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ABASOV Vasif Asif oglu
Azerbaijan State Oil and Industry University, Azerbaijan, Baku
https://orcid.org/0009-0009-1972-5793
e-mail: vasifabasov636@gmail.com

THE ROLE OF CHEMICAL ADDITIVES IN INCREASING THE STRENGTH OF CONCRETE IN THE CONSTRUCTION OF OIL AND GAS FACILITIES

The aim of the article is to study the role of chemical additives in increasing the strength of concrete in the construction of oil and gas facilities. It is noted that various chemical additives improve the mechanical properties of concrete and ensure long-term operation in harsh environmental conditions. It is emphasized that water reducers (plasticizers and superplasticizers) increase the density of concrete by reducing the water-cement ratio, resulting in concrete with high compressive strength. It is also noted that corrosion inhibitors protect steel reinforcement in concrete, preventing rust and destruction.

The research used analysis, synthesis and comparative methods. Systematic, process, resource and effective approaches were used to achieve the scientific results of the work.

The scientific novelty of this research is that it comprehensively addresses the effects of chemical admixtures that increase the strength of concrete used in the construction of oil and gas facilities, revealing how concrete technology adapts to the specific requirements in this field. The effects of various chemical admixtures on the mechanical properties and environmental durability of concrete fill the gaps in the literature in this field and provide a new perspective to optimize the sustainable performance of concrete. In particular, the in-depth analysis on the selection and use of concrete admixtures for the unique operating conditions of oil and gas facilities constitutes a significant innovation compared to previous studies in this field.

As a result, chemical additives used to increase the strength of concrete in the construction of oil and gas facilities play a critical role in ensuring structural integrity and building long-lasting, safe facilities. These additives significantly improve both the mechanical properties of concrete and its resistance to environmental factors. Water reducers reduce the water-cement ratio, resulting in denser and more durable concrete, while accelerators and retarders control the setting process of concrete, providing time efficiency in construction processes.

Keywords: oil and gas facilities, construction, concrete, chemical additives.

АБАСОВ Васіф Асіф оглу
Азербайджанський державний університет нафти і промисловості, Баку, Азербайджан

РОЛЬ ХІМІЧНИХ ДОБАВОК У ПІДВИЩЕННІ МІЦНОСТІ БЕТОНУ ПРИ БУДІВНИЦТВІ НАФТОГАЗОВИХ ОБ'ЄКТІВ

Метою статті є дослідження ролі хімічних добавок у підвищенні міцності бетону при будівництві нафтогазових об'єктів. Зазначається, що різні хімічні добавки покращують механічні властивості бетону та забезпечують тривалу експлуатацію в суворих умовах навколишнього середовища. Підкреслюється, що відновники води (пластифікатори і суперпластифікатори) підвищують щільність бетону за рахунок зниження водоцементного відношення, в результаті чого бетон має високу міцність на стиск. Також зазначається, що інгібітори корозії захищають сталеву арматуру в бетоні, запобігаючи іржі та руйнуванню.

У дослідженні використовувалися методи аналізу, синтезу та порівняння. Для досягнення наукових результатів роботи використано системний, процесний, ресурсний та результативний підходи.

Наукова новизна цього дослідження полягає в тому, що воно комплексно розглядає вплив хімічних домішок, які підвищують міцність бетону, що використовується при будівництві нафтогазових об'єктів, розкриваючи, як технологія бетону адаптується до конкретних вимог у цій галузі. Вплив різних хімічних домішок на механічні властивості та стійкість бетону до навколишнього середовища заповнює прогалини в літературі в цій галузі та відкриває нову перспективу для оптимізації стійких характеристик бетону. Зокрема, поглиблений аналіз вибору та використання бетонних добавок для унікальних умов експлуатації нафтогазових об'єктів є значною інновацією порівняно з попередніми дослідженнями в цій галузі.

Як наслідок, хімічні добавки, які використовуються для підвищення міцності бетону при будівництві нафтогазових об'єктів, відіграють вирішальну роль у забезпеченні структурної цілісності та будівництві довготривалих і безпечних об'єктів. Ці добавки значно покращують як механічні властивості бетону, так і його стійкість до факторів зовнішнього середовища. Редуктори води зменшують водоцементне співвідношення, в результаті чого бетон стає більш щільним і міцним, тоді як прискорювачі та сповільнювачі контролюють процес схоплювання бетону, забезпечуючи ефективність будівельних процесів.

Ключові слова: нафтогазове господарство, будівництво, бетон, хімічні добавки.

INTRODUCTİON

The construction of oil and gas facilities is a complex project that requires great engineering skills and durable structural materials. These facilities must be resistant to harsh environmental conditions, high mechanical loads and chemical agents. In this context, concrete is one of the most widely used building materials in the construction of oil and gas facilities. However, in order to increase the strength of concrete and to build long-lasting, safe structures, it is necessary to use various chemical additives. These additives that increase the durability of concrete improve both the mechanical properties of concrete and its resistance to environmental conditions.

Water reducers, accelerators, retarders, pozzolans, corrosion inhibitors, shrinkage reducing additives, fiber reinforcements and high-performance superplasticizers are important additives that increase the strength gain, workability, long-term durability and resistance to environmental stresses of concrete. These additives increase the quality and performance of concrete, ensuring that oil and gas facilities are safe, durable and long-lasting.

This article will discuss in detail the role of chemical additives that increase the strength of concrete in the construction of oil and gas facilities and explain the effects of each additive on the structural properties of concrete. These additives not only accelerate the construction process but also ensure the long-term performance of the facilities.

Practical significance: In practical terms, this research provides valuable information for civil engineers and material scientists to optimize the use of admixtures that increase the durability of concrete.

MAİN PART

The effect of chemical additives is of great importance in increasing the strength of concrete used in the construction of oil and gas facilities. One of these additives is plasticizers and superplasticizers, known as water reducers. Water reducers are compounds that increase the workability of concrete while also reducing the amount of water used [1]. With the effect of these additives, the water-cement ratio of concrete decreases. The decrease in the water-cement ratio leads to the densification of the microstructure of the concrete and therefore to the improvement of its mechanical properties. This improvement increases the compressive strength of the concrete, ensuring the longevity of the structures.

Concrete used in the construction of the oil and gas industry is characterized by high mechanical strength requirements. These industrial structures are exposed to extreme environmental stresses and large loads. In order for such structures to be used safely and sustainably, it is essential that the concrete has high strength. The use of water reducers plays a critical role in meeting these requirements. Superplasticizers, in particular, further reduce the water-cement ratio, allowing the concrete to exhibit higher strength properties. At the same time, it increases the workability of concrete, thus increasing labor productivity in complex construction processes.

The use of water-reducing additives is indispensable for increasing the strength of concrete in the construction of oil and gas facilities. These additives improve the microstructural properties of concrete, ensuring that structures are long-lasting and durable. In addition, the effective use of these additives increases efficiency in the construction process and helps control costs [2]. The use of accelerator additives plays an important role in the construction of oil and gas facilities to increase the strength of concrete and optimize the construction process. Accelerators accelerate the setting process of concrete and promote hydration reactions. These additives are of critical importance, especially in constructions carried out in cold weather conditions or under tight time constraints. Under the influence of accelerators, concrete hardens and gains strength much faster than the hydration process that occurs under normal conditions. This provides significant time savings in construction processes.

In oil and gas facilities, the rapid strength gain of concrete allows construction processes to be accelerated. Especially in large-scale projects, time management and compliance with construction schedules are mandatory. The use of accelerators allows the concrete to gain strength at an early stage, allowing the structural elements to be used safely in a shorter period. In addition, accelerators eliminate the negative effects of cold weather conditions on the strength of concrete by ensuring that the concrete sets effectively at low temperatures. This increases safety in construction processes and also increases the early load-bearing capacity of the concrete. The use of accelerating admixtures is essential to increase the strength of concrete and speed up the construction process in the construction of oil and gas facilities. These admixtures are effectively used to overcome time constraints in the construction process and to provide early strength to the concrete.

Retarders, one of the chemical additives used to increase the strength of concrete in the construction of oil and gas facilities, play a critical role, especially in hot climate conditions. In hot weather conditions, concrete can harden very quickly due to the acceleration of the hydration process [3]. This increases the difficulties faced by workers during the placement and processing of the concrete and prevents the concrete from reaching the desired strength properties. Retarders eliminate these problems by slowing down the setting process of the concrete. By controlling the hydration reactions, they give the concrete more time during processing and placement.

One of the most important advantages of retarders is that they prevent premature setting in hot weather conditions. Early setting makes it difficult to place the concrete properly and prevents a homogeneous distribution of strength. Retarders control the hydration process, allowing the concrete to harden more uniformly and in a more controlled manner. This contributes to increasing the mechanical strength of the concrete and to the longevity of the structure. In addition, the proper strength development of the concrete increases the overall quality of the construction and prevents possible cracks. Retarders are important additives that increase the strength of concrete in the construction of oil and gas facilities. By preventing premature hardening of concrete in hot weather conditions, they increase workability and properly direct strength development. These additives increase efficiency in the construction process and ensure the durability of the structure.

The addition of pozzolanic materials to the concrete mixture significantly increases the durability and long-term strength gain of the concrete. In particular, pozzolanic additives such as fly ash and silica fume provide significant improvements in the microstructure of the concrete and increase the resistance of the concrete to environmental

influences. When silica fume is incorporated into the concrete, it reacts with free calcium hydroxide during the hydration process and promotes the formation of calcium silicate hydrate (C-S-H) gel [4]. This reaction increases the density of the concrete and significantly reduces its permeability. Lower permeability increases the resistance of the concrete to water, chlorides, sulfates and other chemical substances, which contributes to the longevity of the concrete.

Concrete is exposed to very harsh environmental conditions in the construction of oil and gas facilities. These facilities are often faced with aggressive environmental conditions such as acidic and alkaline components, salt water and high temperatures. In such environments, the concrete must have high resistance to chemical attacks. Pozzolanic materials such as silica fume and fly ash make concrete more resistant to such attacks. Adding silica fume to concrete also increases the early strength of the concrete and contributes to its long-term strength.

Similarly, fly ash improves the performance of the concrete mixture. Fly ash not only increases the strength of the concrete, but also contributes to environmental sustainability. Fly ash is a waste material and can be directly integrated into concrete production, allowing for more efficient use of resources. At the same time, the fine particles contained in fly ash improve the microstructure of the concrete, increasing its durability. The inclusion of pozzolanic materials in the concrete mixture is an effective method to increase the strength and improve the long-term performance of concrete in the construction of oil and gas facilities. Additives such as silica fume and fly ash reduce the permeability of the concrete, increasing its resistance to chemical attacks, thus ensuring the longevity and safety of the structure.

One of the chemical additives used to increase the strength of concrete in the construction of oil and gas facilities is corrosion inhibitors [5]. These facilities are usually exposed to corrosive elements such as salts, chemicals and gases. Such aggressive environmental factors cause the steel reinforcement in the concrete to corrode. The steel reinforcement in the concrete starts to rust over time and loses both its strength and structural integrity. Corrosion inhibitors prevent this negative interaction by forming a protective film on the surface of the steel. This film isolates the steel in the concrete from external chemical attacks and stops the rusting process.

The corrosion resistance of the steel reinforcement increases with the effect of corrosion inhibitors. In order to maintain the strength and longevity of the concrete, it is necessary to protect the steel reinforcement from rusting, because the corrosion of the reinforcement weakens the structural integrity of the concrete. This endangers the safety of the structures. Corrosion inhibitors eliminate this problem, increase the durability of the steel in the concrete and prevent the structure from deteriorating over time.

In oil and gas facilities, concrete structures are often exposed to high temperatures, chemicals, and salty environments. This can cause the concrete and steel to deteriorate more quickly. The use of corrosion inhibitors is especially important in construction on the seashore or in chemical industrial areas [6]. These additives effectively protect the steel reinforcement in the concrete, ensuring that the concrete remains long-lasting and safe. In addition, the use of these additives reduces maintenance costs and reduces the need for re-strengthening the structure. Corrosion inhibitors are important additives that increase the strength of concrete and ensure its longevity in the construction of oil and gas facilities. Protecting the steel reinforcement in the concrete from chemical attacks contributes to the preservation of structural integrity and ensures the safe operation of the facilities.

Concrete tends to shrink during the drying process, which leads to negative consequences such as cracking and reduced durability. Especially in the construction of large-scale oil and gas facilities, maintaining the strength and durability of concrete is of vital importance. Shrinkage usually occurs as a result of water evaporation, and this process threatens the structural integrity of the concrete. For this reason, chemical additives used to reduce concrete shrinkage, especially SRAs (shrinkage-reducing agents), have an important place in civil engineering. SRAs minimize the shrinkage of concrete during drying and thus increase the durability of concrete by reducing the risk of cracking.

When SRAs are added to the concrete mixture, they control the rate of water evaporation and allow the water in the concrete to move in a more controlled manner. These additives prevent excess water in the concrete from damaging the microstructure of the concrete, especially in hot weather conditions or rapid drying processes. Shrinkage of concrete can cause structural problems such as cracking and swelling [7]. SRAs prevent these negative effects and preserve the integrity of the concrete for a long time. In addition, it increases the durability of the concrete, minimizing possible maintenance requirements and repairs.

In oil and gas facilities, concrete must be durable under all conditions. Harsh weather conditions and environmental factors can negatively affect the performance of the concrete. SRAs prevent structural problems by reducing the shrinkage of the concrete, especially during drying. These additives strengthen the long-term durability of the concrete and prevent the negative effects that may occur during the drying process. In addition, the use of SRAs increases the efficiency of the construction process and ensures that projects are completed on time. Shrinkage-reducing additives play an important role in maintaining the strength and structural integrity of the concrete, especially in the construction of oil and gas facilities. SRAs reduce the shrinkage of the concrete, reduce the risk of cracking and contribute to the construction of long-lasting, durable structures. The use of these additives increases the performance of the concrete, ensuring the safety and sustainability of construction projects.

Among the chemical additives used to increase the strength of concrete, fiber reinforcement plays a critical role, especially in the construction of oil and gas facilities where high mechanical demands and thermal or mechanical stresses are intense. Concrete is a material with inherently low tensile strength and limited crack resistance. This can

lead to concrete cracking under stress. However, adding steel, glass or synthetic fibers to the concrete mixture improves these negative properties and improves the overall performance of the concrete.

Fiber reinforcement provides resistance to cracking by increasing the tensile strength of concrete. Tensile strength is related to the ability of concrete to deform under externally applied stresses. The inclusion of fibers in the concrete mixture allows these stresses to be distributed more uniformly and minimizes the risk of localized cracking. Especially in oil and gas facilities, concrete structures are constantly exposed to mechanical and thermal stresses. These stresses can cause the concrete to crack and jeopardize the safety of the structure. Fiber reinforcement significantly reduces the potential for such cracking and increases the strength of the concrete.

As the fibers disperse in the concrete, the network structure of the fibers added to the concrete mixture prevents the propagation of cracks in the microstructure of the concrete. Cracks can especially affect the steel reinforcement and weaken the structural integrity of the concrete over time. Fiber reinforcement increases the durability of the concrete by preventing the propagation of these cracks. In addition, fibers resist physical changes such as thermal expansion and contraction of the concrete [8]. In oil and gas facilities, temperature changes can create intense stresses on the concrete; fibers prevent such mechanical stresses from damaging the structural integrity of the concrete. Fiber reinforcement is an important additive that increases the tensile strength of concrete, improves crack resistance and maintains structural integrity in the construction of oil and gas facilities. Fibers provide durability and longevity of the concrete, while resisting mechanical and thermal stresses. The use of this additive is of great importance especially for the oil and gas industry, which has difficult working conditions.

CONCLUSİON

As a result, chemical additives used to increase the strength of concrete in the construction of oil and gas facilities play a critical role in ensuring structural integrity and building long-lasting, safe facilities. These additives significantly improve both the mechanical properties of concrete and its resistance to environmental factors. Water reducers reduce the water-cement ratio, resulting in denser and more durable concrete, while accelerators and retarders control the setting process of concrete, providing time efficiency in construction processes. Pozzolans increase the resistance of concrete to chemical attack, while corrosion inhibitors protect steel reinforcement and prevent rust. Shrinkage-reducing additives minimize the risk of concrete cracking. Fiber reinforcements improve the crack resistance and tensile strength of concrete, while high-performance superplasticizers increase the workability of concrete and provide high strength with a low water-cement ratio.

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