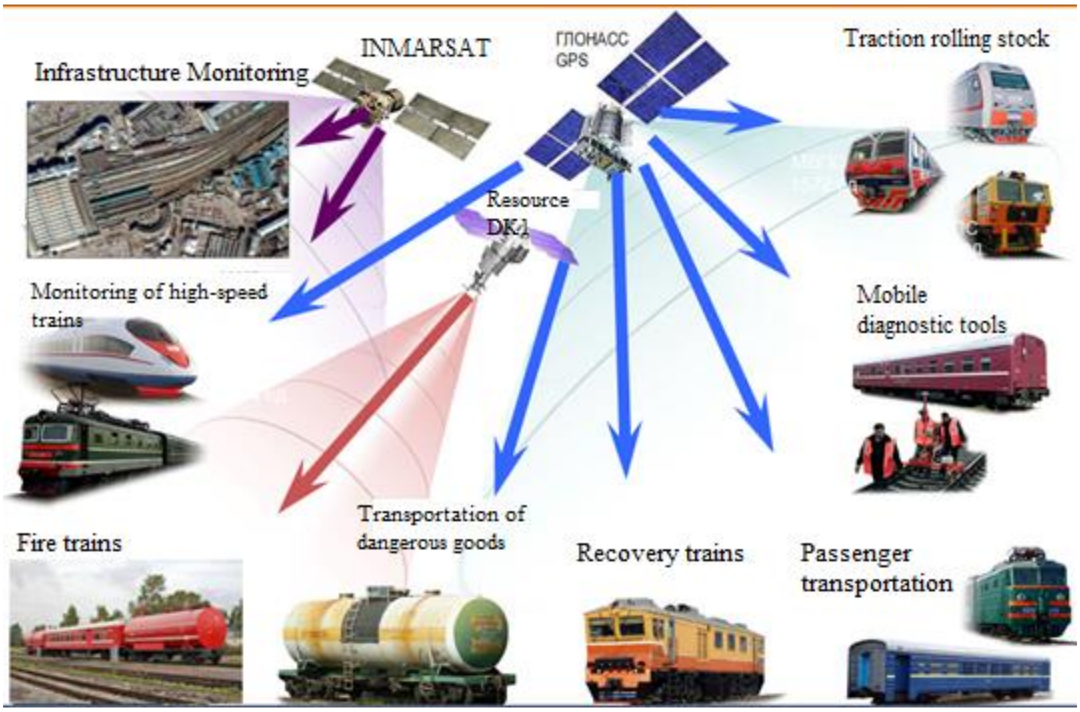

Fig. 3. Information Transport Monitoring

Application of geoinformatics defines the need for selection of geodata as the key data. Geodata is an integrated information base, including social, spatial and time-dependent information. Geodata represents the complementary data system and the information system resource (Savinykh, Tsvetkov, 2014). System resource exhibits characteristics of consistency and integrity. System analysis allows to conduct comprehensive analysis, which is impossible in case of using certain types of monitoring.

Types of Monitoring

The complexity of problems, solvable using the methods of information monitoring, makes necessary not only the use of special data, but also the use of the variety of modeling methods. The use of computer technologies as the primary modeling tool sets the information modelling to be the primary modeling tool in case of transport monitoring. Such modeling can be called common, because it summarizes different types of modeling. Modeling is related to the monitoring types.

Global monitoring is used for observations in terms of the globe. Planetary changes and state of the oceans and seas are studied using global monitoring (Tsvetkov, 2012). Global condition of the soil, flora and fauna dynamics of the entire world are studied using global monitoring. Global environmental monitoring is implemented within the framework of UN programs. Global monitoring is used for the global control of vehicles, which primarily include high tonnage tankers. Global monitoring is used for research of the near-Earth space.

International monitoring is implemented under the joint programs of different countries. It is used to study the phenomena, occurring within the territory of the continent or several countries. International monitoring is used for control of transit traffic.

National monitoring is used to study processes on the territory of one country. This can be the industry-based monitoring or interindustry monitoring.

Regional monitoring is the smaller-scale monitoring. It is used to monitor regional areas, which form separate regions and republics or territorial production complexes. The purpose of this monitoring is to monitor regional transport and traffic within the region.

Local monitoring (monitoring of local zones) is applied to separate large objects (metropolis), and means of transport (Kuzhelev, 2017). Control over the movement of transport objects is the major task for local monitoring. Local monitoring includes installation of on-board signaling units on means of transport. Using the satellite signal, the monitoring system determines the coordinates of the vehicle, that allows to control its movements. The relationship between terrestrial mobile technologies and satellite technologies is worth mentioning. Such monitoring of the route makes possible the real-time identification of vehicle malfunctioning and connects the so-called indicative monitoring.

Local space monitoring is also used for infrastructure monitoring. Metropolis Security program (Homeland_security, 2018) focuses on infrastructure. A modern city has many subsystems, the most important of which is the transport subsystem. All subsystems of the city operate and interact on the basis of the transport subsystem. Space information plays a crucial role for control over the operation of all subsystems.

Information transport monitoring is divided into different groups by the range of electromagnetic waves. They can be listed. Monitoring within the visible spectrum. Monitoring within the infrared spectrum. Radar monitoring. Monitoring within the x-ray range.

3. Conclusion

Development of international transport corridors ensures their competitiveness and efficiency. Information monitoring is required for control of the state of transport corridors. Modern information monitoring of transport infrastructure objects is a new research area, which is being currently developed in the applied aspect. Information monitoring is a broad concept and includes not only monitoring of individual objects, but also their infrastructure, environment and movement situation including forecast of the state of a mobile object. Information monitoring solves a number of important auxiliary problems, such as monitoring of road conditions, fuel consumption, control over operation of the rolling stock, control over transportation of vital cargo. Information monitoring uses a huge number of mathematical and information models, which significantly complicates its synthesis in this area. Information monitoring of transport objects is an integral part of control over the transport and requires further development and research.

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Research and Analysis of the Implementation of the Bearing Sealing Unit for Centrifugal Pumps

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Abstract

Centrifugal sectional pumps (CNS) are used for pumping various liquids having properties similar to water in viscosity and activity, as well as chemically active, abrasive-containing and other liquids. This is one of the most common types of centrifugal pumps used in oil and gas fields for pumping oil and water. They are used at booster pumping stations (BPS), central collection and treatment centers for oil and gas (CSPN), at cluster pumping stations (CPS) for pumping water into productive formations, in water and heat supply systems. The prevalence of pumps is explained by their good adaptation in technological processes with pressure requirements changing in time in pipelines. The sectional design of the pumps, when placed in each section of one stage, allows, although in steps, but at relatively short intervals, it is economical to adapt the pump as close as possible to the optimum head. In comparison, with single-stage centrifugal pumps with comparable technical parameters, CNS pumps have smaller diametrical overall dimensions, dimensions and weights of individual assemblies and parts, therefore they are more convenient to maintain and repair.

Keywords: oil, pump, bearing, assembly, reliability, seal.

1. Введение

Наиболее уязвимыми узлами насосов являются опорно-уплотнительные системы. С целью решения проблем, связанных с недостатками в работе этих двух систем, был разработан опорно-уплотнительный узел. Опорно-уплотнительный узел представляет собой узел для насоса, объединяющий в одном корпусе как опорную, так и уплотнительную системы. Упрощенно конструкция выглядит как разделенное двойное торцовое уплотнение, между уплотнительными ступенями которого помещены два упорных и два радиальных подшипника скольжения.

Конструктивное использование в составе опорно-уплотнительного узла подшипников скольжения совместно с торцовыми уплотнениями дает ряд дополнительных преимуществ опорно-уплотнительной системе:

- отсутствие специальной системы смазки, возможность задействовать имеющуюся систему обеспечения работоспособности торцового уплотнения;
- расположение подшипника в непосредственной близости от торцового уплотнения создает благоприятное рабочее состояние по вибрации;
- применение в качестве пар трения в подшипниках и торцовых уплотнениях одних и тех же материалов с равными, максимально высокими ресурсами.

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В качестве материалов пар трения в подшипниках скольжения используются современные износостойкие материалы: карбид кремния, силицированный графит, углеграфит, карбид вольфрама в различных комбинациях (Майер, 1978).

Опорно-уплотнительный узел изготавливается как по двойной схеме, так и по схеме одинарного торцового уплотнения, возможно использование одинарной схемы с защитной ступенью (при работе на перекачиваемой среде). Затворная жидкость смазывает и охлаждает подшипники и торцовые уплотнения. Для охлаждения затворной жидкости по двойной схеме используется бачок затворной жидкости – аналогично тому, как в торцовом уплотнении.

Применение опорно-уплотнительного узла возможно практически во всех насосах любой марки, так как монтаж и крепление выполняются на существующие посадочные места.

Далее будет рассмотрена конструкция предлагаемого узла.

2. Результаты

Выбор прототипа, физико-химические свойства перекачиваемой среды

Насосы центробежные многоступенчатые секционные ЦНС 300-120...600 предназначены для перекачивания обводненной газонасыщенной и товарной нефти с температурой от 274° К (1° С) до 318° К (45° С) в системах внутрипромыслового сбора, подготовки и транспорта нефти.

Допускается перекачивание нефти с температурой до 333 °К (60° С) при условии применения системы принудительного охлаждения подшипников (ГОСТ Р 54806-2011).

Перекачиваемая нефть должна соответствовать физико-химическим характеристикам приведенным в Таблице 1.

Агрегаты могут применяться для перекачивания воды с водородным показателем pH=7-8,5; с массовой долей механических примесей не более 0,2 %; размером твердых частиц не более 0,2 мм и плотностью не более 1500 кг/м3. Давление на входе в насос 0,05-0,6 МПа (0,5-6 кг/см2) (Паспорт насоса...).

Таблица 1. Физико-химические характеристики нефти

Физико-химические характеристики нефти	Единица измерения	Показатели
Плотность	кг/м³	700-1050
Кинематическая вязкость	м²/с	$1{,}5 \cdot 10^{-4}$
Водородный показатель	pH	7-8,5
Давление насыщенных паров, не более	ГПа	665
Содержание газа (объемное), не более	%	3
Содержание парафина, не более	%	20
Содержание механических примесей с размером твердых частиц до 0,2 мм и микротвердостью 1,47 Гпа, не более	%	0,2
Обводненность, не более	%	90

Конструкция и принцип работы модернизации

Опорно-уплотнительный узел имеет две опоры, которые размещены в крышке всасывания 19 и крышке нагнетания 7 и представляют из себя подшипники скольжения. Внутренние обоймы подшипников фиксируются на валу фиксаторами 40 и поджимаются с рабочей стороны монтажной гайкой 21 и металлическим кольцом 39, а с другой стороны только металлическими кольцами 39. Внутренняя обойма подшипников выполнена со срезами торцевых поверхностей под углом 45° в форме усеченного конуса, металлические кольца 39 и гайка 21 выполнены с ответной, упомянутым торцевым поверхностям внутренней обоймы, поверхностью. Наружные обоймы подшипников 42 расположены во втулках 35 и 23 по напряженной посадке с обязательным подогревом втулок. Наружная обойма подшипников имеет два продольных канала для прохода рабочей жидкости, которые выполнены по внутреннему диаметру обоймы. Рабочая жидкость, проходя через подшипники, по каналам, охлаждает их и образует устойчивую жидкостную пленку. По трубопроводу рабочая жидкость из разгрузочной камеры поступает на торцевое уплотнение 44.

Концевое уплотнение вращающегося вала расположено последовательно за опорой и выполнено в виде плавающего торцового уплотнения. Аксиально-подвижная втулка 29 с удлиненной юбкой расположена в корпусе 24 торцевого уплотнения. Втулка удерживается от проворота фиксаторами 25. Корпус 24 выполнен со ступенчатой внутренней расточкой, в которой расположена пружина 33, выполняющая функцию подвижного упругого элемента. Пружина поджата торцом подвижной регулировочной гайки 26. На вал также устанавливается гладкая рубашка 22 с упорным гнездом, в котором закреплено вращающееся контактное кольцо 44 пары трения. Гладкая рубашка 22 зафиксирована на валу гайкой 32. Корпус поджат поджимным фланцем 28. Вокруг вращающегося вала для защиты от агрессивной среды установлена защитная втулка. Поджимной фланец 28 стягивается шпильками.

Все детали опорно-уплотнительного узла герметизируются от утечек рабочей жидкости маслобензостойкими резиновыми кольцами.

Подшипники и контактные кольца пары трения 44 выполнены из силицированного графита.

Поджимная пружина выполнена с большим ходом и расположена со стороны торцевой юбки. Ход аксиально-подвижной втулки 9-12 мм, что позволяет предохранить пару трения торцового уплотнения 44 от перегрузок при возможном аварийном износе колец разгрузки. (Касаткин, 1984).

Применение в насосах (Рисунок 1) современных высокопрочных и износостойких материалов СГ-П, СГ-Т (силицированного графита) позволило создать вариант экологически чистого насоса, работающего без пропуска жидкости через трущуюся контактную пару торцевого уплотнения. Физико-химические показатели силицированного графита приведены в Таблице 2 (Вишняков и др., 2006).

Таблица 2. Физико-химические показатели силицированного графита

Свойства	Ед. изм.	Марка графита	
		СГ-Т	СГ-П
Плотность, не менее	$кг / м^3$	2300	2200
Предел прочности, не менее - при сжатии - при изгибе - при растяжении	*МПа*	 294,2 88,2 39,2	 411,9 98,1 49,0
Ударная вязкость	$\frac{кДж}{м^2}$	2,75	3,98
Модуль упругости	*МПа*	0,93	1,24
Коэффициент теплопроводности	$\frac{Вт}{м.к.}$	73	112
Коэффициент термического расширения при (20-1000°С)	$10^{-6}\frac{1}{град}$	4,6	4,2
Коэффициент трения		0,05	0,04

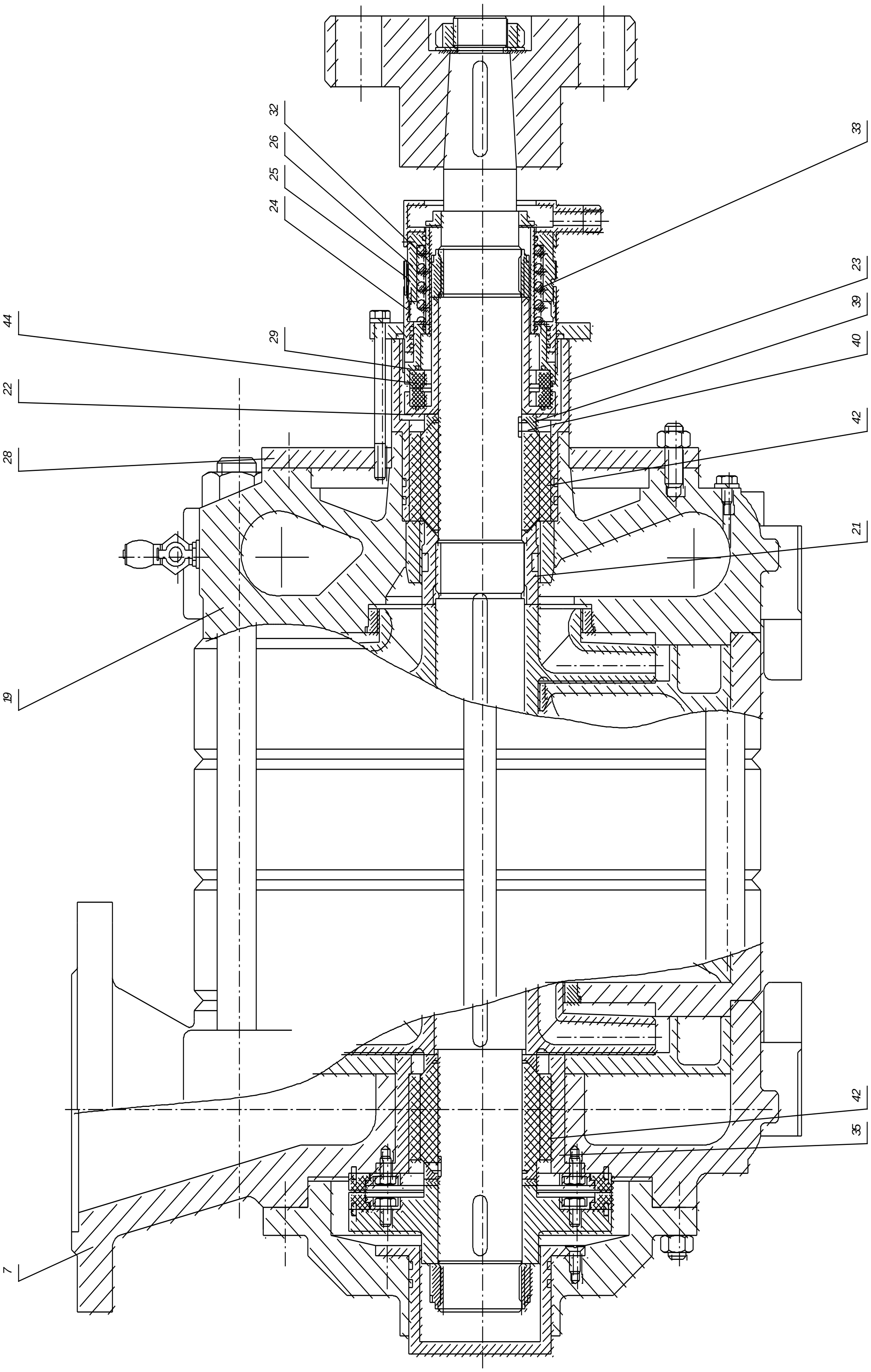

Рис. 1. Насос ЦНС 300-120...600 модернизированный

Соответствие проекта Федеральным нормам и правилам

Согласно требованиям раздела XXIX. «Общие требования к эксплуатации ОПО, технических устройств, резервуаров, промысловых трубопроводов» Федеральных норм и правил "Правила безопасности в нефтяной и газовой промышленности" п.п:

395. Средства аварийной сигнализации, контроля возгораний и состояния воздушной среды, установленные в соответствии с проектной документацией, должны находиться в исправном состоянии, а их работоспособность проверяться в соответствии с заводской инструкцией по эксплуатации по утвержденному в организации плану-графику.

397. На пульте управления насосной станции для перекачки горючих, легковоспламеняющихся и вредных жидкостей должны быть установлены приборы, позволяющие контролировать давление, расход, температуру подшипников насосных установок и состояние воздушной среды в помещении (Федеральные нормы и правила…, 2013).

При изменении базовой конструкции необходимо производить температуру подшипников косвенным методом, то есть производить замер температуры подшипника путем замера температуры перекачиваемой среды на участке установки подшипника скольжения. Температура перекачиваемой среды будет передавать тепловую энергию нагретого критичного элемента на датчик температуры, следовательно на пульт оператора. Рекомендовано применение датчиков типа: NiCr-Ni датчик FTA 131 с магнитной фиксацией на поверхность, NiCr-Ni датчик FTA 026 P с пленочной термолентой.

3. Заключение

Проблема частого и преждевременного выхода из строя упорных и уплотнительных узлов насосов типа ЦНС на сегодняшний день остается актуальной. В данной статье представлен метод решения данных проблем заменой каждого узла по отдельности на один общий. В результате модернизации у насоса повысился объемный КПД за счет сокращения утечек через обыкновенные сальниковые устройства. Так же уменьшился риск повреждения посадочных поверхностей при ремонте или замене подшипников, уменьшилось время на проведение ремонта оборудования.

В данной статье модернизация оборудования соответствует нормам, правилам и государственным стандартам. После выполнения модернизации основные узлы (подвижные и неподвижные) не подверглись изменениям, таким образом, можно сказать, что характеристики узлов и рабочие параметры оборудования не изменились.

Срок окупаемости проекта составит около одного года. Таким образом расчеты показывают достаточно высокую эффективность предлагаемой в проекте модернизации применительно к насосам ЦНС-300 (Курушина, 1998).

Внедрение предлагаемого устройства позволит производить эксплуатацию при более выгодных технологических режимах, что позволит уменьшить число преждевременных отказов и увеличить её межремонтный период. Это позволит сократить количество ремонтных операций.

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Исследование и анализ внедрения блока подшипникового уплотнительного для центробежных насосов

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Аннотация. Центробежные секционные насосы (ЦНС) используются для перекачивания различных жидкостей, имеющих свойства, сходные с водой по вязкости и активности, а также химически активных, абразивосодержащих и других жидкостей. Это один из наиболее распространенных типов центробежных насосов, используемых на нефтяных и газовых промыслах для перекачки нефти и воды. Они используются на дожимных насосных станциях (ДНС), центральных пунктах сбора и подготовки нефти и газа (ЦППН), на кустовых насосных станциях (КНС) для закачки воды в продуктивные пласты, в системах водо- и теплоснабжения. Широкая распространенность насосов объясняется их хорошей адаптацией в технологических процессах с меняющимися со временем потребными напорами в трубопроводах. Секционное исполнение насосов, при размещении в каждой секции одной ступени, позволяет, хотя и ступенчато, но с относительно малыми интервалами, экономично приспособить насос наиболее близко к оптимальному напору. В сравнении, с соизмеримо одинаковыми по техническим показателям одноступенчатыми центробежными насосами, насосы типа ЦНС имеют меньшие диаметральные общие габариты, размеры и массы отдельных узлов и деталей, поэтому они более удобны в обслуживании и ремонте.

Ключевые слова: нефть, насос, подшипник, узел, надежность, уплотнение.

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