Jurnal Pendidikan Vokasi
Volume 12, No. 3, 2022 (273-279)
Online: https://journal.uny.ac.id/index.php/jpv

Evidence-based geology as a basis for improving the efficiency of innovative design of the development of Tengizchevroil oil fields

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ARTICLE INFO

Article History
Received:
11 February 2022;
Revised:
8 June 2022;
Accepted:
5 September 2022;
Available online:
20 January 2023

Keywords
Air pollution;
Gas;
Geological exploration;
Geology;
Hydrocarbon;
Oil

ABSTRACT

The article's main purpose is to study the method of storing sulfur in solid form in a large block at Tengizshevroil deposits and dispose of sulfur residues. Thus, we have to admit that, in this case, the evaluation of the effectiveness of the innovation at the stage of its development was performed incorrectly, and thus the consumer was misled. As a rule, the production activities of enterprises are planned according to the average parameters that are not known reliably in advance and can change randomly. At the same time, a situation with sharp changes in these indicators is extremely undesirable because this means the threat of loss of control. The smaller the deviation of the indicators from the average expected value, the greater the stability. That is why the statistical method based on mathematical statistics has become the most widespread in assessing investment risk. A more complex mathematical apparatus (regression and correlation analysis, simulation modeling methods) allows for a deeper analysis of the risk and its causes. The discrepancy between modern progressive technical capabilities and archaic "expert" geological thinking. Unfortunately, when making decisions, geologists often rely solely on personal experience, while the basis of evidence-based geology is experimental research (including statistical experiments), which serves as material for a systematic review, meta-analysis, and the development of practical guidelines (recommendations) based on them. The use of the principles of evidence-based geology involves a combination of individual practical experience and optimal evidence obtained through a systematic analysis of experimental and experimental-methodical studies. The instrumental support of evidence-based geology is modern technologies of statistical data analysis, data mining and artificial intelligence, and analytical platforms to build applied solutions.

How to cite:
Tauova. N. (2022). Evidence-based geology as a basis for improving the efficiency of innovative design of the development of Tengizchevroil oil fields. *Jurnal Pendidikan Vokasi*, *12*(3), 273-279. https://doi.org/10.21831/jpv.v12i3.47996

INTRODUCTION

In modern realities, a constant increase in the share is hard-to-recover reserves. The complication of mining and geological conditions of development and the need to use new technological solutions to improve the efficiency of the domestic oil and gas production complex, the development of the country's mineral resource base and the preservation of its economic stability, innovative design of geological and technological measures is of crucial importance (Scholz & Wellmer, 2013). The new Kazakhstan classification of hydrocarbon reserves and resources is now project-oriented, i.e., at any stage of geological exploration of the subsurface, the main document determining further study and development is the project of geological study, trial operation, field development, and others (Sergeev et al., 2014).

It was evident that the cost-effective development of reserves, previously considered complex or difficult to recover, is possible only based on introducing new technologies, which, in turn, requires effective, innovative design (Dodson et al., 2012). Here, as an assessment of the effectiveness of innovative design, one can take the share of implemented innovative projects that have given an acceptable economic effect from introducing innovation. Innovation activity is the process of creating a new product, new technology, or service based on the results of scientific research in order to gain competitive advantages in the sale of manufactured products, works, and services in the markets (Baigabylov et al., 2020).

Innovation (innovation) is the final result of innovative activity, which has been implemented as a new (improved) product or technological process (Ionescu & Dumitru, 2015). Each specific innovation appears as a result of the scientific and production cycle and goes through certain stages of development - creation, development, and dissemination (Chiesa et al., 1996). Each of these stages contains several mandatory stages.

Thus, the stage of innovation creation contains the stages of fundamental (obtaining new knowledge) and applied (practical application of knowledge) research, experimental (design, manufacture, testing) development, and others. Product development is the final stage of research, characterized by the transition from laboratory conditions and experimental production to industrial production (Pisano, 1994). At this stage, the final verification of theoretical research results is carried out, the corresponding design and technical documentation are developed, and a technical prototype or an experimental technological process is manufactured and tested.

Based on the results of this stage, an assessment of the effect of the implementation of innovation is carried out, which is necessary to compare the results obtained with the results of using other similar-in-purpose innovation options. The general principle of evaluating effectiveness is comparing results and costs; this comparison is usually made in effect = Result/cost ratio (Reardon, 2005). The above ratio can be expressed both in natural and monetary terms. Effective implementation of innovations involves exceeding the result of introducing innovation over the cost of implementing innovation.

Currently, the specifics of most innovative projects in the oil and gas production complex are such that any assessment is subjective because it is based on the opinions and knowledge of experts. High uncertainty about the future consequences at the time of deciding on the implementation of the project makes it impossible to make a final decision based on the use of formalized methods of investment assessment (Gluch & Baumann, 2004). This increases the risk of making a wrong choice of innovative projects and suboptimal decisions when implementing innovations (Moldabayeva et al., 2021). For example, studying the experience of various organizations' specialists in the geological and hydrodynamic modeling of oil field development processes shows that their points of view need to be revised.

On the one hand, it is noted that "the mass application of modeling technologies has made noticeable improvements in the design practice: the quality of documentation has been unified, the quality of design work has improved," on the other hand, "despite a significant increase in various kinds of research, design work and the volume of costs in general, the existing main drawback of forecasts remains - the discrepancy between actual and calculated technological indicators (current and final oil production)." For mature deposits with a long development history and are in a late stage, the accuracy of forecasts made using traditional analytical techniques is equal to those obtained from reservoir modeling. Meanwhile, numerical reservoir modeling is more time-consuming and expensive and involves significant human and technical resources (Jalalov et al., 2021).

RESEARCH METHOD

Using quantitative methods makes it possible to obtain a numerical assessment of the project's riskiness to determine the degree of influence of risk factors on its effectiveness. Unfortunately, many authors of innovative projects need to pay more attention to the practical (statistical) assessment of the proposed methods' geological (field) effectiveness. As shown below, the success examples cited by the authors to justify the effectiveness of innovative technologies often need to contain sufficient data for reliable, statistically sound conclusions (Chubukova, 2006). In confirmation of the high efficiency of acoustic impact on the formation to increase permeability and flow rate, the author gives an example of successful impact in 3 wells (3 successes in 3 cases).

However, the estimation of the probability of success by the Wilson method, taking into account the sample size, in this case, is only 76% (Sahu & Smith, 2006). The calculation of the interval estimate (confidence probability – 0.95) by the Klopper-Pearson method shows the lower limit of the confidence interval of 37%, i.e., the real success of acoustic exposure, according to this example, may well be below 50% (Ludvigsen et al., 1987). It is evident that these and other similar examples, which are practically useless in terms of evidence due to the small volume of samples used, are given by the authors of innovations solely to have an emotional impact on a potential consumer. Today, the world is transitioning from "impressionist" geology, based on opinions and impressions, to evidence–based geology - "evidence-based geology."

Evidence-based geology is not a new science but a new technology for collecting, analyzing, and interpreting scientific information. The main reasons for the transition to evidence-based geology: First, increasing the volume and access to scientific information. Dozens of geological journals are published in Kazakhstan, and it is almost impossible to assimilate this massive flow of information, sometimes contradictory. Moreover, the introduction of the Internet into everyday activities opens up limitless opportunities for access to information.

All this creates the need for analysis, generalization of the available information, and its presentation in a form ready for practical use. Second, the emergence of new, as a rule, expensive methods of geological-geophysical, geochemical, and others. Research. There is a need to choose methods with high efficiency and lower cost. The emergence of numerous pseudoscientific "methods," lobbying of oil companies, and the so-called "corruption component" further complicate the situation. At the same time, it should be borne in mind that neither the high cost nor the duration of application ("traditional") methods is not a guarantee of its high efficiency (Muslimov, 2018).

The literature generally states that blended learning is a complex method that uses many methods and is unique before it is implemented. This study aims to determine: (1) If Kazakhstani teachers are familiar with blended learning; (2) If Kazakhstani school and university teachers use the blended learning method in their lessons; and (3) If using blended learning is effective in Kazakhstan.

RESULT AND DISCUSSION

This allows us to identify reliable patterns that, unlike expert opinions, are completely objective. Evidence-based geology tools complement the intuition and qualifications of geologists with up-to-date, reliable information about the most effective and economically justified approaches to solving various geological and field tasks, which allows us to offer the best option of geological and technological measures in each case. It is essential to adhere to the principles of evidence-based geology when designing the development of hard-to-recover reserves because it is advisable to provide benefits only to those subsoil users who can correctly and objectively justify the need for this.

At the same time, it should be taken into account that in most real situations, many parameters of the geological environment and, consequently, the forecast and the result of geological and technological measures are uncertain and, therefore, should be expressed in probabilities. In addition, there is always some bias and systematic errors embedded in observations, and any research is subject to the influence of chance. This leads to a natural conclusion: all researchers (including geologists-practitioners) should rely only on such observations based on solid scientific principles, including ways to reduce systematic errors and bias, as well as an assessment of the role of random factors.

In order to meet the above requirements, it is necessary to consider many aspects related to the measurements of the studied indicators and the assessment of the reliability of measurements, their reproducibility, accuracy, interpretability, and others (Volkov et al., 2019). As an example demonstrating the importance of advanced (pre-project) Research and development, it is possible to cite studies carried out under the guidance of Academician Muslimov (2018) in 1998-2008. The results of these studies conducted by TSSMrneft LLC showed that changing the methods of constructing a geological model and revaluation of the Romashkinskoye field, as well as further exploration in combination with measures aimed at increasing the KIN, will extend the development period to 250 years and increase recoverable reserves by at least 770 million tons.

An essential area of the Center's activity is the examination of the innovative infrastructure of oil and gas production enterprises and the developing recommendations for optimizing the interaction of all its elements. Currently, Tengizchevroil has sufficient scientific potential and practical experience both to carry out pre-project studies (assessments, examinations) of the degree of readiness of innovations for pilot tests and to assist the authors of innovative developments in improving the proposed technologies and justifying the feasibility of their implementation (Lobankov & Sviatokhin, 2014).

Table 1. Sulfur Sublimation on Tengizchevroil's Sulfur Maps According to IHN

Card number	Length, m	Width, m	Area, m2	Weight of sublimation sulfur during storage of the block g / m2 per year	Total sublimated sulfur residue per year, t / year
1	227	105	23835	11,25	0,269
2	237	110	26070	11,25	0,294
3	237	110	26070	0	0
4	351	110	38610	11,25	0,435
5	425	310	131750	11,25	1,483
6	425	310	131750	11,25	1,483
7	504	281	141624	11,25	1,594
	Total		352015		5,558

According to Tengizchevroil's sulfur maps, sulfur sublimation is estimated at 5.6 tonnes per year. As a result of research conducted by Zaurbekov et al. (2018), the following conclusions can be made:

> *(1) Tengizchevroil's sulfur stored on sulfur maps is of high purity and meets the requirements of grade 9998, while long-term storage sulfur meets grades below 9995; (2) The primary sources of Tengizchevroil's sulfur in open storage are: microabiological sulfuric acid, sulfur sublimation, dust-forming elemental sulfur, and separation of hydrogen sulfide from sulfur blocks; (3) Elements of arsenic, selenium, Mercury, manganese, and copper were not observed in the Tengizchevroil environment. A low ash content characterizes sulfur here. It is found in small amounts of iron, which has fallen into sulfur from technological equipment; (4) The acidity of sulfur increases depending on the shelf life. Thus, the sulfur content stored for ten years can increase by 25 times, and by weight is 0.025%. This fact indicates the contribution of the process of microbiological acidification of sulfur; (5) The content of organic substances in samples of Tengizchevroil sulfur is 0.006% by weight. 0.0 IR spectrometry methods detected 0.016 and 0.021% organic substances; (6) Sulfur in Tengizchevroil's sulfur Maps has low micro-monopolistic properties, i.e., sulfur extraction technology at TCO prohibits the presence of gaseous compounds; (7) No sulfuric organic substances (mercaptans) were detected in the samples of Tengizchevroil sulfur; (8) The average daily hydrogen sulfide residue from Tengizchevroil's sulfur Maps is at most 3 kg per 1 million tons of open-air sulfur storage; (9) The dust distribution of sulfur in Tengizchevroil's sulfur Maps is 4 tons per year; and (10) Sulfur sublimation in Tengizchevroil's sulfur Maps was 5.6 tons per year.*

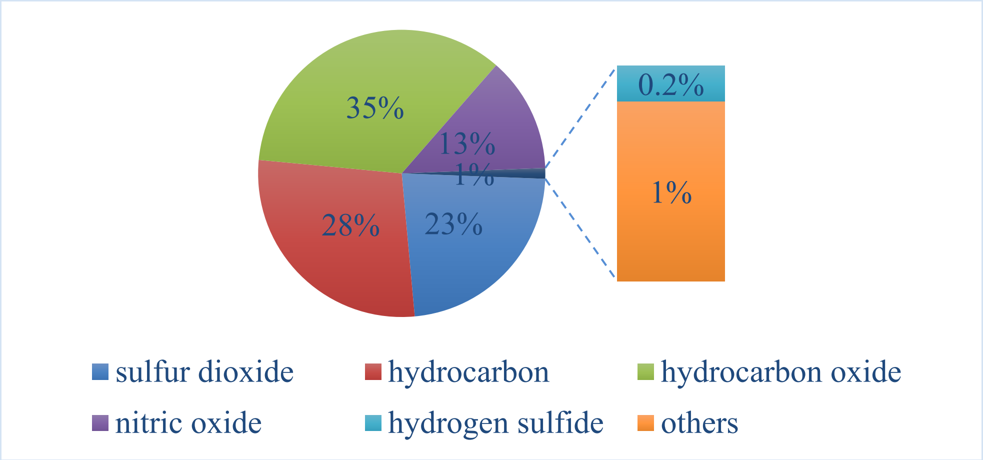

Figure 1. Proportion of Pollutants in Total Emissions

In particular, air pollution is one of the most pressing problems with the excessive release of H2S (hydrogen sulfide). To solve this problem, it is necessary to prevent the release of harmful substances into the air, including eliminating toxic gases and waste, which every resident should deal with. We can not hide the fact that environmental problems are also associated with the destruction of the atmosphere. Thus, the volume of oil production amounted to 13.5 million tons, from which 68.2 thousand tons of harmful substances were released into the atmosphere.

CONCLUSION

Measures to reduce emissions into the atmosphere for Tengizchevroil include (1) a foam dedusting system device, (2) device of a liquid desulfurization system for trapping hydrogen sulfide vapors from liquid sulfur, (3) the Use of two mechanical pumps that reduce waste by 100%, (4) closing fittings with open Stoppers, (5) the use of graphite seals in valves, and (6)control of gasification levels using electronic gas detection systems.

Removal of waste gases (hydrogen sulfide or sulfur dioxide) from sulfur maps. This process has a place because technological sulfur is obtained by acidification of hydrogen sulfide with air, so hydrogen sulfide is constantly present in dissolved sulfur in the form of a semi-sulfide of hydrogen. The residual sulfur content in sulfur dioxide is also taken into account.

Sublimation and dust formation of elemental sulfur on sulfur maps. Sublimation sulfur can be partially oxidized to sulfur dioxide, and the second part of it can form finely dispersed dust. In addition, finely dispersed dust can also form during ventilation, which can harm the health of personnel. On the other hand, sulfur dust can get into the soil, which causes changes in the acidity and alkalinity of the groundwater.

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One of the most pressing problems at present is the sharp deterioration of human health by polluting the ecology of nature. Toxic substances, heavy metals, nitrates, nitrites, pesticides, and others. Among the most common chemicals, carcinogens are the most dangerous - benzopyrene. These substances enter the human body through air, water, and food. Such toxic substances often disrupt the functioning of the respiratory organs-lungs and aorta.

It is known that if we pass 200 liters of air a day through the lungs, we will take in harmful gases in the structure of the air. In particular, air pollution is one of the most pressing problems with the excessive release of H2S (hydrogen sulfide). To solve this problem, it is necessary to prevent the release of harmful substances into the air, including eliminating toxic gases and waste, which every resident should deal with.

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