Разработка учебных программ преподавания по дисциплине «Общая химия» на нехимических специальностях

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Аннотация
В настоящее время, в всестороннем развитии отраслей науки страны проводятся исследования квалифицированных работников, конкурентоспособных на рынке труда, компетентных, свободно владеющих своей профессией и ориентированных в смежных сферах деятельности. Поэтому, для повышения местных специалистов необходимо уделять особое внимание практической направленности подготовки обучающихся. На основе формирования профессиональной и практической направленности в вузе приобретает значение вопрос преподавания курса «Общая химия» по нехимическим специальностям. В связи с этим известно, что разработанная в ходе исследования типовая учебная программа «Учебные программы обучения дисциплине «Общая химия» по нехимическим специальностям» является вспомогательной методикой как для обучающихся, так и для преподавателя. Сведения по данной теме очень мало, в связи с такой проблемой, мы предлагаем учебные программы для нехимических специальностей. Учебные программы по дисциплине «Общая химия» соответствуют содержанию тем, проходящих по каждой нехимической специальности.
Ключевые слова: нехимические специальности, межпредметные связи, общая химия, практическая направленность, учебные программы, программное обучение, ситуационные задания, политехническое обучение.

Development of teaching curricula for the discipline «General chemistry» in non-chemical specialties

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Abstract
Currently, in the comprehensive development of the country's branches of science, research is being conducted on qualified workers who are competitive in the labor market, competent, fluent in their profession and oriented in related fields of activity. Therefore, in order to improve local specialists, it is necessary to pay special attention to the practical orientation of the training of students. On the basis of the formation of a professional and practical orientation at the university, the issue of teaching the course «General chemistry» in non-chemical specialties becomes important. In this regard, it is known that the standard curriculum developed in the course of the study «Training programs for the discipline «General chemistry» in non-chemical specialties» is an auxiliary methodology for both students and teachers. There is very little information on this topic, and due to this problem, we offer training programs for non-chemical specialties. The curricula for the discipline «General chemistry» correspond to the content of the topics that take place in each non-chemical specialty.
Keywords: non-chemical specialties, interdisciplinary connections, general chemistry, practical orientation, curricula, program training, situational tasks, polytechnic training.

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WASTE MANAGEMENT IN THE OIL AND GAS SECTOR: THE EXPERIENCE OF THE ONSHORE COMPLEX AT THE KASHAGAN FIELD

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Abstract
This article describes the comprehensive waste management approach implemented by the North Caspian Operating Company (NCOC) at the Kashagan field. As one of the largest oil fields in the world, Kashagan presents unique challenges for waste management due to its remote location, climatic conditions of the environment and extensive infrastructure. Special attention is given to the integration of circular economy principles, which allows for minimizing waste volumes, promoting recycling, and ensuring the safe disposal of both hazardous and non-hazardous materials. In accordance with global environmental sustainability standards, the main focus is on recycling, resource reuse, and waste prevention. The study looks at how waste is classified, and how it is sent to qualified contractors for disposal and recycling while maintaining strict regulatory compliance. From waste prevention to ultimate disposal, this article shows how the waste management hierarchy can be applied successfully. For industrial projects aiming to balance environmental responsibility with economic growth, NCOC company's approach serves as a valuable model. It illustrates not only developments in the oil and gas industry but also successful and efficient waste management techniques. This makes it a worthwhile read for experts in sustainability and the environment.
Keywords: Kashagan field, waste management, green economy, environmental sustainability, effective methods, recycling.

Introduction

One of the most important sectors of the global economy is the oil and gas sector, which offers enormous economic potential in addition to energy security. However, as oil and gas production continue to grow, waste removal and disposal issues become more and more crucial in terms of environmental safety and legal compliance. Nowadays, the North Caspian Project on the Kashagan field is known as one of the biggest and most intricate oil production initiatives in the world. The North Caspian Project on the Kashagan field is one of the largest and most complex oil production programs in the world. The industrial project is located in the northern part of the Caspian Sea and experiences special difficulty in managing waste due to its remote location and hostile environment. Waste management in this context is not just a technical and logistical exercise but a question of environmental necessity, given the environmental sensitivity of the region and the scale of the operation. Examining the waste management procedures used by the North Caspian Operating Company in the onshore Kashagan field is the goal of this article. The study looks at the types of waste produced, how it is classified, how it is disposed and the current legal requirements. classification techniques, storage, and disposal, including the prevailing regulatory standards. It aims to give a thorough understanding of how waste management in large industrial projects can be integrated with sustainable development ideas and the circular economy. In addition, the article highlights how NCOC' experience can be used as a model for other oil and gas operations across the globe, shedding light on the compromises between operational efficiency and environmental protection [KMG, 2007].

History of the North Caspian Project: Located north of the Caspian Sea, the North Caspian Project is one of the biggest and most intricate oil developments in the world. The project is currently being developed according to the terms of the North Caspian Sea Production Sharing Agreement (NCPSA) signed in 1997 that launched this huge project [NCOC, 2024].

In 2000, supergiant Kashagan field was discovered in the framework of the NCPSA and is referred to as being among the world's largest discoveries of the last several decades. The field id of unique strategic significance to Kazakhstan, if not the global energy markets as a whole, with recovery reserves estimates between 9 to 13 billion barrels of oil. Both onshore and offshore facilities are available at the Kashagan field. The offshore operations are all about the extraction of hydrocarbons from beneath the seabed, while the onshore facilities are all about the processing, transportation, and handling of the resources. But because of the complexity and environmental character of the location, it is onshore operations that play the critical role of ensuring that the extracted oil and waste related to it are handled responsibly. The focus of this paper will be on the onshore activities, the Kashagan field in particular, where industrial waste management is most focused [NCOC, LLP, 2023, P:78]. Eighty kilometers offshore from Atyrau, in three to four meters of water, is the Kashagan reservoir.

It is more than 4 kilometers below the seafloor and is considered to be under high pressure. Light crude oil of the Kashagan field has high H2S (sour gas) and carbon dioxide (CO2) content.

The particular issue of Kashagan is the harsh conditions of operation, under which much more precautions and much more investment are required in order to manage safety risks. More than 50% of rich and varied flora and fauna of the North Caspian Sea and its ecosystems are unique to the Caspian Sea. Although the sturgeon is typically considered the most valuable commercially, the Caspian Sea is home for seals, and coastal wetlands are a habitat for a variety of birds, including some of the Red Book of Kazakhstan species. The Caspian Sea is also a huge flyway for birds that migrate from Asia to Siberia. Protection of this vulnerable environment in the northern Caspian Sea and minimization of effects on the environment are primary concerns in oil and gas field development here [Schwab J., 2024].

Methods

This article evaluates waste management procedures at the Kashagan field in offshore facilities using a combination of several methods. Significant methodologies are used in this article, including examination of NCOC's reports, environmental monitoring data, and regulatory documents [NCOC, 2024]. Waste is categorized in accordance with Kazakhstan's Ecological Code (Article 338) [Ecological Code, 2021]. Additionally, the comparative analysis was made between NCOC's waste management principles with international industry best practices [Hysa E. et al., 2024].

Results and discussion

NCOC manages all the offshore operations as well as onshore operations. While the company deals with the complexities of oil production on the sea, onshore facilities perform most environmental processes, including waste disposal [NCOC, 2024].

As the main operator of the North Caspian Project, NCOC has developed and implemented a "Waste Management Program" in compliance with the Environmental Code of the Republic of Kazakhstan. The program is an overall policy to tackle waste generated at its Category I facilities. This ongoing project will ensure the maintenance of the local and international environmental standards and ensures NCOC to be committed towards adopting environmentally friendly practices in onshore operations [Ecological Code, 2021]. The remaining part of the article will discuss in detail the kind of wastes that occur in the onshore facility as well as touch upon the Environmental Code of the Republic of Kazakhstan with respect to waste categorization [NCOC, 2024].

Onshore Waste Types in the Kashagan Field. Waste Classification. Waste types are classified by a variety of common characteristics such as origin, properties, and management practices. At the onshore complex, NCOC follows a waste classification system that complies with Republic of Kazakhstan Environmental Code (article 338), which lists waste types and how they should be categorized. The officially authorized Waste Classifier used as the foundation for environmental protection. To guarantee appropriate waste management, company has developed thirty-six hazardous and non-hazardous waste passports as well as put in place a matching labeling system, which was issued by the Ministry of Ecology, Geology, and Natural Resources on August 6, 2021 [NCOC, 2024]. It is also supported by the Department of Ecology of the Atyrau Region.

The waste classification system is structured into main three categories. The first category (Class 1) includes hazardous waste, as it poses a risk to human health and the environment due to traits like toxicity, pathogenicity, flammability, corrosiveness, and reactivity. The second category (Class 2) includes non-hazardous waste, which does not present any significant risks.

Depending on the particular properties of the waste, the third category (Class 3) referred to as mirrored waste, is further separated into two subgroups: hazardous mirrored waste and non-hazardous mirrored waste. Mirrored waste is that which can be classified as either hazardous or non-hazardous, based on the concentration of hazardous material or the degree of hazardous characteristics. Different codes are applied based on these conditions, reflecting the potential impact of the waste on human

health and the environment [Yessenamanova M.S. et al., 2022]. This classification system enables NCOC to manage waste more effectively throughout its life cycle. Proper classification facilitates the determination of the necessary transportation, processing, and disposal means.

Onshore Waste Types. Onshore activities, especially in oil and gas production, contribute heavily to the generation of various types of waste, including hazardous (Class 1) and non-hazardous (Class 2) waste. In the North Caspian Project (NCOC), wastes take various types in the forms generated from onshore operations, grouped according to their hazard level. Wastes are generated by numerous processes, including oil treatment, equipment maintenance and repair, sulfur recovery, and support facility processes. The onshore facility of each unit generates specific types of waste, based on the operational activities' nature (Table 1).

Table 1

Following provides an overview of the primary types of waste for each onshore facility*

Facilities	Process Leading to Waste Generation	Waste Class and Category	Main Types of Waste	Possible Treatments
Oil Preparation Unit	Processing crude, oil through desalination, dehydration, stabilization	Class I (Hazardous), Class II (Non-hazardous)	Oil sludge, used technical oils, chemical residues, oily waste	Recycling (oil sludge), recovery of secondary raw materials (technical oils), bioremediation (oily waste), incineration (chemical residues)
Gas Preparation Unit	Gas separation, purification, and dehydration	Class I (Hazardous), Class II (Non-hazardous)	Oily waste, sulfur-containing waste, used technical oils, construction waste	Thermal processing (oily waste), sulfur recovery (sulfur-containing waste), recycling (technical oils), incineration (construction waste)
Sulfur Extraction Unit	Sulfur extraction from sour gas via Claus process	Class I (Hazardous waste), Class III (Mirrored waste)	Sulfur-containing waste, refractory materials, chemical residues	Sulfur recovery (sulfur-containing waste), thermal treatment (refractory materials), incineration (chemical residues)
Pipeline System Unit	Operation and maintenance oil and gas pipelines	Class I (Hazardous), Class III (Mirrored)	Oil sludge, oily waste, chemical residues, construction waste	Landfill disposal (oil sludge), incineration (oily waste), recycling (chemical residues), thermal processing (construction waste)
Utility Support Unit	Operation and maintenance of utility systems for oil and gas processing	Class I (Hazardous), Class II (Non-hazardous)	Oily waste, chemical residues, technical oils, mercury-containing waste	Thermal processing (oily waste), chemical neutralization (chemical residues), recovery of secondary resources (technical oils), demercurization (mercury-containing waste)
Water Treatment Unit	Water treatment and purification for industrial use	Class I (Hazardous), Class II (Non-hazardous)	Oily waste, chemical residues, used technical oils, mercury-containing waste	Water treatment (oily waste), recycling (chemical residues), incineration (technical oils), mercury recovery (mercury-containing waste)
Oil Sludge Dehydration Complex	Dehydration and neutralization of oil sludge	Class I (Hazardous), Class III (Mirrored)	Oil sludge, chemical residues, technical oils, mercury-containing waste	Oil sludge treatment (oil sludge), bioremediation (chemical residues), thermal treatment (technical oils), neutralization (mercury-containing waste)
Shift Camps	Operation of camps for personnel living	Class I (Hazardous), Class II (Non-hazardous)	Food waste, plastic waste, medical waste	Thermal processing (food waste), plastic waste (composting), medical waste (incineration)
Production Laboratory	Conducting analytical research and testing	Class I (Hazardous), Class II (Non-hazardous)	Oily waste, chemical residues, used filters, sulfur-containing waste	Recycling (oily waste), chemical neutralization (chemical residues), incineration (used filters), sulfur recovery (sulfur-containing waste)

**Note: complied by the author*

In the Kashagan field, all onshore waste management works are operated by one of the NCOC's contract companies. Sustainability Ecology Development (SED) is a certified contractor that offers environmental services to the company. The waste generation pattern at the Onshore complex of NCOC shown in Table 1, reflects an increase in the quantity of waste generation during 2022 (1,8427, 7777 t.) compared to 2021 (9,778,8690 t.) [NCOC, LLP, 2023, P:45].

The planned maintenance of onshore production facilities was the reason for the rise in waste generation in 2022. Tank equipment was cleaned, filter elements were changed, and technical fluids, including chemicals were replenished during this procedure. Construction, welding, sandblasting, painting, installation, and service work all produced extra waste [NCOC, 2024] (Figure 1).

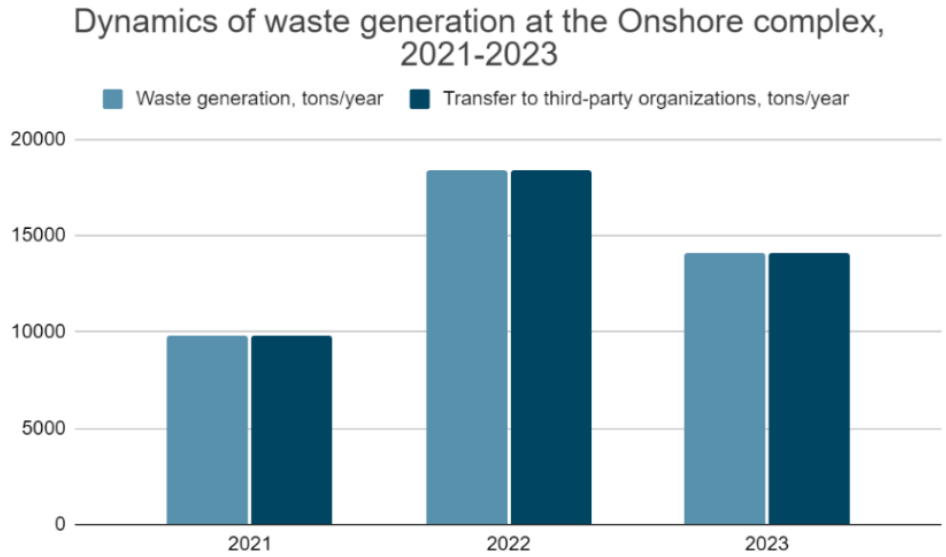

Figure 1. Information on the generation of production waste and its transfer to third-party organizations in 2021-2023 at the onshore complex in the Atyrau region.
Note: *complied by the author**

In 2023, production waste was reduced by 1,4103,6086 tons, i.e., by 1.3 times less than that for 2022 (1,8427,7777 t.). The primary reason for reducing waste in 2023 was the fulfillment of planned maintenance work on ground-based production facilities. One of the key contributors to the volume of waste generation in 2023 (almost 50%) was technical soil during the upkeep of storage ponds/evaporators, which is associated with work done on the maintenance of parts of the Liquid technological waste disposal site (LTWDS) [NCOC, LLP, 2023, P:41].

No operations of disposal, neutralization, incineration, processing and disposal of waste on Company's onshore complex in the Atyrau region are performed, except for compacting (pressing) waste cardboard and paper and plastic waste generated while rotating camp Samal [Yessenamanova M.S. et al., 2024]. Figure 2 - has information on generation of wastes at Onshore complex with division into hazardous, non-hazardous and mirrored wastes, Mirrored waste, however, is categorized into types: with and without hazardous properties [NCOC, 2024].

As it is clear from Figure 2, the proportion of hazardous waste (mirrored hazardous waste included) is roughly 66.6% (9,380,6307 t.) out of the total in 2023, i.e., double that of non-hazardous and mirrored (non-hazardous) wastes (33,4%= 4,697,8004 t.). The main sources of generation of hazardous waste (including mirrored hazardous waste) are technical soil (7,077,7500 t.= 75.4%), chemical residues (liquid) (395,4562 t.= 4.2%), and sewage sludge (1,192,0800 t.= 12,7%) [NCOC, LLP, 2023, P: 41].

The technology of oil production and initial processing of oil and gas imply the unavoidable use of chemicals. Despite the fact that most of the chemicals are utilized hundreds of times, they

occasionally become waste category due to loss of initial properties. Technical soil played a tremendous waste formation, which was utilized for liquid technological waste location. For non-hazardous waste (inclusive of reflected non-hazardous waste), it constitutes one third (4,697,8004 t.=33,4%) in the aforementioned year.

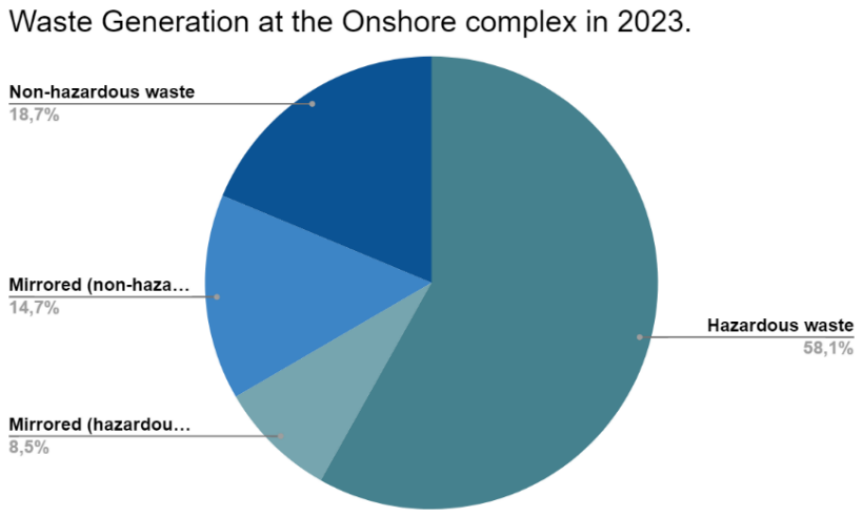

Figure 2. Waste generation at the Onshore Complex, broken down into hazardous, non-hazardous and mirrored waste. Note: *complied by the author**

The largest sources of non-hazardous waste are spent grit blasting (917,7400 t.=19,5%) household waste (712,1085 t.=15%), waste concrete (646,1300 t.=13,7%) and building demolition waste (564,1900 t.- 12%). All these types of waste are most common because of the high intensities of construction and demolition operations (564,1900 t.), additional usual household waste generation [NCOC, LLP, 2023, P: 41]. Spent grit blasting in induced due to industrial processes, while construction and concrete wastes are created due to massive infrastructure and building. Routine household activities create household waste.

Waste Management System Onshore at NCOC Company, Implementation of the Pollution Prevention Principle in Waste Management Hierarchy. Waste Management Hierarchy is at the center of waste management at NCOC, with waste prevention, reuse, recycling, and recovery being the priority over disposal and destruction. This method is widely accepted and its incorporation into laws and waste management procedures is regarded as an international standard [Schwab J., 2024]. NCOC implements the principle of prioritizing various waste management strategies, represented in the design of a waste management hierarchy (Figure 3.).

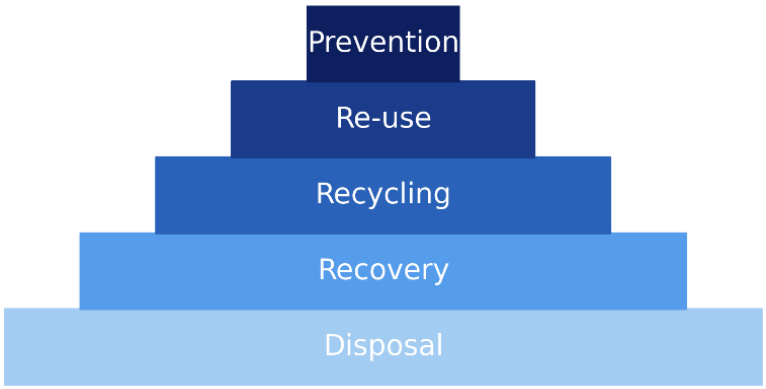

Figure 3. Waste Management Hierarchy. Note: *complied by the author**

Reducing waste at its source is the first step in preventing pollution, according to the waste

management hierarchy. Alternative methods of material reuse should be investigated if further reduction is not practical. Waste is sent to recycling or material recovery when reuse is not an option. When all other options have been exhausted, landfilling is regarded as a last resort [NCOC, 2024].

The main rule of the waste management system of the Company is the responsibility to ensure proper disposal from the moment of generation up to the moment of transfer [NCOC, 2024]. That is why the NCOC separately collects the waste in specially equipped areas within the period stipulated by the Ecological Code of the Republic of Kazakhstan and delivers waste to specialized enterprises for additional processing.

Stages of Waste Management: NCOC facilities have law compliant solid waste management process. To begin with, waste is generated from various operation activities including drilling, maintenance, and administration operations. The initial stage is critical as it acts as the foundation for subsequent processes of managing waste [Schwab J., 2024]. Following generation, each waste is defined and categorized based on its nature and potential hazards, allowing proper management practices to be implemented so they meet environmental regulations and allow handling safety.

Waste is sorted and collected where it is being produced in NCOC to separate hazardous waste from non-hazardous. This initial sorting is crucial in ensuring that waste is treated according to its particular needs, minimizing environmental risks. Waste is sorted in properly labeled containers, indicating the nature of waste and level of hazard. These containers are replaced at designated points of collection within the premises for easy collection and sorting.

NCOC assigns specialized contractors like SED with the responsibility of processing the waste. Long-term contracts regulate the terms of managing waste, including the requirement to report and monitor [NCOC, LLP, 2023, P: 64].

However, NCOC still controls how it guarantees compliance with standards as far as environmental issues are concerned in the process. While SED manages waste disposal and recycling is responsible for ensuring compliance with environmental policies. Regular reviews and audits are conducted on SED operations to ascertain compliance and performance (Figure 4) [NCOC, 2024].

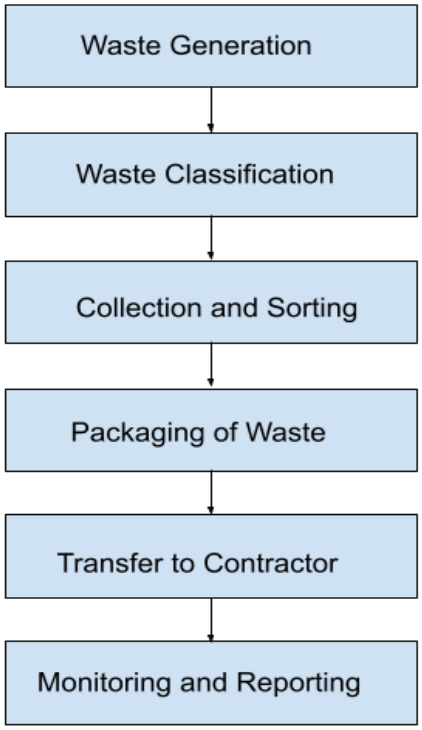

Figure 4. Stages of the waste management. Note: *complied by the author**

Circular Economy and Waste Reutilization in NCOC's Onshore Operations. NCOC is deliberately

embracing circular economy principles in its waste management system, with the focus on the reutilization of waste and resource conservation [Circular Economy, 2015].

It is intended to minimize waste generation and enhance the recovery rate. The company has prioritized some forms of waste for reduction and recovery measures, as the company does not directly engage in recycling or disposal of waste generated within the onshore complex. Of prime importance are the following key areas of focus:

1. Prevention of waste production: through buying only quantities necessary of consumables and avoiding purchasing excess for stockpiling, NCOC does not let harmful materials be classified as waste due to their expiration date. The same holds for food waste, where an aim is put forth towards increasing stock control and decreasing over-buying [Hysa E. et al., 2024].

2. Segregation and Recovery: NCOC is pf the opinion that source segregation of construction and municipal waste is critical. By segregating materials like plastic, paper, and cardboard, the company facilitates recycling them into secondary raw materials with ease [Schwab J., 2024].

3. Prioritized waste streams: the program has several waste streams which are to be handled through various initiatives like chemical residues, construction waste, cardboard and paper, plastics, food waste, and municipal waste. These have been selected on the basis of economic feasibility and the availability of specialized recycling facilities [NCOC, 2024].

4. Collaboration with specialist contractors: NCOC seeks to collaborate with waste management companies employing environmentally friendly recycling technologies [NCOC, 2024]. It intends to bring on board guarantees that the processes of waste processing are at the best standards and adhere to both international and national environmental guidelines.

By following these steps, NCOC aims to increase the rate of waste diversion from landfills while promoting sustainable practices in its operations. The initiative not only reduces environmental impact but also optimizes the firm's operating efficiency and resource utilization.

Conclusions

The findings of this study confirm that the North Caspian Operating Company (NCOC) has come up with an extensive and sustainable waste management plan in the Kashagan field onshore operations. By applying a circular economy system, NCOC effectively minimizes waste generation, encourages recycling, and disposes of hazardous and non-hazardous waste properly. The adherence to strict regulation compliance, along with operating in tandem with expert contractors, ensures that the company's practices adhere to local and international environmental requirements. Despite the natural challenges inherent in high-volume oil and gas production in environmentally sensitive regions, NCOC's waste management program is a model that other industrial projects can realistically pursue as they seek to balance economic growth and environmental care. This research emphasizes the importance of continued innovation in waste handling in operations that have a significant footprint on the environment. What can be learned from the North Caspian Project may be beneficial to similar operations around the globe, as it stresses the value of sustainable practices on the oil and gas industry. With tighter environmental regulations being implemented annually, NCOC's strategy offers a proactive solution to minimizing the environmental risks that industrial waste poses.

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Мұнай-газ секторындағы қалдықтарды басқару: Қашаған кен орнындағы жерүсті кешенінің тәжірибесі

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Аңдатпа
Бұл мақалада Қашаған кен орнында North Caspian Operating Company (NCOC) компаниясы қолданатын қалдықтарды басқарудың кешенді әдіс тәсілдері айтылған. Әлемдегі ең ірі мұнай кен орындарының бірі болсада, орналасу аймағына, қоршаған ортаның климаттық жағдайларына, дамыған инфрақұрылымына байланысты қалдықтар мәселесі қазіргі таңда өзекті болып тұр. Қалдықтардың көлемін азайту жұмыстары, қайта өңдеу, өндіру және қауіпті материалдарды да кәдеге жаратуды ұйымдастыру жасыл экономика қағидаттарын енгізуге ерекше назар аударылады. Халықаралық экологиялық тұрақтылық стандарттары бойынша қалдықтарды кәдеге жарату, екінші реттік қайта пайдалануға және қалдықтарды қайта өңдеу жұмыстары жүргізіледі. Кен орнын зерттеуге байланысты қалдықтарды жіктеу әдістерін және нормативтік талаптардың қатаң сақталуын қамтамасыз ете отырып, қайта өңдеу және көму үшін арнайы мердігерлерге қалдықтарды беру процесін қарастырады. Кен орнын зерттеу нәтижесінде қалдықтардың алдын алудан бастап, оларды түпкілікті жоюға дейінгі әрекеттер қалдықтарды басқару иерархиясының сәтті қолданылуын көрсетеді. NCOC-нің қоршаған ортаға әсерді азайту және өндірістік процестерді жеңілдету тәжірибесі экономикалық өсу мен экологиялық жауапкершілік арасындағы тепе-теңдікті қамтамасыз етуге бағытталған өнеркәсіптік жобалар үшін құнды үлгі болып табылады. Бұл жұмыс қоршаған ортаны қорғау мамандары мен тұрақты даму сарапшылары үшін өте маңызды, өйткені ол мұнай-газ саласындағы инновациялар мен қалдықтарды басқарудың тиімді әдістерін көрсетеді.
Түйін сөздер: Қашаған кен орны, қалдықтарды басқару, жасыл экономика, экологиялық тұрақтылық, тиімді әдістер, кәдеге жарту.

Управление отходами в нефтегазовом секторе: опыт наземного комплекса на месторождении Кашаган

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Аннотация
В данной статье изложены комплексные подходы к управлению отходами, применяемые компанией North Caspian Operating Company (NCOC) на Кашаганском месторождении. Несмотря на то, что это одно из крупнейших нефтяных месторождений в мире, проблема отходов, связанных с зоной размещения и климатическими условиями окружающей среды, в настоящее время остается актуальной. Особое внимание будет уделено внедрению принципов зеленой экономики по сокращению объемов отходов, организации переработки, добычи и утилизации опасных материалов.
По международным стандартам экологической устойчивости проводятся работы по утилизации отходов, вторичному повторному использованию и переработке отходов. Рассматривает методы классификации отходов, связанных с исследованием месторождения, и процесс передачи отходов специальным подрядчикам для переработки и захоронения, обеспечивая строгое соблюдение нормативных требований. Исследования месторождения показывают успешное применение иерархии управления отходами, начиная от предотвращения отходов и заканчивая их окончательной утилизацией. Практика NCOC по снижению воздействия на окружающую среду и упрощению производственных процессов является ценной моделью для промышленных проектов, направленных на обеспечение баланса между экономическим ростом и экологической ответственностью. Эта работа имеет решающее значение для специалистов по окружающей среде и экспертов в области устойчивого развития, поскольку она демонстрирует инновации в нефтегазовой отрасли и эффективные методы управления отходами.
Ключевые слова: месторождение Кашаган, управление отходами, зеленая экономика, экологическая устойчивость, эффективные методы, утилизация.

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