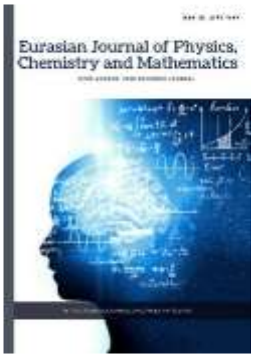

Questions About the Protection of Corrosion Inhibitors of Equipment and Pipelines in the Oil and Gas Industry

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ABSTRACT

The gas industry is associated with the consumption of a huge amount of metal, which by its nature is subject to corrosion. Corrosion occurs in preparation for gas production, in the process of its processing and transportation. Especially intensively corrodes metal equipment during gas production, because. natural gas contains such aggressive metal components as hydrogen sulfide, carbon dioxide, water vapor and organic acids. The article deals with the issues of inhibitor protection of oil and gas equipment from corrosion.

Keywords: gas and oil pipelines, inhibitor protection, volatile inhibitors, steel protection, hydrogen sulfide.

At gas fields, mainly imported carbon steel is used. Sulfur is found in natural gas in free form and in the form of hydrogen sulfide. Of all the components of the produced gas, hydrogen sulfide is the most corrosive. Hydrogen sulfide in the presence of moisture causes electrochemical corrosion of the metal, as a result of which, along with general corrosion, mechanical destruction of the metal occurs. The latter is caused by the onset of hydrogen or so-called "sulfide" brittleness in the metal. It is especially dangerous for live metal equipment.

Metal corrosion is sharply enhanced due to the presence of highly mineralized deposits in the environment that negatively affects the well equipmentaste water. They contain, as a rule, chlorides, sulfates of alkali and alkaline earth metals, hydrogen sulfide, carbon dioxide, organic acids and other organic components. Corrosive destruction of underground and surface equipment of gas fields leads to an increase in the cost of repairs, replacement of pipes, and in some cases - to the breakage of pipe parts.

That is why the fight against corrosion in the gas industry is one of the important national economic tasks, the solution of which leads to the saving of significant material and technical resources.

The high aggressiveness of operating media is determined by the presence of aggressive gases (hydrogen sulfide, carbon dioxide and oxygen) in them, as well as the presence of an aqueous phase and its physicochemical properties (pH, temperature and salinity). The presence of corrosive gases in the product leads to corrosion destruction of steel equipment and pipelines in the process of production, purification, transportation and processing of hydrocarbon raw materials. When operating oil and gas fields containing large amounts of acid gases, there is a difficult problem of protecting gas production equipment from corrosion. Inhibitor protection is one of the most convenient and economical means of combating corrosion under these conditions [1].

The main danger for gas and oil pipelines is condensate formed when the temperature of oil and gas decreases, which consists of a two-phase system, in the water part of which corrosion processes occur. Characteristically, the surface area in contact with the vapor phase is often much larger than with the liquid. Certain requirements are imposed on inhibitors in terms of technological and protective properties. Inhibitors should have high protective properties in hydrogen sulfide-containing water and vapor phases of at least 85% of total corrosion and at least 70% of hydrogen embrittlement and not have a negative impact on technological processes [2].

Conditions of periodic wetting of the metal surface usually occur during the transportation of raw gas through the pipeline. The high corrosiveness of such an environment can pose a serious threat to the integrity of the gas pipeline system. The rate of corrosion of samples in the vapor phase and not subjected to wetting increases with an increase in the acidity of the medium from 0.1 (pH 8.4) to 0.39 (pH 3.0) mm/year. With an increase in acidity, the vapor pressure of H_2S and its amount in the vapor phase increase. When CO_2 is added to this system, the corrosion rate is approximately 0.1 mm/year over the entire pH range studied, which is apparently associated with the presence of certain protective properties of carbonate-sulfide films. However, when these films are exposed to liquid, they are easily washed off. These results confirm the information about the high corrosiveness of the gas phase of storage tanks for oil and oil products. As is known, in acidic environments, H_2S, stimulating corrosion, also accelerates the hydrogenation of steel, which leads to the loss of its plastic properties and cracking. We have established [3] that the amount of hydrogen absorbed by steel in the vapor-gas phase above the H_2S-containing solution is not less than in the aqueous phase. The hydrogen content in steel increases with time, and already after 24 hours its amount in the metal in both phases exceeds 7.0 cm3 /100 g of steel. In an oxygen-free environment, the corrosion rate reaches a constant value of 0.1–0.15 mm/year 3–4 hours after the beginning of the passage of a moist H_2S-containing gas through the container where the steel samples were located [3].

Nitrogen-containing compounds have received the greatest application for protecting steel from hydrogen sulfide corrosion as inhibitors. Despite the fact that a large number of inhibitors recommended for use in these operating conditions are known, the problem of creating an effective and affordable inhibitor remains relevant. Comparative analysis of known amine-type corrosion inhibitors failed to find compounds that are equally effective in various investigated media. As mentioned earlier, in H_2S-containing media, corrosion occurs equally intensively both in the gas and vapor phases. Liquid-phase (contact) inhibitors of hydrogen sulfide corrosion protect the metal only when applied to the surface, require special injection methods to completely cover it and do not always provide high-quality treatment of all hard-to-reach areas of an extensive gas transmission system where the steel surface is in contact with an aggressive vapor-gas phase, and, therefore, do not guarantee their protection. In connection with the shortcomings of contact inhibitors, the question of using volatile corrosion inhibitors under these conditions, which have the ability to spontaneously reach the protected surface from the vapor-gas phase and adsorb on it, is of interest.

The most difficult thing is to obtain volatile inhibitors that would effectively protect both in the water and vapor phases, often containing high concentrations of H_2S and CO_2. Under these conditions, high protective properties are usually shown with a high molecular weight. In this regard, the search for new highly effective H_2S and CO_2 corrosion inhibitors with a low molecular weight remains an urgent problem. Unfortunately, many amine-type compounds can have a negative impact on technological processes in the preparation and processing of hydrocarbon feedstock. This significantly limits the scope of their application. Although many inhibitors of sulfide corrosion as inhibitors are known, the problem of developing effective volatile corrosion inhibitors to combat it remains relevant. Nitrogen-containing bases synthesized by the Schiff reaction look promising. It is known that these compounds - Schiff bases, or azomethines, have a good adsorption capacity and can inhibit the corrosion of steel in solutions of mineral acids. In addition, some compounds of this class are capable of undergoing various transformations on the metal surface, in particular, polymerization with the formation of protective films, and their lower homologues can be quite volatile [4].

Conclusions

1. The corrosion rate of steel in a two-phase system containing H2S is either higher in the vapor phase or the same in both phases. The hydrogenation of steel occurs equally intensively both in the steam and in the water phases.

2. Mineralized formation waters with a low content of hydrogen sulfide or with its complete absence have a high degree of aggressiveness. Most of the classes of compounds used as corrosion inhibitors are ineffective in this environment. Mixed inhibitors can become effective means of protection.

3. Conventional amine-type inhibitors are often unable to effectively protect steel from hydrogen sulfide corrosion in the vapor phase. In addition, they are not free from technological disadvantages. Azomethines synthesized by the Schiff reaction can be effective volatile corrosion inhibitors in the H_2S-containing vapor phase. They are able to reduce not only the corrosion rate, but also the hydrogenation of steel, and also have a significant aftereffect of protection.

4. Regardless of the heat transfer mode, the safety of metal in relatively hermetic systems is achieved by using volatile corrosion inhibitors that form azeotropes with water at a dosage that provides $C_{sing}>C_s$, at $C_s>C_{sat}$ for the entire possible temperature range of the medium.

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