Scientific and Educational Experiment in the Engineering Training of Students in the Bachelor's Degree Program in Energy Production

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***Abstract:** In the paper, the experience of the teachers of the Department of Physics, working with the students of the Yelabuga Institute of the Kazan (Volga) Federal University of Russia and organizing educational and scientific experimental activity in the engineering training of students in the Bachelor's degree program in energy production for the system of institutions of secondary, secondary special and additional education of the Republic of Tatarstan, is presented and analyzed. The research on the wide introduction into the educational process of automated research experiments was conducted on the basis of the Faculty of Mathematics and Natural Sciences in 2016-2018. Altogether 112 students, future holders of the Bachelor's degree in energy production, participated in the study. The students themselves participated in the designing, manufacturing, and upgrading of the experimental equipment. In the process of research, both theoretical and empirical methods were used: analysis of regulatory and program documents, scientific and educational literature on the problem under study, realization of research projects in the field of physics and energy production, as well as the introduction of innovative and digital technologies in the preparation and realization of educational experiments. A conclusion is made that the approach under study fosters an increase in the interest in the subject, intensification of the training process, individualization of its character, improvement of the quality of mastering the educational material.*

***Index Terms**: About four key words or phrases in alphabetical order, separated by commas.*

I. INTRODUCTION

In recent years, in the system of secondary vocational and higher education in Russia, a tendency has become more and more apparent of training specialists using both traditional and innovative educational, scientific and technical, informational and digital technologies. The main indicators of the country's development, as well as cooperation with foreign partners in the field of basic education, power engineering and the system of training of professionals, are growing especially rapidly. It is in these fields that traditions and innovations play an important and decisive role [1]. Russian and foreign scientists note that the system of education and training can be used to manage the reserves of the society, to organize the technology transfer from science and education to manufacturing and backwards, which leads to improvements in the economic and social life of the society [2, 3].

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This is manifested most prominently in the realization of engineering training of the Bachelor's degree program students of various technical specialties, each of whom must possess not only professional competencies in a certain narrow field but also deep knowledge and skills in the adjacent fields of activity [4-6]. For example, this may be organization of teaching physical and power engineering disciplines at institutions of secondary special education (SSE), which include carrying out scientific research and physical-technical experiments [7, 8].

Such transformations have been observed for a rather long time at all levels of education, including the system of preschool, school and extra-curriculum training and upbringing [9, 10]. However, this is especially strongly manifested in the activity of institutions of secondary professional and higher education, the radical changes in which (especially, in the area of introducing digital technologies) have been taking place especially intensively in recent years [11].

Among senior schoolchildren, SSE students and higher education students of Russia, traditional competitions are organized in the knowledge of the basics of blue-collar jobs, professional skills, participation in the city, district, republican, all-Russian, international Olympiads, volunteer movement, public organizations, research groups and associations [4, 12].

Quite naturally, participating in all these transformations under the supervision of their senior tutors, pedagogues, teachers, and scientific researchers, modern youth aspire to demonstrate their high level of knowledge and interest in the future scientific research work. It is also important for them to convince their supervisors about the presence of high professional qualities, practical knowledge, skills, abilities, as well as the abilities to work in a creative team, in a working or educational collective.

Thus, in a person's activity, responsible attitude to the activity, learning, people, nature, society, ability to take upon him/herself leadership responsibilities and many other qualities come to the fore. Moreover, presently such work covers by its influence the people of most different age groups and categories:

pupils, students, junior specialists, and even pensioners. The goal of the present paper is generalization and analysis of the experience of the teachers of the Yelabuga Institute of the Kazan Federal University (EI of KFU) of Russia in the realization of the practice-oriented approach in the realization of engineering training of students in the Bachelor's Degree program in energy production. At the foundation of this approach, there is a wide usage of educational and scientific experiments, the larger part of which is realized by means of modern IT technologies.

II. METHODS

The research on the realization of the practice-oriented approach, based on the wide introduction of research experiments into the educational process, was carried out on the basis of the Faculty of Mathematics and Natural Sciences by the Yelabuga Institute of KFU in 2016-2018. Altogether 112 students, future holders of the Bachelor's Degree in energy engineering, took part in the research.

In the research process, theoretical and empirical methods were used. Among the theoretical methods, there is analysis of program documents of higher education and literature on the problem under study. The empirical methods include analysis of the effectiveness of the contact (classroom-based) and out-of-class interactive forms of training, applied by the authors of this study; the psychological and pedagogical methods of information gathering (pedagogical observation, questioning, analysis of the results of students' creative activity). Modern IT technologies were used for managing educational and scientific experiments, as well as to automate the processing of the obtained results. A separate area was the computer simulation of a number of physical processes.
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III. RESULTS AND DISCUSSION

Analysis of the pedagogical experience of the Republic of Tatarstan, in which the teachers and students of the Yelabuga Institute of KFU actively participate, shows that the entire many-faceted work in this direction should be considered as a modern high-technology educational-upbringing scientific-research process, where the main role belongs to organization of various kinds of academic lessons in natural science, humanities, psychological-pedagogical and social disciplines. In particular, an important place in this process belongs to the methodology of studying the analog and analog-digital electronic devices and courses of teaching physics as a science.

First of all, the approach to teaching physics is changing, both as a school and a university discipline, in which teachers play an active role, regardless of the length of work in their educational institution. The status of a higher education teacher changes significantly, the range of his/her professional and public duties expands.

For instance, to popularize knowledge in physics, mathematics, computer technology, and various other school subjects, open lectures, science evenings, demonstration experiments, and other types of public activities are held. To carry them out, pupils of senior classes, technically gifted schoolchildren, and students of institutions of secondary special education (SSE) are invited, under the guidance of their senior mentors, researchers, as well as junior, secondary, senior students of pedagogical higher education institutions, other educational institutions, and their parents.

In the experience of the Yelabuga Institute of KFU, such directions of work where university teachers implement their higher mission include, for example, classes at the "Children's University", the summer health improvement camp "Intelletto", evenings of science and technical creativity, master classes with school teachers and pedagogues of institutions of secondary special education (SSE) [4, 8]. All this radically changes and updates the activities of the leading scientific departments and faculties of the Institute.

In recent years, in the activities of the YeI of K(P)FU, the Department of Physics is gradually turning into an inter-institutional structural unit, successfully working with the Department of Informatics of the Faculty of Mathematics and Natural Sciences, as well as with the Engineering-Technological and Biological Faculties. The experience is accumulating of such interaction with the Departments of Physical and Primary Education, Pedagogy, Psychology, and, in the perspective, of Pre-School, Out-of-School Education and a number of others. The centers of such work are research laboratories and the creative initiative of all participants in the pedagogical process.

A number of directions of work are successfully implemented on the organization of research experiment in preparing future Bachelor Degree holders to carry out full-scale work in the system of school, specialized secondary and additional education, the content of which is not only updated (while preserving the best traditions), but also completely innovative. This is most clearly manifested in the example of student training in the Bachelor's Degree program in energy production, which, in the authors' opinion, requires a more detailed description. Several directions of work can be identified there.

The first direction is connected with the technologies of conducting demonstration experiments, physical experiments and laboratory classes for schoolchildren of various age groups, especially senior pupils and students, deeply studying physics and the related subjects as educational disciplines of natural science and mathematical cycle, as well as general electrical engineering and electronics. As is known, the demonstration experiment is considered to be one of the most important components of teaching natural sciences (biology, chemistry, astronomy, etc.), and especially physics, the studying of which continues in a number of professional educational institutions of a technical profile or at the relevant departments of secondary and higher educational institutions.

Moreover, studying physics at schools, professional colleges, lyceums and even at a higher education institution is based on the research of a number of physical phenomena for the purpose of obtaining vivid (often demonstrational) training material concerning the physical laws earlier revealed by scientists. Here the vividness, demonstration, experiment, and their analysis provide the possibility to master more deeply, quickly, and, above all, with a higher quality the studied material, promoting, at the same time, increasing interest in the studied subject. It helps to understand more difficult issues of any science, the experience of the theoretical and practical solution of more difficult experimental problems.

Besides, the physical experiment often acts as the basis for obtaining and fixing new knowledge, skills, the formation and development of creative, technical, research abilities for any person, irrespective of his/her age, including the area of development of modern energy generation [13].

Moreover, the organization of the demonstrational (individual, group or mass) physical experiment in front of pupils familiarizes schoolchildren, students with the scientific approach to cognizing the physical phenomena from the world around in an available, vivid, highly technological form. This also includes studying the operation of modern equipment and mechanisms, the organization of technological processes in the oil and gas industry, the sphere of production, the organization of people's activity, supporting their health and wellbeing in the society.

Here it is also important to note a fact that the demonstrational experiment is, in essence, the justification of various theoretical statements of the course of physics, other exact sciences and the disciplines connected with them. For example, it concerns energy production, the development of microelectronics, radio engineering, information and computer technologies. Here a set of statements, illustrating on concrete experimental data the scientific and technical justification, applications of the concrete facts of physical laws, promotes the development of scientific views, beliefs, judgments, conclusions, developing concrete knowledge, abilities, skills, professional competencies of pupils and students.

On the other hand, the personal interest of the teacher of physics is observed. To increase the interest of pupils, students to studying rather difficult subject domains, and, hence, to achieve good results in mastering laws, regularities, he/she has to widely use an experiment and also demonstrational classical and modern laboratory equipment. This fact is also reflected in the new requirements of federal state educational standards, the content of which is radically updated once in several years.

As the authors' experience testifies, for pupils of secondary schools and SSE, for example, it may concern the issues of modern sources of electrical energy, ways of obtaining alternating and direct current, their transformation, opportunities of conversion, use, increasing efficiency, decreasing the production cost, etc.

Obviously, on the basis of these technical and technological ideas, it is possible to develop a system of creative tasks of different levels of complexity, for example, the organization of demonstrational experiments on creation of a chemical DC power source, extension of the service life of salt batteries, use of solar electric power, the wind power or Peltier elements, use of Tesla coils and many other.

Ultimately, all this prepares pupils of any age group to the organization of independent kinds of experimental research; while, in reviewing the educational material, the analysis of the experiment results enables pupils to more clearly reproduce in memory the earlier studied material, go deeper into the essence of physical phenomena and regularities. A deep and comprehensive analysis of the performed work also allows noticing the features and properties of the studied objects which earlier escaped from attention.

The second direction of work concerns the organization of scientific experiments in training students in the Bachelor’s Degree program in energy production, connected with regional features, deepening of informatization of society and transferring of education to digital technologies.

Indeed, in modern society, a global process of informatization, computerization, and introduction of digital technologies takes place, which influences all spheres of the modern world; it has already become traditional and, at the same time, has an innovation character. As for the informatization of society, transition of education to digital technologies, it has become in recent years one of the priority directions of development of modern society, the essence of which is the active (sometimes excessively hasty, persistent and even aggressive) implementation of new technologies, technical means of training in the general development, formation of the identity of the person, process of his/her training and professional formation. At the same time, the attitude of society to these processes is very contradictory.

First of all, it concerns the questions of using the computer programs, which help to solve the everyday, scientific-technical and applied academic tasks and creative research problems in various areas of knowledge.

Undoubtedly, introduction in the educational process of various information technologies, on the one hand, opens wide opportunities for increasing the efficiency of the educational process, and, on the other hand, significantly narrows the field for individual development of the person, first of all, memory, thinking, speech, abilities to think, analyze, desires to create with own hands, etc. [14-17].

In view of the fact that informational and digital technologies have started to enter fairly recently the educational field and the area of everyday psychological-pedagogical, hi-tech research, one sees that the need for considering the practice of application of various computer programs, which help to solve various applied problems, is becoming crucial in training future Bachelor’s degree holders. In particular, it concerns, for example, studying the problems on the use of computer programs for the correct solving of applied didactic tasks (examples, problems, specific situations) in physics and energy manufacturing in different types of educational institutions. This defines the purposes and tasks of research work.

In general, they can be outlined in the form of a chain of specific consecutive steps, for example, the steps of implementation of a roadmap. It includes:

Step one. Based on the analysis of scientific, educational literature and electronic sources, one studies the possibilities of application of computer programs in the practice of work of the concrete person (secondary school student, student, teacher, junior (young) scientist-experimenter).

Step two. Analysis (compilation) of computer programs, the practice of their usage in the training, educational and scientific processes.

Step three. Identification of the features of using the computer programs applied to solve educational or practice-oriented tasks relevant for the person of this or that age, their strengths, weaknesses and social risks.

Step four. Studying (refreshing knowledge of) programming languages or mastering technologies of operation of microcontrollers (machines with program control, programmable robots mechanisms) and other types of modern programmable devices.

As a rule, having formulated the problems, one can define the object, the subject of research, realizing them in the subsequent steps of the proposed roadmap.

Step five. Suppose that one has as the object of research (the first case) the solving of applied tasks (problems) while studying the school course of physics at institutions of SSE [18-25].

Then the methods of using computer programs for performing physical and mathematical calculations, experience, ways of their implementation in solving applied tasks while studying (or teaching) physics as a scientific discipline and also for the output of the obtained information to paper and (or) digital carriers become the object of research.

In this case, the essence of the organization of research experiment in training of the students in the Bachelor's degree in the energy production program, involving pedagogical dimension, can include the choice of methods of the research organization.

Step six. Analysis of scientific, educational literature, the Internet resources, materials of search engines, regulatory documents, and the developed program material.

Step seven. Studying the opportunities of the program material, the existing textbooks, educational, reference books, scientific publications (on certain subjects) of the teaching community and wide categories of scientists.

Step eight. Collection and generalization of the obtained results in the form of practical and scientific-methodical recommendations. It can be: videos, presentations, term and final qualification papers, as well as scientific papers, educational and methodical guides, monographs and many other things.

Step nine. Improvement of the mechanisms of training, based on the development of the choice of methods of selecting the educational-didactic materials, the ways of their usage in the process of training and upbringing of the pupils of various age groups and each individual person.

Step ten. Creation of favorable psychological-pedagogical and didactic conditions, the character of work of the entire class, individual groups, pupils and teachers with the final orientation of the process of training directed to the improvement of the results of intellectual, creative development of each personality.

Step eleven. Prevention of social risks connected with using information and digital technologies (psychological, gaming and selfie-dependences, oncological, cardiovascular diseases, etc.). This problem concerns all age groups of world's population, along with the need of each person for quality food and clean air, their orientation to a healthy, reasonable way of life or abilities to carry out various research activities.

Step twelve. Systematic and continuous (annual) updating, improvement of working plans, programs of training the educatees and educator, their work documentation and also use of various (systematic) types of control and assessment of the level of quality of knowledge of trainees. Surely, this step most of all affects the activity of the professional pedagogical community.

It includes:

1) Change in the processes of memorizing and assimilation of the training material, checking the gained knowledge in the operating, training or final modes of activity of the educational institution, with significant saving of time;

2) A vivid, dynamic, figurative, sound, colorful representation of the training material and efficiency of keeping all types and forms of documentation (electronic diary, journal, session transcript, etc.);

3) Individualization of the process of training and upbringing of personality, a high degree of objectivity of control, self-checking, analysis, diagnostics, assessment of results of training, level, quality of professional competencies, knowledge, and skills of pupils or students;

4) Promptness of reproduction of the training material, the creation of more favorable conditions for the organization of educational, scientific experiments on the basis of implementation of computer technologies;

5) Finally, the creation of a bank of reference and other types of data for solving the didactic, practice-oriented and research problems, formulated in the process of organization of educational and creative types of activity.

The third direction of activity is connected with modernization, improvement and updating scientific and experimental work of students pursuing a Bachelor's degree, their educational, independent, creative and other types of academic activity, connected with the measurements of physical quantities characterizing the operation of technical devices and carrying out technological processes.

As is known, the most important among them are measurements of the pressure of gas, time, speed and temperature [26-34]. Such work has to be carried out often on the classes in physics, power engineering, the organization of work of creative research groups and youth associations.

It should be noted that the range and conditions of measurement of temperature can be absolutely different, which, in turn, provides wide opportunities for carrying out learning sessions, the approbation of various educational technologies in the activity of SSE of the power manufacturing profile.

As an innovative idea, the authors offered students to investigate a very practical (at the first sight) scientific problem on the topic: "Arrangement and principles of operation of digital sensors of temperature, the methods of their studying in the course of physics at SSE institutions".

Here, as the research object, there acts a device (system) of semiconductor, digital temperature sensors, the principles of their work and also modern educational technologies applied during classes in physics, electrical technology and other related subjects at SSE institutions. The study subject is the technique of organization of classes in physics (radio-electrical equipment, digital technologies) when studying temperature sensors with pupils of secondary professional education.

The purpose of such work is studying the arrangement and operation principles of the digital sensor of temperature and methodical aspects of studying this topic in the physics course at SSE institutions.

To achieve the formulated goal, it is important to outline the circle of research tasks. Among them, there can be:

1. Studying modern engineering devices (equipment) and explanation of the principles of operation of semiconductor temperature sensors, analysis of their technical capabilities and ways of classification;
2. Description of the general characteristic of modern educational technologies applied in SSE in studying semiconductor (digital) temperature sensors;
3. Justification of technologies of the organization of the educational-upbringing

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process during the classes in physics, electrical equipment, and other subjects in studying semiconductor, digital temperature sensors, revealing the essence of methodical means and training methods, by the example of the laboratory practical work [35-37].

Proceeding from these positions, the content of technology of teaching a course of physics, within the main provisions of modern educational standards (fundamentals of electrodynamics, magnetism, electric oscillation, etc.), can include such directions of the student's work under the guidance of the teacher as:

1. To a question of measurement of physical quantities: from theory to practice, including the background knowledge, the generalization of the best practices, etc.; main characteristics of the temperature sensors, their types, functions, features of work;
2. Semiconductor, digital temperature sensors, specifics of their application in science, modern technology and in the manufacturing. Analysis of specificities of the organization of the educational-upbringing process with pupils at SSE institutions of the power manufacturing profile;
3. Formulation and solution of specific educational-didactic and research tasks during the classes with pupils of SSE of different age groups (from the first to fourth year of study) when studying the temperature sensors.

Thus, the innovative search and approbation of modern educational technologies are carried out (lectures, seminars, laboratory practical classes, tests, etc.) when studying sensors of temperature at SSE institutions for future power engineering specialists, the pupils of profile classes and groups.

IV. CONCLUSIONS

The experience of development and practical use of a number of automated measuring complexes for carrying out educational-research experiments allows making the following conclusions.

1. Laboratory or experimental installation has to be arranged in the classical style, i.e. has to meet the conditions of setting a classical experiment.
2. Computerization of the physics experiment has to be followed by methodical recommendations, aimed at the improvement of results on the intensification of the process of training itself.
3. Rearrangement of standard experimental installation has to be minimal, so that the possibility of its work in the original form is not lost.
4. In view of the shortage and high cost of the special equipment for linking experimental installation to the computer, it is necessary, when possible, to look to the devices included in the installation.
5. The interface blocks have to be designed with the minimum use of constituent elements, so that a university graduate having average radio-engineering skills could make, if required, independently or with pupils, the devices developed by the authors.

In particular, such approach allowed, without changing the structural diagram of carrying out standard laboratory research, carrying out additional original experiments on studying the temperature dependence of resistance (conductors, semiconductors), the Hall effect, and others.

Modernization of laboratory works on mechanics is connected, first of all, with the development of the corresponding sensor (converter), allowing entering the necessary information from the laboratory installation to the computer. While manufacturing this device, the authors focused on the minimum use of peripheral supplemental equipment (power supplies, measuring devices, etc.), the maximum use of opportunities and speed of the developed unit. To create such a unit, the authors chose the idea of using the optical sensor realized in the Mouse manipulator.

The developed complex is intended for carrying out laboratory and demonstration works on physics (the section of mechanics). Its main advantage consists in that it allows quantitatively studying and verifying the basic fundamental laws of mechanics.

For sure, the introduction of digital equipment into educational, research and demonstration experiment promotes deeper studying of the subject and consolidation of theoretical training material. In particular, this is in accord with the conclusions of the paper [38] that modern education has to be organized in the paradigm of "training through research, heuristic cooperation, and creative discoveries".

The use of a computer in an educational experiment solves a number of topical problems connected with the training of the creative personality of a future teacher of professional education. First, practically, it always increases the interest of the trainees in the subject as a scientific discipline, in the methods of teaching. Secondly, the use of computer equipment shows the modern methods of work of the experimenter. Thirdly, it allows investigating the physical phenomena inaccessible for studying on the traditional educational or laboratory equipment.

The use of a computer as an element of the experimental installation is especially effective for studying fast processes, measuring time dependences of various physical quantities, processing of big data arrays and also for the creation of experimental technological installations operated by means of a modern computer.

As practice shows, the introduction of automated systems into educational process allowed intensifying the training process, individualizing its character, improving control of assimilation of the training material and also increasing students' interest in the studied subject.

The gained experience, materials of the studies can be used for upgrading standard laboratory equipment at institutions of basic and vocational education and also become a basis for the organization of out-of-school classes in technical creativity. The development, manufacturing, and tuning-up of the automated measuring installations and complexes intended for carrying out educational and research experiments can be carried out in the framework of performing the end-of-year and final qualification (diploma) works.

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REFERENCES

1. Canning, M., Moock, P. and Heleniak, T. Reforming education in the regions of Russia, World Bank technical

paper no. 457, Washington DC: The World Bank, 2009.

2. European innovation scoreboard 2008 Comparative analysis of innovation performance. European Communities, 2009. Available: https://ru.scribd.com/document/28203023/European-innovation-scoreboard-2008-Comparative-analysis-of-innovation-performance
3. OECD. Quality Time for Students: Learning in and out of school, OECD Publishing, 2011. Available: http://dx.doi.org/10.1787/9789264087057-en
4. Samedov, M. N. O. et all. *Biosciences Biotechnology Research Asia*, 12(3), 2015, pp. 2711–2722.
5. Shurygin, V. Y. and Krasnova, L. A. *International Journal of Environmental and Science Education*, 11(8), 2016, pp. 1743–1751.
6. Krasnova, L. A. *Astra Salvensis,* 5 (10), 2017, pp. 307–314.
7. Essel, D. D. and Wilson, O. A. *International Journal of Information and Communication Technology Education*, 13(1), 2017, pp. 14–22.
8. Shurygin, V. Y. *Astra Salvensis*, 2017(Suppl. 1), 2017, pp. 47–54.
9. Yulmetyev, R. M. and Galeev, R. I. *Physics Letters A*, 202(4), 1995, pp. 258–262.
10. Yulmetyev, R. M. *Physica A: Statistical Mechanics and its Applications*, 242(3-4), 1997, pp. 509–521.
11. Aikashev, G. S. *Middle - East Journal of Scientific Research*, 20(11), 2014, pp. 1339–1343.
12. Shurygin, V. Y. *Espacios,* 38(40), 2017, 39. Available: http://www.revistaespacios.com/a17v38n40/17384039.html
13. Drigas, A. and Kontopoulou, M. T. L. *International Journal of Engineering Pedagogy*, 6 (3), 2016, pp. 53–59.
14. Udaya Sri, K. and Vamsi Krishna, T. V. *International Journal of Computer Science and Information Technologies*, 5(5), 2014, pp. 6124–6126.
15. Latipova, L. N. and Latipov, Z. A. *Mediterranean Journal of Social Sciences*, 6 (2S3), 2015, pp. 250–253.
16. Tsai, C. C. and Chai, C. S. *Australasian Journal of Educational Technology*, 28(6), 2012, pp. 1057–1060.
17. Sabirova F. M. *Eurasia Journal of Mathematics, Science and Technology Education*, 15 (3), 2019, em1669. Available: https://doi.org/10.29333/ejmste/102420
18. Abramovich, B. N., Sychev, Y. A., & Zimin, R. Y. (2019). The hybrid correction system, based on active and passive filters for harmonic compensation in networks of oil enterprises. Paper presented at the 2018 International Multi-Conference on Industrial Engineering and Modern Technologies, FarEastCon 2018, doi:10.1109/FarEastCon.2018.8602638
19. Melnichuk, M. S., Fokina, S. B., Boduen, A. Y., & Petrov, G. V. (2018). Co-recovery of platinum-group metals and chrome in processing of low-grade dunite ore material. Obogashchenie Rud, (1), 50-55. doi:10.17580/or.2018.01.09
20. Kuznetsov, V. S., & Suprun, I. K. (2017). Reduction of an adverse impact during well drilling by means of drilling waste usage. Journal of Ecological Engineering, 18(2), 12-15. doi:10.12911/22998993/68211
21. Nikolaeva, N.V., Aleksandrova, T.N., Elbendari, A.M. Ore strength property evaluation in the design of ore preparation cycles. (2018) Geomechanics and Geodynamics of Rock Masses, 1, pp. 333-338. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85061369094&partnerID=40&md5=d89a72a7d3673c3030532717727c51f8
22. Dashko, R. E., & Lebedeva, Y. A. (2017). Improving approaches to estimating hydrogeological investigations as a part of engineering survey in megacities: Case study of st. petersburg. Water Resources, 44(7), 875-885. doi:10.1134/S009780781707003X
23. Melnichuk, M. S., Petrov, G. V., Fokina, S. B., & Zotova, I. E. (2018). Enhancing optimal performance of the platinum concentrates by reduction sulfuric acid. Acta Technica CSAV (Ceskoslovensk Akademie Ved), 63(3), 467-474.
24. Darin, A. A., & Telyakov, N. M. (2017). Processing of ferromanganese concretions with the use of sulfatising roasting. Journal of Engineering and Applied Sciences, 12(5), 1113-1115.
25. Telyakov, N. M., Darin, A. A., Telyakov, A. N., & Petukhov, A. A. (2016). Influence of the specific character of the content of iron-manganese concretions of the pacific ocean and baltic sea on technological indicators of valuable component extraction. Tsvetnye Metally, 2016(2), 40-45. doi:10.17580/tsm.2016.02.06
26. Kochneva, O. E., Nefedov, U. V., & Fedorov, N. V. (2019). Establishing the correlation between reservoir properties and facies features of the bashkir sediments of the gagarinskoye field. Neftyanoe Khozyaystvo - Oil Industry, 2019(2), 24-27. doi:10.24887/0028-2448-2019-2-24-27
27. Petrov, G. V., Fokina, S. B., Boduen, A. Y., Zotova, I. E., & Fidarov, B. F. (2018). Arsenic behavior in the autoclave-hydrometallurgical processing of refractory sulfide gold-platinum-bearing products. International Journal of Engineering and Technology(UAE), 7(2), 35-39. doi:10.14419/ijet.v7i2.2.9897
28. Fokina, S. B., Petrov, G. V., Sizyakova, E. V., Andreev, Y. V., & Kozlovskaya, A. E. (2019). Process solutions of zinc-containing waste disposal in steel industry. International Journal of Civil Engineering and Technology, 10(1), 2083-2089.
29. Petrov, G. V., Fokina, S. B., Boduen, A. Y., Fidarov, B. F., & Zotova, I. E. (2019). Aspects of electrochemical reaction mechanis of magnetite reductive leaching in sulfuric acid medium. International Journal of Mechanical Engineering and Technology, 10(1), 1595-1601.
30. Sizyakov, V. M., Tikhonova, E. V., Sizyakova, E. V., & Cherkasova, M. V. (2017). Synthesis of hydrocarboaluminates of alkali earth metals from natural magnesium-containing feedstock in conditions of alumina production. Russian Journal of Non-Ferrous Metals, 58(1), 36-43. doi:10.3103/S1067821217010114
31. Golubev, I., & Lebedeva, Y. (2017). Two-stage treatment technology as a way to improve quality of oil-contaminated wastewater meant for injection into geological formation. ARPN Journal of Engineering and Applied Sciences, 12(13), 4002-4006.
32. Dashko, R. E., & Kotiukov, P. V. (2018). Fractured clay rocks as a surrounding medium of underground structures: The features of geotechnical and hydrogeological assessment. Paper presented at the Geomechanics and Geodynamics of Rock Masses, , 1 241-248.
33. Sizyakova, E. V., & Ivanov, P. V. (2017). Multifunctional coagulants based on hidrocarboaluminates. Journal of Ecological Engineering, 18(2), 16-20. doi:10.12911/22998993/68306
34. Movchan, I. B., & Anatol'evna Yakovleva, A. (2019). Approach to automation of field diagnosis data interpretation for localization of pitting in the pipeline wall. International Journal of Civil Engineering and Technology, 10(2), 1571-1581.
35. Abramovich, B. N., Kuznetsov, P. A., & Sychev, Y. A. (2018). Protective controller against cascade outages with selective harmonic compensation function. Paper presented at the Journal of Physics: Conference Series, , 1015(2) doi:10.1088/1742-6596/1015/2/022001
36. Kuznetsov, V. S., Suprun, I. K., & Petrov, D. S. (2017). Assessment and reduction of drilling waste impact on the environment components. Neftyanoe Khozyaystvo - Oil Industry, (1), 94-95.
37. Afanasova, A., Aleksandrova, T., Nikolaeva, N. Processing of carbonaceous ores containing ultra-dispersed metals with using high-frequency current. (2018) International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, SGEM, 18 (1.4), pp. 119-124. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85058893992&doi=10.5593%2fsgem2018%2f1.4%2fS04.016&partnerID=40&md5=737aa4703232e4c039b8fe9dbaec473d DOI: 10.5593/sgem2018/1.4/S04.016
38. Charikova, I. N. and Zhadanov V. I. *International Journal of Mechanical Engineering and Technology*, 9(10), 2017, pp. 325–333.