European Journal of Technical and Natural Sciences

2024, No 3–4

PREMIER Publishing

Vienna
2024

European Journal of Technical and Natural Sciences

Scientific journal

№ 3 – 4 2024

ISSN 2414-2352

Proofreading Kristin Theissen

Cover design Andreas Vogel

Additional design Stephan Friedman

Editorial office Premier Publishing s.r.o.

Praha 8 – Karlín, Lyčkovo nám. 508/7, PSČ 18600

E-mail: pub@ppublishing.org

Homepage: ppublishing.org

European Journal of Technical and Natural Sciences is an international, English language, peer-reviewed journal. The journal is published in electronic form.

The decisive criterion for accepting a manuscript for publication is scientific quality. All research articles published in this journal have undergone a rigorous peer review. Based on initial screening by the editors, each paper is anonymized and reviewed by at least two anonymous referees. Recommending the articles for publishing, the reviewers confirm that in their opinion the submitted article contains important or new scientific results.

Premier Publishing s.r.o. is not responsible for the stylistic content of the article. The responsibility for the stylistic content lies on an author of an article.

Instructions for authors

Full instructions for manuscript preparation and submission can be found through the Premier Publishing s.r.o. home page at: http://ppublishing.org.

Material disclaimer

The opinions expressed in the conference proceedings do not necessarily reflect those of the Premier Publishing s.r.o., the editor, the editorial board, or the organization to which the authors are affiliated.

Premier Publishing s.r.o. is not responsible for the stylistic content of the article. The responsibility for the stylistic content lies on an author of an article.

Included to the open access repositories:

Crossref eLIBRARY.RU Google Scholar

H – 15 and more than 500 citations in international periodicals and monographs.

INDEX COPERNICUS INTERNATIONAL The jurnal has Index Copernicus Value (ICV) 92.08 for 2022.

The European Journal of Technical and Natural Sciences 2024, No 3–4
ISSN 2414-2352

PREMIER Publishing
ppublishing.org

Section 1. Agricultural sciences

DOI:10.29013/EJTNS-24-3.4-3-6

THE STORAGE TECHNOLOGY OF LOCAL WINTER APPLES IN CONTROLLED ATMOSPHERE STORAGE

Merganov Avazkhon [1], ***Abdullaev Zokir*** [1], ***Halimboev Abbos*** [1]

[1] Agricultural sciences, Namangan Institute of Engineering and Technology

Cite: *Merganov A., Abdullaev Z., Halimboev A. (2024). The Storage Technology of Local Winter Apples in Controlled Atmosphere Storage. European Journal of Technical and Natural Sciences 2024, No 3–4.* https://doi.org/10.29013/EJTNS-24-3.4-3-6

Abstract

Harvest of the locally grown winter apple sorts “Renet Simirenko” and “Kandil Sinap” are preserved in storages annually. To keep apple fruits quality and quantity, different technology of storage should be applied. Worldwide, every year, different types of methods are being applied and researchers are being done as well as in our country. In order to find appropriate method which provides both quality and quantity analysis in three different storages was carried out. Winter apple types “Renet Simirenko” and “Kandil Sinap that have been harvested in the mountainous areas of the Namangan region were analyzed in both pre- and post-harvest period.

According to the research, in three samples that had been stored in three different storages, natural loss of weight varied. In addition, their chemical and biophysiological features altered. These changes were observed under electronic microscope and necessary images were captured.

Keywords: *controlled atmosphere storage (CA), apple, microscope, shelf life, natural loss, reduction, microbalance*

Introduction

Apples are among the most harvested fruits in the world (“Apple production in 2021; from pick lists: Crops / World Regions / Production Quantity”. 2023). Every year millions of tons of apples are cultivated and delivered to consumers worldwide. Apples are mostly consumed after harvest season though some are used commercially to produce food, sweets, juice and so on (“Apple Varietals”. 2017). However, significant part of the apple harvest usually preserved annually. Storing apples in cold rooms helps to keep nutritional value of the fruit. Unlike the other food, fruits continue doing life actions even though they are removed from the tree, such as breathing, metabolism (Zhang W., Jiang H., Cao J., Jiang W., 2021). Shelf life is period of time which product can be consumed. Shelf life varies according to fruit type, condition of storing and physiological features of fruit. There are more than 7500 varieties of apple over the world and these types differ from each other by many

measurements (Elzebroek, A. T. G., Wind, K., 2008). Winter types are group of apples that usually harvested later than others and can be handled easily and stored longer than autumn type. Also, their tissue structure, cells are slightly stronger than other apples which helps to make shelf life longer. Today, most of the apples are stored in modern controlled atmosphere storages where percentage of gases in air are altered (Gary Mount).

Fruit tissues keep breathing and transpiring even after harvested from plant. In storage period, these processes cause weight loss and changes in biological and biophysical features (Kassebi, Salma & Korzenszky, Péter. 2021). Sugars, salts, macro- and microelements in fruit are necessary for human body and it helps people to act healthy life. In addition, water is main part of the fruit and accounts for roughly 70–80% (Vicente A. R., Manganaris G. R., Sozzis G. O., Crisosto C. S., 2009; Stefano Musacchi, Sara Serra. 2018). After harvesting, when storage process begins, changes in fruit start happening and continues until they are consumed. In this period, value of changes is depended on storage technology.

In Uzbekistan, apple is one of the most harvested fruit every year. Most of the harvest is primarily consumed or recycled in factories. The remaining part is usually stored in a traditional way. In northern part of the regions where whether is considerably cool most of the year, farmers keep apples in a storage room with no help of coolers (Merganov Avazkhon, Halimboev Abbos. 2024). This traditional method helps to store apples around 3–5 months. Although outer appearance remains slightly changed, inside of the fruit changes drastically. There are not any measurement equipment or cooling fans, loss of both physical and biochemical cannot be calculated or analyzed.

Materials and methods

In order to study changes that occur during storage, winter types of local apples: “Renet Simirenko” and “Kandil Sinap” were selected and collected mountainous regions of Namangan. After fruit samples were placed in controlled atmosphere storage in Pap, Namangan. Additionally, other storage methods were conducted in laboratory of Namangan Institute of Engineering and Technology. Average fruit sample weight was around 160 ± 10 grams.

In controlled atmosphere storage, samples firstly pre-cooled in order to get the fruit heat out until 2 ºC. Then they were placed to main room with the temperature –0.5 + +1 º C. Relative humidity was 95%. 3 different gas regimes were set in order to find optimal regime for winter apples (N_2 97.4%, O_2 1.4%, CO_2 1.2%/ N_2 97%, O_2 1.5%, CO_2 1.5% / N_2 96%, O_2 2%, CO_2 2%).

In laboratory, the same type of apple samples was put in 2 º C refrigerators. Temperature of storage room chamber was measured by hand thermometer once a week.

Last type of storage type was traditional way of storage where apples were put in cold room with no refrigerator unit or temperature sensor. Temperature of the room changes as weather alters.

Percentage of fruit weight loss was calculated from initial mass minus every monthly fruit weight loss, then compared to the initial weight, changes were given in grams. The measurements were performed in agricultural diagnosis laboratory in Namangan Institute of Engineering and Technology.

Results and discussion

Winter apple types used in the experiment were stored in three different gas regimes in controlled atmosphere, in cold storage and in a traditional way at a room temperature. Weight loss was tracked every month in order to follow ongoing processes. Results were given in a table. During the observation, from every fruit sample, we took pictures of tissue under an electronic microscope.

It can be seen that, between three different gas regimes, in N_2 97.4% O_2 1.4% CO_2 1.2% regime, apples lost the least weight. In three gas chambers, temperature, amount of ethylene gas and relative humidity was the same.

Weight loss kept declining constantly but minimized. Observation lasted eight months, but any changes in apple tissues or other diseases were not observed. “Renet Simirenko” winter apple lost 2.9 grams of its weight during storage, while “Kandil Sinap” ‘s loss was 2 grams.

However, in cold storage and traditional storage, weight loss date was different (Table 2).

Table 1. *Weight loss of winter apples stored in controlled atmosphere storage*

CA storage gas regime	September	October	November	December	January	February	March	April	Difference
Renet Simirenko									
N2 97.4% O2 1.4% CO2 1.2%	137.2	136.8	136.4	135.9	135.6	135.1	134.7	134.3	2.9
N2 97% O2 1.5% CO2 1.5%	137.4	137	136.5	136.1	135.4	135.1	134.6	134.1	3.3
N2 96% O2 2% CO2 2%	137.3	136.4	136.1	135.8	135.2	134.8	134.4	133.9	3.4
Kandil Sinap									
N2 97.4% O2 1.4% CO2 1.2%	116.1	115.9	115.5	115.2	115	114.6	114.2	114.1	2
N2 97% O2 1.5% CO2 1.5%	116.4	116.1	115.7	115.3	114.8	114.4	114	113.7	2.7
N2 96% O2 2% CO2 2%	116.3	115.9	115.4	114.9	114.3	113.9	113.5	113.1	3.2

Table 2. *Weight loss of winter apples stored in cold storage room and traditional storage chamber*

CA storage gas regime	September	October	November	December	January	February	March	April	Difference
Renet Simirenko									
Room storage at 10 °C–20 °C	136.5	130.4	124.9	116.1	110.4	108.5	104.3	X	32.2
Cold storage	120.1	114.8	109.3	105.8	104.2	102.4	101.5	99.98	20.1
Kandil Sinap									
Room storage at 10 °C–20 °C	151.2	144.3	134.5	129.0	124.3	122.2	118.7	X	32.5
Cold storage, 2–3 °C	130.2	125.3	120.8	116.3	115.1	114.2	113.1	111.9	18.3

Temperature played significant role on weight loss in three different methods of storage. In traditional way, after six months apple samples suffered from various changes and diseases and could not be stored after March. Additionally, weight loss date was significantly rose compared to controlled atmosphere storage. Numbers are around 10 times greater than best result for both apple varieties.

References

"Apple production in 2021; from pick lists: Crops / World Regions / Production Quantity". FAOSTAT, UN Food and Agriculture Organization, Statistics Division. 2023. Retrieved 23 April 2023.

"Apple Varietals". Washington Apple Commission. Archived from the original on 2 July 2017. Retrieved 7. December 2017.

Zhang W., Jiang H., Cao J., Jiang W. Advances in biochemical mechanisms and control technologies to treat chilling injury in postharvest fruits and vegetables. Trends in Food Science & Technology. 2021; 113: 355–365. Doi: https://doi.org/10.1016/j.tifs.2021.05.009.

Elzebroek, A. T. G., Wind, K. (2008). Guide to cultivated plants. Wallingford: cab international.–P. 27. Isbn 978-1-84593-356-2. Archived from the original on 20 october 2020. Retrieved 6, october 2020.

Gary Mount. Storing apples. URL: https://www.terhuneorchards.com/storing-apples

Kassebi, Salma & Korzenszky, Péter. (2021). The effect of post-harvest storage on the weight of Golden Delicious apples. Science, Technology and Innovation. – 13. – P. 7–11. 10.5604/01.3001.0015.5265.

Vicente A. R., Manganaris G. R., Sozzis G. O., Crisosto C. S. Nutritional quality of fruits and vegetables. In: Florkowski WJ, Prussia SE, Shewfelt RL, Brueckner B, editors. Postharvest Handling: A Systems Approach. San Diego, CA: Academic Press; 2009: 57–106.

Stefano Musacchi, Sara Serra. Apple fruit quality: Overview on pre-harvest factors, Scientia Horticulturae,– Vol. 234. 2018.– P. 409–430. ISSN0304-4238. URL: https://doi.org/10.1016/j.scienta.2017.12.057. URL: (https://www.sciencedirect.com/science/article/pii/S030442381730780X)

Merganov Avazkhon, Halimboev Abbos. Importance of innovative technology on the storage of apple varieties. Agro Ilm.– Vol. 2. 2024.– P. 31–32.

submitted 04.05.2024;
accepted for publication 18.05.2024;
published 07.08.2024

Contact: abboskhalimboev5@gmail.com

The European Journal of Technical and Natural Sciences 2024, No 3–4
ISSN 2414-2352

PREMIER Publishing
ppublishing.org

Section 2. Biology

DOI:10.29013/EJTNS-24-3.4-7-9

DETERMINATION OF THE EFFECTIVE DOSE OF "SUMAKH FRUIT EXTRACT" IN THE PROCESS OF ARTIFICIAL MUTATION CREATED USING 4-NITROQUINOLINE-1-OXIDE

Guliyev Mahir [1]***, İsrafilova Sabina*** [1]***, Yildirim Leyla***[1]***, Sadiqi İlaha*** [1]

[1] Department of Sitology, embryology and histology, Azerbaijan Medical University

Cite: *Guliyev M., İsrafilova S., Yildirim L., Sadiqi İ. (2024). Determination of the Effective Dose of "Sumakh Fruit Extract" in the Process of Artificial Mutation Created Using 4-Nitroquinoline-1-Oxide. European Journal of Technical and Natural Sciences 2024, No 3–4.* https://doi.org/10.29013/EJTNS-24-3.4-7-9

Abstract

The study evaluated the antimutagenic efficacy of sumakh fruit extract in artificial mutagenesis caused by 4-nitroquinoline-1-oxide (4NQO). The extract was tested on peripheral blood lymphocytes of healthy donors exposed to 4NQO after administration of various doses of the extract. The frequency of chromosomal aberrations in metaphase cells was used to assess antimutagenic activity.

The results showed that the extract reduces the frequency of chromosomal changes in doses from 0.001 to 1.0 mcg/ml, with the greatest effectiveness at 0.01 mcg/ml. Thus, sumakh fruit extract has demonstrated potential as an antimutagenic agent protecting the genome from damage.
Keywords: *Sumakh fruit extract, Antimutagenic activity, 4-nitroquinoline-1-oxide (4 NQO), Artificial mutagenesis, Natural antimutagenic substances*

Introduction

Since the beginning of the last century, the search for correctors of mutation processes of synthetic and natural origin, which have the ability to resist the harmful effects of mutagenic and carcinogenic substances, has continued. In this regard, the search for natural substances of plant origin, as well as artificial substances, is of particular interest.

In the study initiated by us, "Sumakh fruit extract", containing a natural substance of plant origin, was tested in a wide range to determine the effective dose as a modifier under conditions of artificial mutagenesis.

In order to determine the value of genome protection efficiency, the highest dose of antimutagenic activity of sumakh fruit extract under the influence of mutagens differing in their nature, type, mechanism of interaction with hereditary substrates, as well as the initial damage they cause to the DNA molecule was determined.

Some of the studies were conducted on highly developed objects – human peripheral

blood lymphocytes. 4NQO (4-nitroquinoline-1-oxide) was used as a mutagen. In this part of the experiments, the subjects were given test doses of the extract before the mutagen was administered.

The primary culture of peripheral blood lymphocytes from healthy donors, which can be obtained from humans, was used as an experimental model for testing the extract. To do this, the composition includes (1: 3) heparinized plasma (0.1 ml of ready-made Richter heparin solution + 10 ml of donor blood), gelatin-precipitated blood (1 ml of gelatin + 10 ml of blood), ready-made nutrient medium (medium No. 199–3 parts + lactalbumin hydrolysate – 1 part + bovine serum – 1 part, a mixture containing phytohemagglutinin (PHA) (Welcome – 0.1 ml / 10 ml of the mixture), then doses from 0.001 to 10 mcg / ml of the extract were prepared, and after 17 hours, 4NQO (2.5 *10–7 M) was added to the medium of vials containing experimental parts for 2 hours. An hour later, the environment of both variants was replaced with a fresh standard environment. After 24 hours of culture development, 5-bromodeoxyuridine was added to all experimental and control vials at a final dose of 10 mcg/ml and placed in a thermostat. The frequency of changes (aberrations) in the chromosome structure was analyzed by analyzing metaphase cells recorded at the 72nd hour of cultivation. When selecting model mutagens in this part of the experiments, the spectrum of types of primary damage they cause in the DNA molecule was also taken into account. According to the main types of damage caused by 4NQO, cyclobutane pyrimidine dimers, mutational monoadducts and interstrand covalent bonds of the DNA molecule are distinguished.

In experiments on human peripheral blood lymphocytes obtained from a healthy donor, sumakh fruit extract was tested in an environment of artificial mutation of 4-nitroquinoline-1-oxide (4NQO), which behaves like UV rays due to its ability to reparation, replication, as well as artificial mutation, cell death. When analyzing metaphase cells, recording the frequency of changes in the chromosome structure serves as a valuable criterion for identifying the antimutagenic nature of the extract under study.

The results of experiments conducted in studying the frequency of chromosomal aberrations in primary human peripheral blood lymphocyte tissue showed that sumakh fruit extract prevented the formation of structural changes in chromosomes in doses ranging from 0.001 to 1.0 μg/ml. On the other hand, the dose of 0.01 μg/ml showed the greatest efficiency.

Table 1. *Antimutagenic activity of sumakh fruit extract in primary human peripheral blood lymphocyte tissue*

Mutagens	Experience options	Extract dose, mcg/ml	Chromosome aberration frequency M±m	td		P		AEF
				By control	By mutagen	By control	By mutagen	
Control		0	1.83 ± 0.49	–	–	–	–	–
4 NQO	4NQO	0	12.16 ± 1.32	7.33	–	< 0.001	–	–
	Sumakh extract+ 4NQO	0.001	6.11 ± 0.73	4.61	4.01	< 0.001	< 0.001	0.50
		0.01	5.38 ± 0.59	4.61	4.68	> 0.001	< 0.001	0.56
		0.1	6.79 ± 0.78	5.39	3.51	< 0.001	< 0.001	0.44
		1.0	8.15 ± 0.84	6.51	2.55	< 0.001	< 0.05	0.33
		10	9.44 ± 0.99	6.92	1.65	< 0.001	> 0.05	–

Calculation method:

$$M = \frac{n * 100\%}{N}; \quad M = \sqrt{\frac{M * (100 - M)}{N}};$$

$$td = \frac{M_2 - M_1}{\sqrt{M_1^2 + M_2^2}}$$

M – the frequency of mutations; M_2 – the frequency of mutations of the experimental variant; M_1 – the frequency of mutations of the control variant; M_1^2 – error of the control variant; M_2^2 – error of the experimental variant;

$AEF - \frac{i-c}{i}$. $AEF -$ Antimutagen effectiveness factor, i – primary (previous), c – subsequent (determined by dividing the difference between the primary and modified mutation levels by the primary indicator).

n = chromosome aberration. N = all stadied cells.

References

Current Trends and Future Perspectives of Antimutagenic Agents // Journal of Food Chemistry&Nanotechnology. URL: http://dx.doi.org/10.17756/jfcn.2016-01

Muhammad Akram, Muhammad Riaz, Abdul Wadood Chishti Wadood, Ali Hazrat et. all. Medicinal plants with anti-mutagenic potential // Biotechnology & Biotechnological Equipment,– 34:1.– P. 309–318. DOI: 10.1080/13102818.2020.1749527

Muhammad Mushtaq, Bushra Sultana, Farooq Anwar, Sidra Batool. Antimutagenic and Antioxidant po- tential of aqueous and acidified methanol extracts from citrus limonum fruit residues // J. Chil. Chem. Soc.,– No. 2. 2015.

Wang L. E., Hsu T. C., Xiong P., Strom S. S., Duvic M., Clayman G. L., et al. 4-Nitroquinoline-1-oxide-induced mutagen sensitivity and risk of nonmelanoma skin cancer: a case–control analysis. J Invest Dermatol. 2007; 127: 196–205.ы

submitted 13.06.2024;
accepted for publication 27.06.2024;
published 07.08.2024

Contact: israfilovi0506@mail.ru

The European Journal of Technical and Natural Sciences 2024, No 3–4
ISSN 2414-2352

PREMIER Publishing
ppublishing.org

DOI:10.29013/EJTNS-24-3.4-10-14

CHAOTIC BIOLOGICAL SYSTEMS

Mikhail Tokarev [1]

[1] AXIS Consulting, CEO

Cite: *Tokarev M. (2024). Chaotic Biological Systems. European Journal of Technical and Natural Sciences 2024, No 3–4.* https://doi.org/10.29013/EJTNS-24-3.4-10-14

Abstract

At first glance, the movement of amino acids and proteins (peptides) in the cell appears chaotic. How is a clear temporal order maintained, with strict sequential processes following one after another, creating the impression that someone accurately guides them? How does DNA replication occur? On one hand, the model of this replication, using a special protein, DNA polymerase, has been established for a long time. On the other hand, there are still more questions than answers in this process. Due to limitations in measurement tools, cellular biologists cannot answer all questions. In this article, we will attempt to address some of these questions using a systemic approach. The study will also help answer questions about the content and interactions of other proteins in the cell. These answers can then be verified using established biological methods.

Keywords:

Introduction

The DNA model was presented by Watson and Crick in 1953. The model of DNA replication was proposed five years later by Meselson and Franklin (Crick, 1954; Meselson, 1958).

According to Watson and Crick, nitrogenous bases (adenine, guanine, thymine, or cytosine) on each level of one strand are connected by hydrogen bonds to the base at the same level of the other strand. Structural requirements permit only adenine-thymine and guanine-cytosine base pairs, resulting in the complementarity of the two strands.

In this article, we delve into the question of the availability of a sufficient number of nucleotide molecules and proteins for DNA replication and the mechanism of their incorporation into daughter chains. It should be noted that all processes – DNA-DNA replication, DNA transcription to RNA, RNA translation to protein, and reverse transcription from DNA to RNA – operate on the same principle of complementary nucleotide interactions.

Text

Let us review the DNA replication mechanism:

- Unwinding of the double-stranded DNA is carried out by Helicase, at a speed of approximately 100,000 base pairs per minute in prokaryotes, and approximately 500 base pairs per minute in eukaryotes;

- Primase synthesizes the initial segment, the primer, after which the secondary DNA chain will be built;
- DNA polymerase synthesizes DNA by initially binding to the primer, using freely floating nitrogenous bases (adenine, guanine, thymine, or cytosine) in the cell plasma;
- Ligase "stitches" DNA fragments into a single chain after ribonuclease removes unnecessary fragments (primers, etc.) from the chain.

We have omitted many mechanisms that are specific to different organisms or too complex for the purposes of this article and do not affect its conclusions. The accuracy of replication is ensured by the precise matching of complementary pairs of bases and the activity of DNA polymerase, which recognizes and corrects errors. The human genome contains approximately 3 billion pairs of nucleotides, approximately 1.5 billion units of the nitrogenous bases. During the replication of the entire DNA chain (for example, before cell division), the same number of nucleotides must be extracted from the cell's plasma. Nucleotides also play various roles within the cell, including functioning as coenzymes, providing energy, regulating cellular activities, and transporting sulfate and methyl groups. Additionally, they supply the cell with remnants of phosphoric acid. In some cases, RNA can serve as a nucleator.

Many researchers are convinced that DNA not only encodes proteins but also the sequence of various processes. However, this is not actually the case. The processes themselves, their sequence, and the initiation and termination of protein work occur randomly, "chaotically," or more precisely, due to self-organization. In particular, it has been proven that Cooley bodies can form starting from any protein. There is no strictly defined assembly sequence, only self-organization. However, there are structures, such as paraspeckles, that cannot form randomly.

The majority of processes in the cell are controlled by proteins. The proteome inside the cell is very dynamic and depends on many factors, such as the cellular environment, cellular stresses, etc. In turn, the concentration of proteins directly influences the functions carried out within the cell (Brandon, 2017). Researchers have estimated the number of proteins in a yeast cell to be approximately 7.9*10^7 (with a median number of 4.2*10^7). The entire proteome of a yeast cell is estimated to consist of 5858 proteins. Approximately two-thirds of cells contain between 1000 and 10.000 protein molecules, with low-molecular-weight proteins being, on average, five orders of magnitude less abundant than high-molecular-weight proteins. In living cells, organic substances are represented by proteins (10–20%), lipids (1–5%), carbohydrates (0.2–2.0%), and nucleic acids (0.1–0.5%). Thus, the number of nucleic acids in a yeast cell is generally estimated to be between 10^5–10^6 (Овсепян, 2014).

The composition of proteins constantly changes depending on their production from mRNA, participation in processes like replication, and degradation of used proteins (Laurent, 2010), mRNA contains both translated and untranslated regions that play an important role, for example, acting as a timer in protein production. When a ribosome "skips" a stop codon, it gets stuck on the mRNA, preventing the ribosomes following it from continuing to read and produce incorrect proteins from the triplets following the stop codon. This process also appears to be random. However, if it were entirely random, no regular processes could occur in the cell.

Let's provide several definitions that are necessary for further discussions:

Natural system – a model constructed by the subject who investigates the object (elements, relationships, purpose), having integration potential, emergence, and integral properties.

Chaotic system – a biological system in which the sequence of processes is unpredictable, the interaction of elements is random, and the result of its work can be anything.

Ordered system – a stable dynamic biological system that adequately responds to external influences.

In the context of biological systems, there is no difference between chaos and order. Moreover, we assert that order does not arise from chaos (Prigogine, 1984), as chaos itself does not exist. Let's explore this using simple examples.

Consider a closed Thermodynamic system consisting of two hydrogen molecules. Knowing the initial state at time T and the

particles' momentum, we can easily calculate their subsequent movements and interactions. If we increase the number of molecules to 5, using a more powerful computer, we can also calculate the system's state at time T + ΔT. However, if we increase the number of molecules to 100, we would exceed the computational capacity available to humanity to perform such calculations. In this context, chaos is the order that we are unable to calculate, so we are forced to use statistics and probability theory.

Another example: A good hostess has all the necessary tools for cooking, consuming food, and storing it always in the right places on shelves, in cabinets, and in refrigerators. Food ingredients are also always located in the same places. During cooking or eating, people always know where and what to take to perform the necessary functions. The second scenario is "chaos," where all the tools and ingredients are scattered around the kitchen in random order, and the hostess has to search for the necessary tools each time to perform any tasks.

It's impossible to perform processes in a timely and correct manner in such a "chaotic" kitchen. However, if we imagine a kitchen of the future, perhaps all the tools and food ingredients will be flying through the air in a random order and very quickly, so with correct timing the hostess will be able to simply grab the necessary items from the "flying" ingredients to facilitate the cooking (or consumption) process. Perhaps the speed of these processes will be even faster than a scenario in which all the ingredients are in their places, and the hostess has to move around the kitchen to retrieve them from their storage locations. However, in a biological cell, such "chaos" is always organized. How does the cell perform its functions? In a cell, there is no "hostess" who knows what ingredients are needed at what time. Here, chemistry and physics are at work, whose laws are the same on interstellar scales as they are on the cellular level. Specifically, the necessary molecules are preassembled in the appropriate areas of the cell (for example, in the nucleus and nucleoli,) where they move about in a chaotic manner. Past the DNA polymerase, the required nitrogenous bases are constantly "flying through," from which it constructs the DNA's duplicating chain. If this process were carried out exclusively by transport proteins, bacterial cells wouldn't be able to divide every half hour, and eukaryotic cells wouldn't be able to duplicate within the framework of mitosis at the necessary speed.

As a result, the chaotic movement of molecules in specific areas of the cell allows necessary reactions to occur orders of magnitude faster than if they were to occur using transport proteins, which move relatively slowly. An individual molecule can reach any area of the cell within a few minutes. Stable structures are formed from highly dynamic molecules for the duration necessary for interaction (Misteli, 2001). Microtubules aid in the self-organization of cell structures. They randomly assemble and disassemble, creating random structures (networks, whirls, asterisks.) Like all self-organizing systems, structures arise abruptly, not gradually, and different initial arrangements of molecules occasionally lead to the same results. This is due to autocatalysis, autoinhibition, and cross-catalysis (where the concentration of certain molecules can lead to a sharp increase in the production of the same molecules, a decrease in production, or a mixed effect of various molecules.) Biologists know that there is a glycolytic cycle. The fluctuations in the concentration of ADP and ATP are determined by processes that activate ADP and inhibit ATP.

Often, we assume that a biological cell is homogeneous because molecules within it move freely. However, we forget that just as there are waves in space, matter, and energy, there are also waves in the concentration of certain molecules in the cell. It is entirely possible that during DNA replication, local concentrations of the required amino acids arise near DNA polymerase. It is also possible that the concentration of amino acids serves as a driver for DNA replication. The activity of specific proteins during their binding occurs very rapidly, within milliseconds, at most, a few seconds. Upon release, they can remain at the reaction site for a significant amount of time, thanks to these concentration waves. It is important to remember that these are not two-dimensional waves but three-dimensional, volumetric ones. Such states are referred to as "strange attractors" (Prigogine, 1984).

When a cell requires symmetry, it is forced to contend with spatial waves (for example, when pulling chromosomes to the poles before cell division.) To achieve this, the cell uses microtubules, which, in turn, also form and disassemble in a wave-like manner. Thus, the seemingly random movement of molecules, due to self-organization, symmetry disruption, and spatial waves, begins to adhere to strict biological laws. This is how most processes in a living cell occur.

A striking example is the assembly and disassembly of nucleoli depending on the phase of cell division. During the M-phase, the nucleolus is repressed, and its constituent proteins participate in other processes. During telophase, rDNA transcription resumes, and the nucleolus reassembles.

Research on molecular movement inside living cells demonstrates the fundamental possibility of organizing directed movement based on random motions. Stochastic mobility of molecules contributes to the creation of macroscopic order (Misteli, 2001; Арифулин, 20180.

Let's consider another simple example from everyday life. Ask a specific person to imagine a dog. Then ask another person to do the same. The images of the "dog" will almost never exactly coincide between two different people. Why? The cause-effect relationship is straightforward: they were asked to imagine an object, and they imagined an object. However, in reality, the initial conditions for two different people are absolutely distinct. Each person's experience is unique. These questions were extensively discussed by Prigogine in the context of fractal attractors in examples of chemical reactions. The main idea here is that with even the smallest change in initial data, the system ends up in a completely different state, an attractor, and predicting this state seems impossible (Misteli, 2001).

Conclusions

We assert that chaotic motion enables life processes within the cell to occur orders of magnitude faster than in a stable state where cell content remains motionless. DNA polymerase, for instance, cannot swim through the cell nucleus in search of necessary components; it is tethered to the DNA strand itself. Hence, these components must "search" for the precise location where they are needed.

Ultimately, chaotic molecular motion within the cell, along with their concentration, is influenced by both global processes (such as external temperature and illumination,) and minor fluctuations in concentration, spatial arrangement, attraction force, external molecule concentration, molecular movement speed within the cell, concentration auto-oscillations, and so forth. It is crucial to understand that in non-equilibrium states, even a very slight disturbance can serve as a trigger for new processes (cell division, protein production, etc.).

Many significant processes are known to biologists, but we still lack understanding of which "noise" effects affect the cell and how they can act as triggers. When studying processes in living cells, it is necessary to build models that account for all known periodic and non-periodic disturbances of the system. We cannot construct a model in the common variant where the researcher disregards insignificant processes. It is not always possible to suffice with a simple dynamic model.

The main conclusion we reach is that all living things cannot be considered systems because there is no predefined goal and it is impossible to define absolutely all elements and processes, as well as their interactions. On the other hand, when modeling, it is impossible to exclude insignificant processes, elements, external influences, and even quantum processes within living organisms. This paradox cannot be resolved with existing research technologies, but it is possible to significantly expand the model using modern computational power capable of analyzing hundreds and thousands of elements, interactions, external and internal factors.

The second conclusion arising from the systems approach is that the model, which is studied as a system, must constantly change. That is, its structure, connections, external and internal influences must change. This new dimension adds immense complexity to the study of future systems.

Questions for discussion

In practice, it turns out that some proteins or amino acids may appear where they theoretically shouldn't be. Experiments con-

ducted using GFP (Green fluorescent protein) have shown that proteins needed only in nucleoli can not only appear but also accumulate outside nucleoli. Such situations are usually dismissed by researchers as they are experimental errors. However, upon closer examination, it becomes clear that due to "chaotic" movement, these proteins first end up in areas of the cell where they are not used, and then accumulate to perform functions in the cell that researchers are not yet aware of. This is essentially a new area of cellular biology that requires a lot of work from interested researchers.

References

Brandon Ho, Anastasia Baryshnikova, Grant W. Brown (2017) «Unification of Protein Abundance Datasets Yields a Quantitative Saccharomyces cerevisiae Proteome», University of Toronto, Toronto, ON M5S1A8, – Canada. URL: https://www.cell.com/pb-assets/journals/research/cell-systems/cels_384.pdf

Crick F. H.C., Watson J. D., Proc. Roy. Soc. – London, A, 223, 80, 1954.

Laurent Jon et al. (2010). Protein abundances are more conserved than mRNA abundances across diverse taxa. Proteomics. Dec; 10(23): 4209–4212.

Meselson Matthew and Franklin W. (1958). Stahl. The replication of DNA in Escherichia coli (англ.) // Proceedings of the National Academy of Sciences of the United States of America: journal.– Vol. 44.– P. 671–682.

Misteli Tom. (2001). The concept of self-organization in cellular architecture. J Cell Biol, Oct 15; – P. 181–186.

Prigogine I. (1984). Stengers Isabelle, Order Out of Chaos, Bantam.

Yordanova Martina M., etc., (2018). AMD1 mRNA employs ribosome stalling as a mechanism for molecular memory formation. Nature, URL: https://www.nature.com/articles/nature25174

Anokhin P. K. (1973). Fundamental issues of the general theory of functional systems. Principles of systemic organization of functions.– M., "Science",– 5061 p.

Arifulin E. A., Musinova Y. R., Vasetsky E. S., Sheval E. V. (2018). Mobility of cell nucleus components and genome functioning. BIOCHEMISTRY,– Vol. 83.– Issue. 6.– P. 870–882.

Hovsepyan S. V., Bobrova S. N. (2014). Structure and chemical composition of eukaryotic cells. Educational and methodological manual, Gomel, Gomel State Medical University.

submitted 15.07.2024;
accepted for publication 29.07.2024;
published 07.08.2024

Contact: elefant1@mail.ru

The European Journal of Technical and Natural Sciences 2024, No 3–4
ISSN 2414-2352

PREMIER Publishing
ppublishing.org

Section 3. Electrical engineering

DOI:10.29013/EJTNS-24-3.4-15-20

AN ALGORITHM FOR DESIGNING A HYBRID WIND TURBINE WIND WHEEL

Babakhan Shokhrukh Abdilkasymuly [1],
Kokanbay Yernar Zhaksylykuly [1], ***Pernebaev Kuanysh Orazbekuly*** [1]

[1] International Kazakh-Turkish University named after Khoja Ahmed Yasawi

Cite: *Babakhan Sh.A., Kokanbay Y.Zh., Pernebaev K.O. (2024). An algorithm for designing a hybrid wind turbine wind wheel. European Journal of Technical and Natural Sciences 2024, No 3–4.* https://doi.org/10.29013/EJTNS-24-3.4-15-20

Abstract

The paper proposes an algorithm for calculating the design of a hybrid wind-solar installation. By attaching a magnet to the blades of a wind turbine, a magnetic flux is created that depends on the energy of the wind flow. If you attach a solenoid to the mast of a wind turbine, it will be possible to generate additional electrical energy. The paper proposes an algorithm for calculating wind wheels for a hybrid wind turbine.

Keywords: *Algorithm, hybrid wind turbine, generator, solenoid, generation, design*

Introduction

Distributed energy generation systems are hybrid energy supply systems combined from various energy sources that are built in close proximity to consumers and take into account their individual characteristics in terms of power and profile to the maximum extent possible.

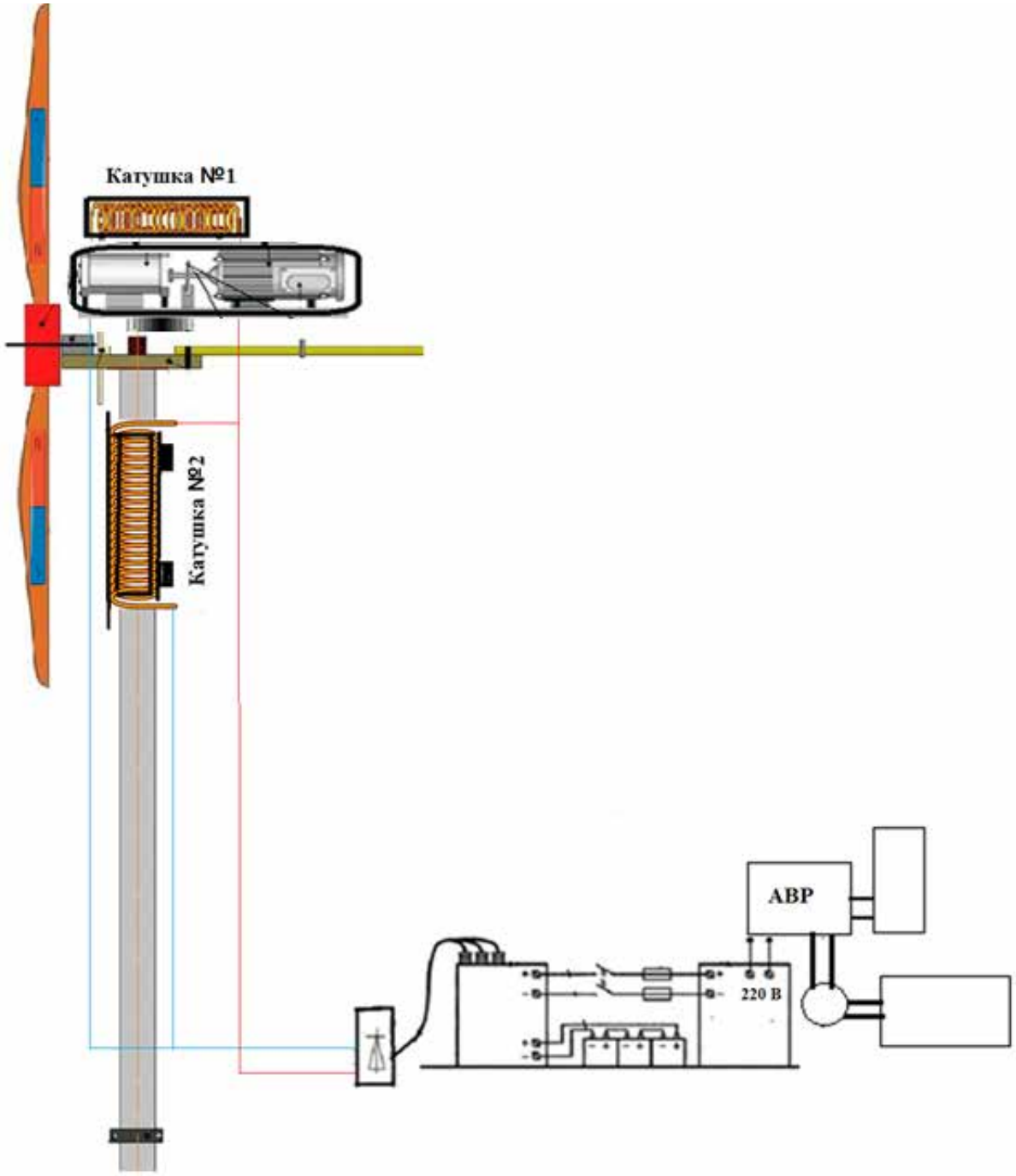
One of the main generating devices of distributed generation is a wind power device. Therefore, currently, with the help of a wind energy device, it is possible to solve energy solutions for remote areas, far from the main distribution lines and places where it is impossible to install large power plants due to environmental problems. This state of affairs requires an increase in the efficiency of the wind energy device. One of the methods to increase the efficiency of a wind energy device is its hybridization.

The purpose of this work is to develop a method of hybridization of a wind energy device and an algorithm for calculating the wind wheels of this installation.

The solution method. To achieve this goal, first you need to design a hybrid wind energy device that works much more effectively than a conventional wind energy device. In (Rustamov N.T., Babakhan Sh.A., Orysbaev S.A., 2020; Rustamov N.T., Meirbekov A.T., Avezova N.R., Meirbekova O.D., Babakhan Sh.A., 2023), such a wind energy device was proposed, in which, in addition to magnetic blades on masts, Solar photopanels

were constructed. Such a hybrid wind power device generates three types of current: alternating current i_1 from the generator, alternating induction current i_2 from coils attached to the masts and above the generator. Interestingly, such an installation will also generate direct current I from a Solar photopanel (Fig.1). The advantage of such a hybrid wind energy device is the efficient use of wind and solar energy.

Figure 1. *Hybrid wind power device*



The algorithm for calculating the power of a hybrid wind-solar installation

Step 1. Determination of the diameter of the wind wheel

The initial data for determining the diameter of the wind wheel are:

– rated power of the wind turbine – N_H

– estimated wind flow velocity – V_B.

When determining the required air flow power (N_p) for a wind generator of a certain power (N_H), it is necessary to take into account the efficiency coefficients of the wind wheel (η_{vk}), wind generator (η_{vg}) and transmission (gearbox) (η_t);

$$N_n = \frac{N_н}{\eta_{вк} * \eta_{вг} * \eta_т} \quad (1)$$

On the other hand, at a known speed, the power of the airflow is determined by the dependence:

$$N_n = \frac{q * W_в}{102}[kW] \quad (2)$$

where: $q = \frac{\rho * V_в^2}{2}$ – is the flow pressure (velocity head)

ρ = 0.125 kg *s^2/m^4 – air density;

$W_в = V_в * S_n$ – second flow rate (m^3/s)

$S_n = \frac{\pi * d_n^2}{4}$ – the area of the airflow bounded by a circle with a diameter of – d_n:

Then, the power of the air flow, limited by a circle with a diameter of – d_n, is determined by the dependence:

$$N_n = \frac{\frac{\rho * V_в^2}{2} * V_в * \frac{\pi * d_n^2}{4}}{102} = 0.000481 * V_в^3 * d_n^2;$$

$$N_n = 0.481 * 10^{-3} * V_в^3 * d_n^2 \ [kW] \quad (3)$$

By equating the right sides of equations (1) and (3), the required diameter of the air flow can be determined:

from: $\frac{N_н}{\eta_{вк} * \eta_{вг} * \eta_т} = 0.481 * 10^{-3} * V_в^3 * d_n^2$

$$d_n = \sqrt{\frac{N_н}{0.481 * 10^{-3} * \eta_{вк} * \eta_{вг} * \eta_m * V_в^3}} \quad (4)$$

If, as a first approximation, we take:

$\eta_{вг} = 0.85;\ \eta_т = 0.94;$

that $d_n = 51 * \sqrt{\frac{N_н}{\eta_{вк} * V_в^3}}$ (5)

Note that the power developed by the wind wheel is higher, the higher its efficiency – η_{vc}

Based on static data, in the first approximation, it can be assumed: η_{vc} = 0.45; Then, the required diameter of the wind wheel equal to the diameter of the airflow can be determined by the dependence:

$$d_n = d_{вк} = 51 * \sqrt{\frac{N_н}{\eta_{вк} * V_в^3}} = 76.026 * \sqrt{\frac{N_н}{V_в^3}};$$

$$d_{вк} = 76.026 * \sqrt{\frac{N_н}{V_в^3}} \quad (6)$$

For the assumed value of the efficiency coefficient, the required power of the air flow can be determined by the dependence:

$$N_n = \frac{N_н}{\eta_{вк} * \eta_{вг} * \eta_m} \approx 2.78 * N_н;$$

Examples of calculations of the diameter of a wind wheel at different capacities of wind turbines and air flow velocities.

Table 1. *Calculation of the diameter of the wind wheel*

No.	$V_в$ m/s	$N_{вг}$ kW	$d_{вк}$ m	$N_{вг}$ kW	$d_{вк}$ m	$N_{вг}$ kW	$d_{вк}$ m	$N_{вг}$ kW	$d_{вк}$ m
1	6	2	7.34	5	11.6	10	16.4	20	23.22
2	7	2	5.8	5	9.2	10	13	20	18.42
3	8	2	4.7	5	7.5	10	10.6	20	15
4	9	2	4	5	6.3	10	8.9	20	12.6
5	10	2	3.4	5	5.4	10	7.6	20	10.8

Step 2. Estimates of the speed of rotation of the wind wheel

One of the main tasks in the design of a wind wheel is the choice of speed, which has the following dependence on speed, diameter and flow velocity:

$$Z = \frac{\omega * r_л}{V_в} = \frac{2 * \pi * n_{вк} * r_л}{60 * V_в} = 0.05236 \frac{n_{вк} * d_{вк}}{V_в}$$

where: $n_{вк}$ – the speed of rotation of the wind wheel (rpm)

$r_л$ – radius of the wind wheel blade

The speed of the wind wheel is the ratio of the circumferential speed of the end of the blade to the wind speed.

Based on experimental data, wind wheels with various $n_{вк}$, $d_{вк}$, $V_в$ it was found that the maximum value of the efficiency of the

wind wheel (pvk.max) is achieved at values Z = (4...6) with the number of blades $n_л$ = = 3 pcs.

For a wind wheel with a speed of Z = 5, the rotation frequency of the wind wheel can be determined by the dependence:

$$n_{вк} = \frac{Z * V_в}{0.05236 * d_{вк}} \approx 19.1 \frac{Z * V_в}{d_{вк}} \approx 95.5 \frac{V_в}{d_{вк}} \left[\text{rpm}\right]$$

Examples of the calculation of $n_{вк}$ for various values of $N_н$ and $V_в$ are presented in (Table No. 2).

Table 2.

$N_н$ kW	$V_в$ m/s	$d_{вк}$ m	$n_{вк}$ rpm	$N_н$ kW	$V_в$ m/s	$d_{вк}$ m	$n_{вк}$ rpm	$N_н$ kW	$V_в$ m/s	$d_{вк}$ m	$n_{вк}$ rpm
2	6	7.3	78	5	6	11.6	49.4	10	6	16.4	35
2	7	5.8	115.3	5	7	9.2	72.7	10	7	13	51.4
2	8	4.7	160	5	8	7.54	101	10	8	10.66	71.7

Thus, in the speed range $V_в$ = (6...8) m/s, the highest rotational speed

$n_{вк}$ =160 rpm correspond to $N_н$ = 2 kW, $V_в$ = 8 m/s, the lowest rotation speed $n_{вк}$ = = 35 rpm correspond to $N_н$ = 10 kW, $V_в$ = = 6 m/s. For the air flow velocity $V_в$ = 7 m/s for a wind generator with a power of $N_н$ = = 5 kW, the rotation frequency of the wind wheel is $n_{вк}$ = 72.7 rpm.

If we take into account that the rotation frequency of the rotor of the wind generator corresponding to the rated power is $n_{вг}$ = = (400... 600) rpm, then, for the wind wheels in question, it is necessary to use a step-up gearbox (multiplier) with a gear ratio from 5 to 10 times.

3. Step Calculation of the available power of wind power devices at a wind speed less than the calculated one.

Depending on the diameter of the wind wheel on the rated power of the wind generator;

so: $d_{вк} = 76.026 * \sqrt{\frac{N_н}{V_в^3}}$;

$$N_н = N_p^* = 0.000173 * d_{вк}^2 * V_в^3; \quad (9)$$

The rotation frequency of the wind wheel can be estimated using the formula (8).

Table 3. *Examples of calculating the available power N_p for a wind power device, with an estimated wind speed $V_в$ = 7 m/s*

$V_в$	N_p^*	$d_{вк}$	$n_{вк}$	N_p^*	$d_{вк}$	$n_{вк}$	N_p^*	$d_{вк}$	$n_{вк}$
m/s	kW	m	rpm	kW	m	rpm	kW	m	rpm
7	2	5.8	115	5	9.2	72.7	10	13	51.4
6	1.25	5.8	98.8	3.16	9.2	62.3	6.3	13	44
5	0.73	5.8	82.3	1.83	9.2	52	3.65	13	36.7
4	0.37	5.8	66	0.94	9.2	41.5	1.87	13	29.4
3	0.16	5.8	49.34	0.4	9.2	31	0.79	13	22

4. Step. The algorithm for calculating the induction current.

Given the characteristics, we find the coils of the coil:

$$\omega = \frac{l_{кат}}{D_{пров}} = \frac{10 * 10^{-2}}{9 * 10^{-4}} = 1.11 * 10^2 = 111 round \quad (10)$$

1. We find the resistance of the wire wound on the coil:

$$R = \rho \frac{l_{wire}}{S} = 1.68 * 10^{-8} * \frac{17.4}{63.5 * 10^{-8}} = 0.46 \left[Ом\right] (11)$$

$$l_{1-round} = \pi * D_{\text{coil}} = 3.14 * 5 * 10^{-2} = 15.7 * 10^{-2} м (10)$$

$$l_{wire} = \omega * L_{1-round} = 111 * 15.7 * 10^{-2} = 17.4 м \quad (11)$$

where ρ – is the resistivity of honey:

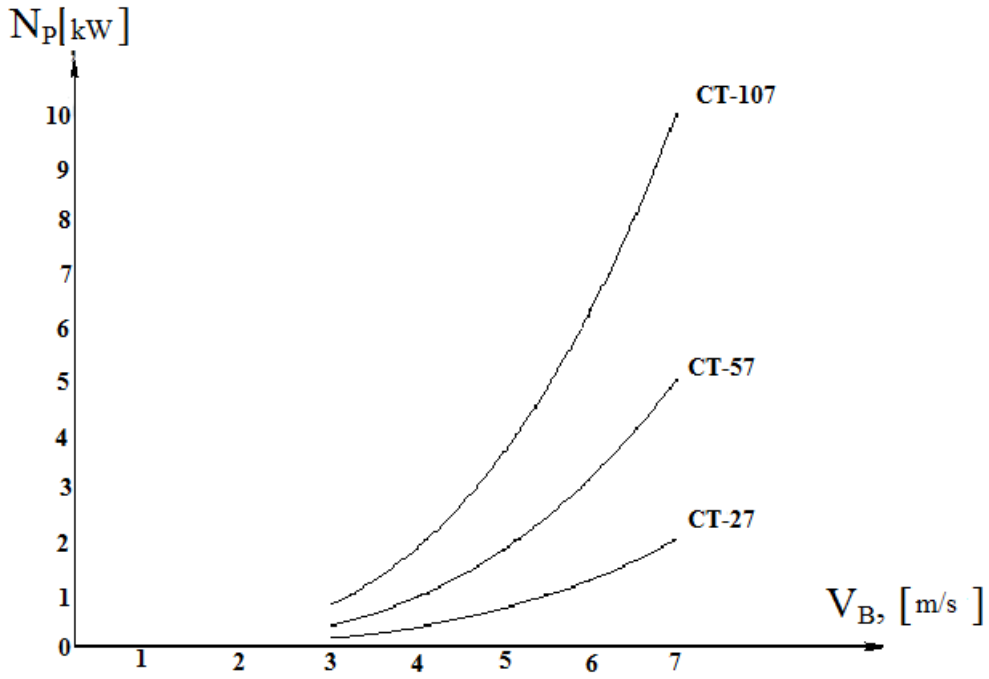
$\rho = 1.68 * 10^{-8}$, l_{wire} – wire length, S – the area of the wire section

2. We find the electromagnetic flux Φ that occurs when the blade rotates with a magnet:

$$\Phi = \rho_{вз} * P_{вп} \quad \left[wb\right] \quad (12)$$

here: $\rho_{вз} = 0.125 \text{кг} * \frac{\text{с2}}{\text{м3}}$ – air density;

Figure 2. *Dependence of N_p on wind speed $V_в$ for wind power devices of different rated power*



5. $P_{вп}$ it is determined from the formula (5):

$$P_{вп} = 0.481 * 10^{-3} * \vartheta_в^3 * D_{вк}^2 = 0.015[kW] \quad (13)$$

wind speed $\vartheta_в = 5м/с$

Diameter of the wind wheel $D = 16 * 10^{-2} м$

6. Putting everyone in their place, we will get:

$$\Phi = \rho_{вз} * P_{вп} = 0.125 * 0.015 = 0.0019\ [Вб] \quad (12)$$

7. We find the electromotive force of the induction coil:

$$\varepsilon = N\frac{d\Phi}{dt} = 111 * \frac{0.0019}{1} = 0.21[B] \quad (16)$$

8. With the electromotive force of induction, we find the current in the wire of the coils:

$$I = \frac{\varepsilon}{R} = \frac{0.21}{0.46} = 0.45\ [A]$$

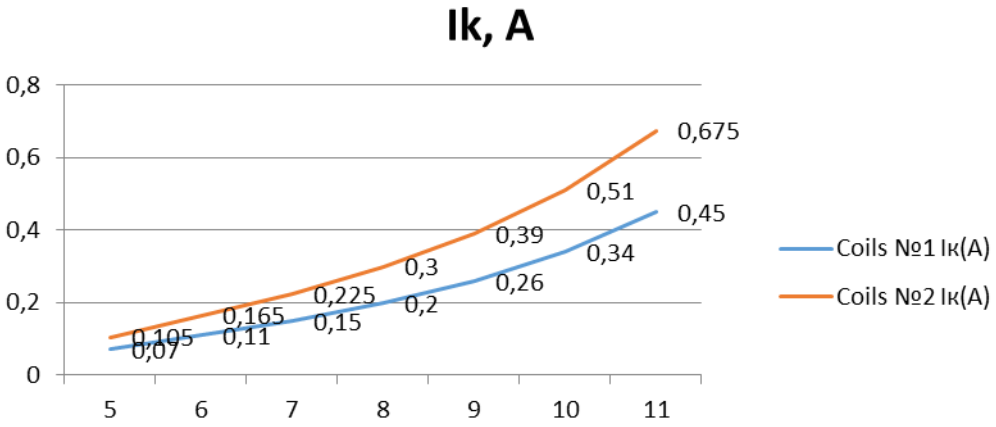


Table 4. *Comparative results of two coils*

Wind speed m/s	Coils № 1 Iк (A)	Coils № 2 Iк (A)
5	0.07	0.105
6	0.11	0.165
7	0.15	0.225
8	0.2	0.3
9	0.26	0.39

Wind speed m/s	Coils № 1 Iк (A)	Coils № 2 Iк (A)
10	0.34	0.51
11	0.45	0.675

Conclusions

The use of hybrid systems based on renewable energy sources is a promising solution for decentralized power supply in rural areas and remote facilities, as well as to ensure the accumulation of excess electric energy, removing peak loads during the operation of seasonally and weather-dependent renewable energy sources of high capacity (wind farms). Which has good coverage of the entire territory with energy networks, hybrid solutions will not be so effective. However, in connection with the long-term program of agricultural development, the construction of agro-towns, new farms, livestock complexes, hybrid technologies should be considered as an alternative to centralized energy supply.

References

Nassim Rustamov, Shokhrukh Babakhan, Naci Genc, Adylkhan Kibishov, Oksana Meirbekov. An Improved Hybrid Wind Power Plant for Small Power Generation. International Journal of Renewable Energy Research N,– Vol. 13.– No. 2.– June, 2023.– P. 629–635. (скопс Q=2)

Rustamov N. T., Egamberdiev B. E., Meirbekova O. D., Babakhan Sh. Hybrid distributed energy generation system. European Journal of Technical and Natural Sciences 1/2023.– P. 37–44.

Rustamov N. T., Meirbekov A. T., Babakhan S. A. Hybrid wind-solar power station. Patent of the Republic of Kazakhstan for utility model No. 7391 dated 19.05.2022.

Rustamov N. T., Babakhan Sh.A., Orysbaev S. A. Single-Stage Power Supply Based on Wind Turbines.– Yekaterinburg. International Scientific Research Journal, 2020.– No. 12 (102).– P. 71–75. Part 1.

Rustamov N. T., Meirbekov A. T., Avezova N. R., Meirbekova O. D., Babakhan Sh. A. Hybrid system for generating thermal and electric energy. Patent of the Republic of Kazakhstan for utility model – No. 7970.– Dated 11/24/2023.

Rustamov N. T., Meirbekov A. T., Babakhan S. A. Hybrid wind-solar power station. Patent of the Republic of Kazakhstan for utility model – No. 7391. Dated 19.05.2022.

Rustamov N. T., Egamberdiev B. E., Meirbekova O. D., Babakhan Sh., Hybrid distributed energy generation system. European Journal of Technical and Natural Sciences 1/2023.– P. 37–44.

submitted 09.05.2024;
accepted for publication 23.03.2024;
published 07.08.2024

Contact: babakhan.shokhrukh@ayu.edu.kz

The European Journal of Technical and Natural Sciences 2024, No 3–4
ISSN 2414-2352

PREMIER Publishing
ppublishing.org

Section 4. Technical sciences in general

DOI:10.29013/EJTNS-24-3.4-21-26

ANALYSIS OF THE PROCESS OF BREAKING DOWN WATER-OIL EMULSIONS OF HEAVY OILS USING THE DEVELOPED LOCAL DEMULSIFIER

***Ochilov Abduraxim Abdurasulovich*[1], *Abdikamalova Aziza Baxtiyarovna*[2], *Salixanova Dilnoza Saidakbarovna*[2], *Uzakbaev Kamal Axmet uli*[1]**

[1] Bukhara Engineering and Technology Institute

[2] Institute of General and Inorganic Chemistry of the Academy of Sciences of the Republic of Uzbekistan, Uzbekistan

Cite: *Ochilov A.A., Abdikamalova A.B., Salixanova D.S., Uzakbaev K.A. (2024). Analysis of the Process of Breaking Down Water-Oil Emulsions of Heavy Oils Using the Developed Local Demulsifier. European Journal of Technical and Natural Sciences 2024, No 3–4.* https://doi.org/10.29013/EJTNS-24-3.4-21-26

Abstract

In this article, samples of water-oil emulsions of local deposits in oil production facilities are studied and their composition and properties are studied. The images of water and salts in the obtained high-viscosity water-oil emulsions were studied using an electron microscope. Also, demulsification of these emulsions was carried out using a demulsifier synthesized on the basis of local raw materials, and the obtained results were compared with export demulsifiers.
Keywords: *dewatering, desalting, deemulsifier, emulsion aging, water globule, armored layer*

Introduction

Currently, the development of oil fields is characterized by an increase in the production of heavy, high-viscosity oils. Such hydrocarbon systems contain heavy components, asphaltene-resin substances and mechanical impurities together with a large amount of water. Their presence significantly complicates oil production processes, especially dehydration processes. In addition, during the processing of high-viscosity oils, intermediate layers (salvat layer) are formed, which are characterized by a very high resistance to decomposition. These layers can accumulate in the settling equipment, which causes the complete oil purification process to be continuous.

Also, one of the main sources of environmental pollution as a result of man's man-made activities is oil extraction and oil processing industries. Due to emergency situations, as well as during the production

activities of oil extraction and oil refining enterprises, a lot of oil waste accumulates.

Methods

During the operation of oil fields, the formation of permanent water-oil emulsions, their properties change over time and depend on many factors. With long-term storage in open embers and reservoirs, the stability of such systems increases significantly. This happens due to the «aging» of emulsions, the compression and hardening of armored shells in water droplets over time, the evaporation of light fractions, the decomposition of petroleum products, the increase of mechanical impurities due to atmospheric dust, etc.

The processing of oil waste is considered a complex technical and technological task, which is primarily caused by a stable oil emulsion with a large amount of mechanical impurities. Its main task is to separate into three parts: water, mechanical compounds and hydrocarbon parts.

Like any pollutant, refinery waste also has a negative impact on the environment. Oil waste belongs to the 3rd class, it disrupts the natural balance in ecosystems, another negative effect on the environment is the adaptation of solar radiation. In the process of this phenomenon, gas exchange and evaporation processes are disturbed. .

Traditional methods of heavy oil preparation (dewatering, desalination) in field conditions can be done using thermal, chemical and their combined methods, as well as electric field methods. However, their acceleration, which is necessary in such cases – increasing the temperature of oil processing, increasing the doses of flow-selective reagents-demulsifiers, increasing the strength of the electric field – leads to a significant increase in the cost of the oil preparation process.

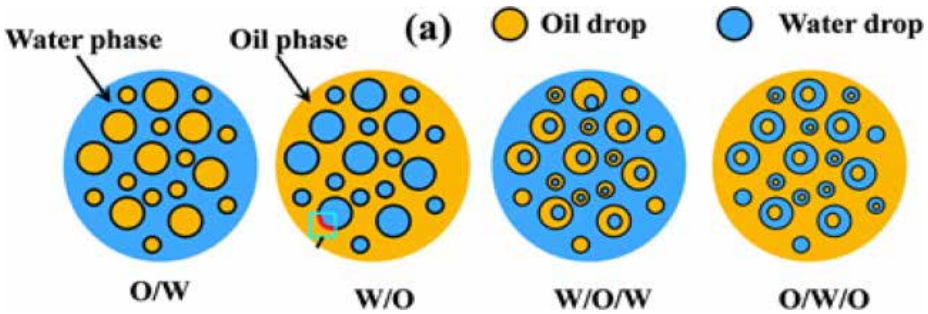
Various methods are used to break oil emulsions, each of which has its own advantages and disadvantages. These methods are characterized by high capital and operating costs and the unstable effects of breaking emulsions. Therefore, the improvement and development of existing effective methods for the separation of oil emulsions are urgent tasks.

Water-in-oil emulsions are one of the few problems directly related to the oil industry. The presence of a large amount of emulsified water increases the cost of transportation of crude oil, increases corrosion and causes other types of additional technical services. These emulsions are stabilized in the presence of asphaltenes. When the emulsion is stabilized, the water-oil emulsion is difficult to separate into phases. When a water-oil emulsion rises to the surface and is poured into production facilities, the formation of an emulsion increases the cost of oil production.

The stability of most oil emulsions increases with time. During the aging of the emulsion in water globules, the emulsifier layer increases and, accordingly, its mechanical strength increases. When such globules collide, they do not come together due to the presence of a strong hydrophobic film. To combine the water globules, it is necessary to destroy this film and replace it with a hydrophobic layer of any surfactant. Aging of emulsions continues intensively only in the initial period after their formation, and then slows down significantly.

Emulsions commonly used in crude oil production include oil-in-water (o/w), oil-in-water (w/o) emulsions, oil-in-water-in-oil (o/w/o) and water-in-oil-in-water (w/o/w) emulsions. A complex emulsion is also called a multi-emulsion. Four types of emulsion are shown in (Figure 1).

Figure 1. *Types of emulsions*



A water-in-oil emulsion is a type of emulsion in which the continuous phase is usually hydrophobic materials such as oil, and the dispersed phase is water. More than 95% of water-in-oil emulsions are inverted emulsions. The "aging" characteristics of the inverse emulsion depend on the composition and properties of oil, water sources, conditions of emulsion formation (temperature, intensity of phase mixing).

The main properties of oil emulsions include the degree of disintegration over a certain period of time, the effective (in some cases structural) viscosity, the average diameter of the emulsified droplets of the aqueous phase. Together, these parameters reflect the intensity of the oil emulsion, its physical and chemical properties, and the adsorption of the emulsifier.

Emulsion decomposition intensity can be estimated by the difference between water and oil densities ρ_d as well as the ratio of the total content of asphaltene (a) and resins (s) to the content of paraffin (n) in oil (a+s)/n. The last indicator determines the method of emulsification of oil emulsions. The indicator ρ_d orresponds to the driving force of gravity sedimentation. Both indicators are quality characteristics of emulsions, which allow them to be divided into groups.

Depending on the density ratio of water and oil, emulsions are classified as difficult to decompose $\rho_d = (0.200 - 0.250\ g/sm^3)$, decomposable $\rho_d = (0.250 - 0.300\ g/sm^3)$ and easily decomposed $\rho_d = (0.300 - 0.350\ g/sm^3)$. According to the (a+s)/n indicator, oils are divided into types: mixed ((a + s)/n = 0.951–1.400); resin ((a+s)/n = 2.759–3.888); and high pitch ((a + s)/n = 4.774–7.789).

Results and discussion

In our research, we took 6 water-oil emulsion samples from local heavy high-viscosity oil fields and studied their composition based on existing methods and standards, and the results are presented in (Table 1) below.

Table 1. *Composition and description of samples of water-oil emulsions*

Sample	Density kg/m³	Viscosity (20°C) Pa*s	Paraffin quantity,%	Sulfur quantity,%	Asphalten, %	Salt, mg/l	Watering%
Sample 1	990	35.3	5.97	4.9	14.5	11330	84.7
Sample 2	947	30.1	3.85	3.5	8.8	470.5	77.7
Sample 3	973	32.3	4.52	2.33	7.9	7000.5	83.9
Sample 4	953	29.7	4.69	3.6	7.4	762	80.6
Sample 5	946	33.2	5.94	3.81	7.3	888.96	82.1
Sample 6	963	30.1	3.78	4.55	8.9	762.02	80.9

As can be seen from (Table 1), the studied samples are heavy oils that require deep purification in terms of hydration, viscosity, sulfur and salt quantity. Also, as a result of extraction of these oils from the well with the help of pumps, a complex water-oil emulsion is formed.

Viscosity oils are emulsions the main task of the cracking process is to separate water and oil into separate phases. In the process of breaking down emulsions, it consists in destroying the outer shell of the contained water globules. To prepare oils for industrial processing, the speed and efficiency of the stage of breaking up of emulsions is of great importance. Nowadays, it is important to choose the appropriate equipment, effective demulsifiers and technological regimes to optimize the processes of dewatering and desalination of oils.

A chemical cracking method was used to break up water-in-oil emulsions of high-viscosity heavy oils. For this, the demulsification process was carried out in laboratory conditions at a temperature of 60°C with the TKM-1 demulsifier synthesized on the basis of local raw materials at a consumption of 90 g/t.

The role of demulsifiers acting on emulsions of high-viscosity oils is that they break up the emulsifiers surrounding the water globules and precipitate them. We used an electron microscope to study the mechanical compounds, salts, etc. that cause the stability

of various types of stable emulsions of local oils.

In order to determine the efficiency of demulsification, the images of water-oil emulsions of samples 1 and 3 before demulsification and after demulsification were obtained using an electron microscope with optical indicators of brand NLCD-307B (made in Czechia). Conducting electron microscope studies of emulsions of high viscosity oils provides an opportunity to obtain more information about them.

Of course, with a small error, particles of water globules are visible, that is, evenly distributed. The obtained results are presented in Figure 2 below, where it is possible to see the localization of high viscosity oil emulsions and water globules.

Figure 2. *Electron microscope view of highly viscous water-oil emulsions before the demulsification process*
A) sample 1; B) sample 3

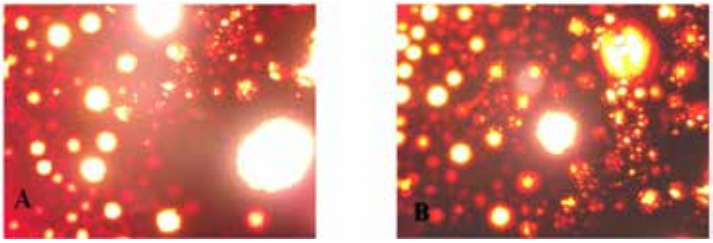


Figure 2 shows water and salts in water – oil emulsions imaged under an electron microscope the most complex of the obtained samples (a) sample 1 at 20 °C (a) sample 3 at 20 °C you can see the temperature state (b). It is observed that the additives in the oil act as an emulsifier and surround the dispersed phase of the emulsion from the outside.

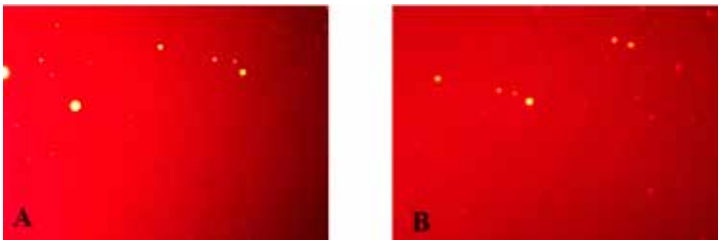
Taking them into account, based on the properties and stability of emulsions, emulsions the task of removing stabilizers separately is set. In the process of hydrodynamic action and in the presence of surfactants, mechanical mixtures with a hydrophilic surface are well wetted with water and transition to the aqueous phase (washed) due to the increase in the concentration of the mechanical mixture.

The result of removing mechanical impurities in the oil (highly dispersed mixture, asphaltene, tar, iron sulfide, etc.) is the formation of water globules in emulsions. there is an opportunity to reduce the surface tension force and the process of coalescence is observed in water droplets.

In recent years, various chemical reagents have been added to oil wells to facilitate oil extraction and processing processes, which affect the formation of stable emulsions.

The conducted studies show that it is effective to describe the external structure of water -oil emulsions of local high-viscosity oils using the electron microscope method. Currently, demulsifiers and non-traditional methods are used to break down the outer shells of water globules in emulsions and collect the water droplets in the emulsion. Also, the amount of water remaining after the demulsification process at high consumption of demulsifiers can be seen in (Figure 3).

Figure 3. *Electron microscope view of high viscosity water-oil emulsions after demulsification process*
A) sample 1; B) sample 3



As can be seen from Figure 3, a certain amount of water and salt remains after the process of demulsification of water-oil emulsions. In order to break down emulsions at the desired level, it is necessary to use a high demulsifier consumption or use other cleaning methods.

Deemul gator is one of the main technical and economic indicators of the processes of dewatering and desalination of WOE of especially heavy oils.

We analyzed the amount of residual water after the deemulsification process of water-oil emulsions at a temperature of 20 °C in laboratory conditions, and the obtained results are presented in (Table 2) below.

In practice, the selection of demulsifiers for breaking down water-oil emulsions of highly hydrated oils is carried out experimentally to determine the optimal technological regimes (temperature, mixing speed, demulsifier flow, etc.) for this process.

Table 2. *Experimental results of demulsification of WOEs of local oils with synthesized TKM –1 and existing demulsifiers DEKS-017 and SNPX-4410*

WOE fields	Emulsion hydration,%	Type of demulsifier	Demulsifier consumption, g\t	Separation time, min	Amount of residual water in oil,%
Sample 1	88	DEKS-017	90	30	11
Sample 1	88	SNPX-4410	90	30	9
Sample 1	88	TKM-1	90	30	6
Sample 3	81	DEKS-017	90	30	10
Sample 3	81	SNPX-4410	90	30	7
Sample 3	81	TKM-1	90	30	4

As can be seen from (Table 2), the proposed TKM-1 demulsifier is more efficient than the currently used demulsifiers. But these indicators are not at the level of the standards set for the preparation of oil.

In addition, the more complex the composition of stagnant water-oil and oil-slurry emulsions, the more difficult it is to break them up even with a large amount of demulsifier. Or it is necessary to carry out the demulsification process under temperature, that is, to carry out the chemical method by thermochemical method.

It is known that an increase in temperature usually has a positive effect on the demulsibility, so we studied the effect of this factor on the stagnation time. The experiments were carried out when TKM-1, SNPX-4410 demulsifiers were used in the amount of 0.01% of the total weight of the broken emulsions. From Table 3, the study was continued at the temperature of all emulsion samples from 20 °C to 80 ° C.

If we compare the previously known SNPX-40 deemulsifier, compared to TKM-1 deemulsifier, it is possible to reduce the residence time by 0.5 hours.

Heating of stable water emulsions under industrial conditions is associated with significant energy and material costs. Therefore, water-oil emulsion decomposition experiments are conducted at a temperature of 60 °C.

Table 3. *Time-dependent effect of temperature on the process of decomposition of water-oil emulsions*

The temperature is °C	WOE demulsification time, minutes	
	Sample 1 SNPX-4410 (control)	Sample 3
20	72.0	80.0
40	65.0	60.0
60	55.0	52.0
80	45.0	48.0

The temperature is °C	WOE demulsification time, minutes	
	Sample 1	Sample 3
	SNPX-4410 (control)	
	Demulsifier TKM-1	
20	45.0	48.0
40	30.0	35.0
60	25.0	30.0
80	15.0	17.0

Conclusion

Residue after cracking of water-oil emulsions in North Ortabulak oil production facilities with developed demulgators the amount of water serves as one of the important indicators of the success of the demulsification process. In demulsification process, it can be seen that the breaking time of emulsions decreases with increasing temperature. That is, if we heat the emulsions from 20 ° C to 80 ° C during the deemulsification process, the time for the 1st sample was shortened from 45 minutes to 15 minutes, for the 3rd sample from 48 minutes to 17 minutes. Also, after breaking down, the amount of residual water in the water-oil emulsion is reduced.

Therefore, in this case, import substitution based on domestic reagents allows to reduce the cost of products obtained in oil producing enterprises and improves their quality.

References

Тронов В. П., Грайфер В. И. Обезвоживание и обессоливание нефти.– Казань: 1974.– 184 с.

Капустин В. М., Рудин М. Г. Химия и технология переработки нефти.– М.: Химия, 2013.– 495 р.

Nour A. H., Pang S. F., Nour A. H., Omer M. S. Demulsification of water-in-grude oil (W/O) emulsions by using Microwave radiation // Journal of Applied Sciences: – Vol. 10 (22): 2010.– P. 2935–2939.

Ochilov, A., Sattorov, M., Yamaletdinova, A., & Bokieva, S. (2021, September). Reduction the viscosity of oil-slime emulsions of heavy oils using gas condensate. In *IOP Conference Series: Earth and Environmental Science* (Vol. 839, No. 4, p. 042082). IOP Publishing.

Ochilov, A. A., Abdurakhimov, S. A., & Adizov, B. Z. (2019). Heavy oils of Uzbekistan and their stable oil-water emulsions. *Universum: technical sciences,– (9 (66))*.

submitted 10.05.2024;
accepted for publication 23.05.2024;
published 07.08.2024

Contact: ochilov82@mail.ru

Contents