

БЕЙОРГАНИКАЛЫҚ ЗАТТАРДЫҢ ХИМИЯЛЫҚ ТЕХНОЛОГИЯСЫ

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THE USAGE OF PHOSPHATE INHIBITORS AGAINST CORROSION OF EQUIPMENT IN THE OIL INDUSTRY

Abstract

Protection of steel from negative effects with chemical reagents has been one very efficacious technique to enhance the endurance of production facilities and oil pipelines in invasive environments for a long time. The majority considerable damages were experienced by the heat power, water supply oil and gas industries. The application of inorganic inhibitors is a general practice in the mining industry in order to efficiently save steel in an invasive environment, in the existence of CO₂ and H₂S, due to the fact that corrosion inhibitors setback or decrease the impact of different factors on corrosion processes. The inhibitory method is characterized by high efficiency, low cost and ease of implementation. The use of inhibitors allows to avoid processing metal surfaces with protective enamels and mastics, and order expensive pipes made of alloy steel. In order to prevent corrosion, it is sufficient to place a chemical compound in an aggressive environment to neutralize or slow down the corrosion processes.

Keywords: corrosion, phosphates, inhibitor, oil industry, protection.

Introduction. One of the most considerable issues in the mining industry is protection of pipeline from corrosion. Due to the exhaustion of readily accessible reserves of oil the demand for oil and gas production under more rigid conditions is rising. Internal and external corrosion takes place in drilling equipment, transportation system and processing and storage facilities. This condition not only points out wear and loss of metal parts, but will also ultimately lead to equipment failure. High levels of variety gases such as hydrogen sulfide, carbon dioxide, and oxygen, as well as water and acids, create perfect environment for corrosion in a pipeline. Operating temperature, and pressure fluctuations cause many difficulties among side with presence of CO₂ and H₂S [1].

Therefore, this article is intended to examine the basic concepts of corrosion and identify the most common and modern inhibitors that are used to improve the effectiveness of corrosion protection in the oil and gas industry.

Basic concepts of corrosion. Consideration of various methods of reducing corrosion reveals the main mechanisms of the process and the destruction of metal in different environments. Corrosion is a process in which metal reacts with the environment, resulting in gradual degradation and destruction of the metal itself [2]. Rust is the most famous example of corrosion, is the result of the reaction of a metal with the oxygen of the environment under conditions of high humidity in the atmosphere. The possibility of free access of oxygen to the metal surface is the main feature of atmospheric corrosion [3]. This form of corrosion has a negative impact on the structural integrity of the metal. The corrosion process is associated with thermodynamic instability of the system [4].

The most common types of corrosion occur as a result of electrochemical reactions. Metal corrosion is caused by redox reactions. As a result of oxidation-reduction reactions metals are transferred to the oxidized form, and it leads to loss of its properties [5].

Corrosion in oil and gas pipelines. The process of metal destruction negatively affects the state of technological products that were made of this metal. The cost of repairing or partially

replacing various components, such as an oil pipeline, is an additional financial burden. In addition, accidents on pipelines can violate the environment and impair the health of animals and human beings [6].

Due to the fact that oil pipelines are made of metal, all of the pipelines are subject to corrosion. The aggressive environment contains water, hydrogen sulfide, and oxygen that react with metals. Special corrosion inhibitors for the oil industry help prevent premature destruction of the pipeline.

As the field reaches its final stage, corrosion increases for the following reasons: increased water logging, equipment wear, and intensification methods used to increase the productivity of oil fields. In this regard, the number of failures of producing wells is increasing [7].

One of the most dangerous factors for the metal pipelines is the content of hydrogen sulfide. The release of hydrogen sulfide is dangerous for both service personnel and equipment. Formation of perforating holes emerge as a result of accumulation of iron oxides on the outer wall of the pump-compressor pipe. This can be either general or pitting corrosion that disrupts the operation of the well and pumping equipment.

The appearance of pits in large pipelines with a diameter of 426 mm reduces its service life by several times [8].

The introduction of oil corrosion inhibitors helps to reduce the aggressive effects of liquid and gaseous environment and protect the inner surface of the pipeline from cracking and local damage.

The following factors influence the rate and distribution of corrosion of underground and surface well equipment:

- well type and method of oil production;
- productivity and mode of motion in the well of the gas-liquid mixture;
- composition and properties of extracted oil;
- composition and properties of formation water extracted with oil;
- composition and properties gases such as hydrogen sulfide, CO₂, etc.;
- the ratio of oil and water in the produced products and the nature of the distribution of these phases in each other;
- formation of passive films and coatings on a metal surface made of organic and inorganic material (paraffin, resins, iron sulfide, calcium, magnesium and iron carbonates);
- presence of abrasive particles in the liquid flow (sand, iron sulfide, salt crystals, clay, etc.);
- microbial corrosion [9].

The most popular methods of corrosion protection are: creating rational coatings, coating products with protective corrosion-resistant metals (chrome plating, zinc plating), painting metal products with paints and varnishes, metal alloying, using special materials to create equipment that is not affected by corrosion[10].

Phosphate inhibitors. Film-forming inhibitors protect metal by creating adsorption films on its surface. Film-forming inhibitors include phosphates, NaOH and Na₂CO₃[10]. Phosphates are widely used to protect iron and steel in the system of household and municipal wastewater. The presence of phosphates leads to the formation of a protective film on the surface of iron. It consists of iron hydroxide sealed with iron phosphate. Phosphates are often used in a mixture with polyphosphates in order to improve its protective properties [11].

Phosphates, including metaphosphates, orthophosphates, and sodium polyphosphates, are used as corrosion inhibitors in Kazakhstan and abroad. Phosphates are less effective than chromates and nitrites, however they are non-toxic and they prevent scale formation [12].

Conclusion. This article considers the main factors that affect the process of corrosion. Basic concepts of corrosion and the main methods of protection are established. The role of various inhibitors on the thermodynamic stability of the system in its presence is determined. The usage of phosphate inhibitors is effective in aggressive environments.

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ТҮЙІН

Болатты химиялық реагенттердің теріс әсерінен қорғау агрессивті орталарда өндірістік объектілер мен мұнай құбырларының ұзақ мерзімділігін арттырудың неғұрлым тиімді әдістерінің бірі болып табылады. Коррозия жылу энергетикасына, мұнай-газ өнеркәсібін сумен жабдықтауға айтарлықтай залал келтірілді. Органикалық емес ингибиторларды қолдану тотығу ингибиторлары әртүрлі факторлардың коррозиялық процестерге әсерін баяулатуына немесе азаюына байланысты, CO_2 және H_2S болған кезде агрессивті ортада болатты тиімді сақтау мақсатында тау-кен өнеркәсібінде жалпы қабылданған тәжірибе болып табылады. Тежеуші әдіс жоғары тиімділікпен, төмен құнмен және іске асырудың қарапайымдылығымен сипатталады. Ингибиторларды қолдану металл беттерін қорғағыш эмальдармен және мастикалармен өңдеуден аулақ болуға, сондай-ақ қоспаланған болаттан жасалған қымбат тұратын құбырларға тапсырыс беруге мүмкіндік береді. Коррозияның алдын алу үшін коррозия процестерін бейтараптандыру немесе бәсеңдету үшін химиялық қосылысты агрессивті ортаға салу жеткілікті.

РЕЗЮМЕ

Защита стали от негативного воздействия химических реагентов является одним из наиболее эффективных методов повышения долговечности производственных объектов и нефтепроводов в агрессивных средах. Коррозия металла причиняет значительный ущерб теплоэнергетике, водоснабжению и нефтегазовой промышленности. Применение неорганических ингибиторов является общепринятой практикой в горнодобывающей промышленности с целью эффективного сохранения стали в агрессивной среде при наличии CO_2 и H_2S в связи с замедлением или уменьшением воздействия различных факторов на коррозионные процессы. Метод применения фосфатов для коррозионной защиты характеризуется высокой эффективностью и низкой стоимостью. Использование ингибиторов позволяет избежать обработки металлических поверхностей защитными эмалями и мастиками. Для предотвращения коррозии достаточно внести химическое соединение в агрессивную среду для нейтрализации или замедления процессов коррозии.