AMERICAN JOURNALS
Open Access, Peer Reviewed Journals

American Journal of Pedagogical and Educational Research
ISSN (E): 2832-9791| Volume 18, | November, 2023

PECULIARITIES OF CORROSION OF THE EQUIPMENT OF THE SYSTEM OF PURIFICATION OF HYDROCARBON GASES FROM ACIDIC COMPONENTS

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A B S T R A C T	K E Y W O R D S
Today it is difficult to imagine various sectors of the national economy, including the oil and gas and chemical industries, without metal equipment. Equipment used in various industries is constantly exposed to external and internal environments, as a result of which metal equipment loses its original properties. This, in turn, leads to the formation of oxides and hydroxides of the metals used as a result of contact with the external and internal environment, and corrosion of metal equipment is observed. The article analyzes the causes of corrosion damage to metal equipment and equipment of devices for purifying hydrocarbon gases from acidic components.	MDEA (methyldiethanolamine), corrosion, pitting, pitting, solid-uneven, shell-and-tube heat exchanger, piping network

Introduction

Chemical and electrochemical corrosion is one of the most common types of corrosion in gas processing plants. The main problem that arises in cleaning hydrocarbon gases from acidic components is the internal corrosion of heat exchangers, which mainly manifests itself in the form of corrosion cracks under the influence of various aggressive environments[1].

In the research of corrosion decay of devices, the data obtained as a result of continuous inspection of the device, as well as the analysis of the corrosion condition of the installed samples were used as a basis. The material design of devices for purifying hydrocarbon gases from acidic components, possible corrosion damage and their nature are considered using the example of the Gazli gas processing plant. For the first time, all possible types of corrosion degradation and zones of aggressive corrosion by current, by type of corrosive agents and type of corrosive environment were studied at the amine hydrocarbon purification plant[2].

RESEARCH METHODOLOGY

In addition to general corrosion, pressure equipment and plant equipment are susceptible to various types of localized corrosion, including stress corrosion cracking and pitting corrosion (Figure 1).

The K-1 absorber is made of 09G2C steel. The inner surface of the device is covered with a 2-3mm thick corrosion-resistant material, which protects the shell made of 09G2S steel from the aggressive environment. Therefore, despite the fact that the environment in the K-1 absorber is very aggressive (H_2S, CO_2, CH_4, H_2O and MDEA), the corrosion process is relatively slow. However, in layers coated with anti-corrosion material and in welded seams of columns, tanks and condensation-cooling equipment, as a result of corrosion erosion, cracks are formed that spread to the surface of the base metal - carbon steel (the base metal does not "temporarily" weather)[3].

However, when carbon steel with low corrosion resistance is exposed to an aggressive environment, it results in severe corrosion of the base metal.

The separation of natural gas released from the bottom of the K-1 absorber and added to the saturated amine solution is carried out in the C-1 separator. Separator S-1 is made of steel 20YCh.

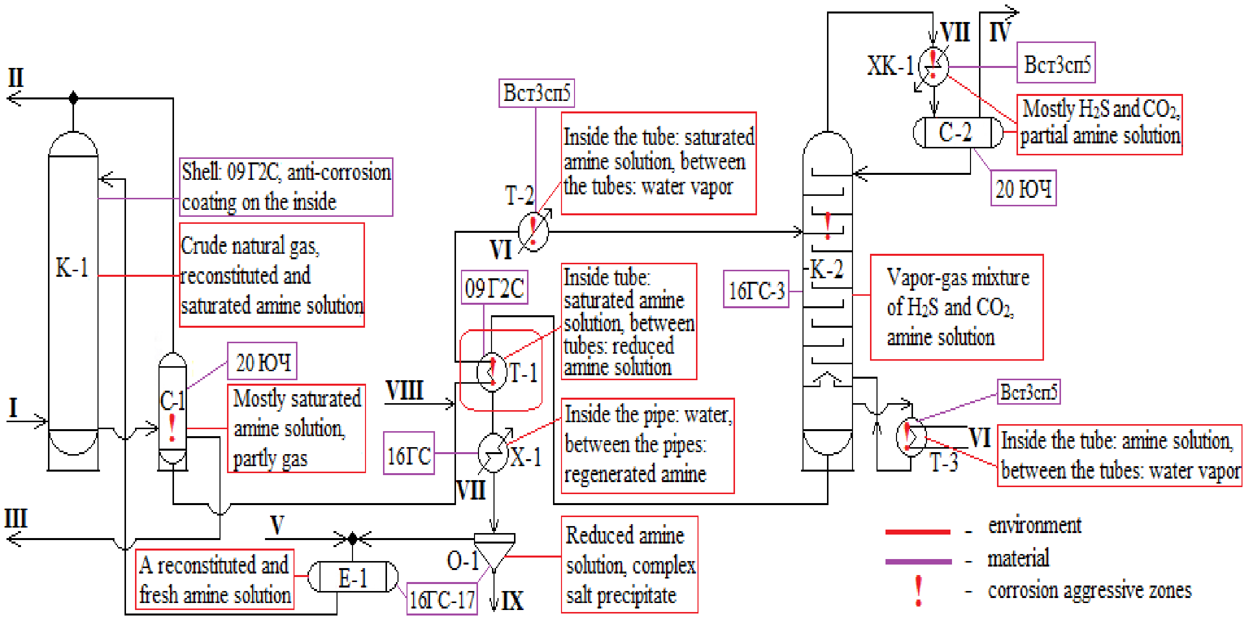

Figure 1. Calculation of corrosion-aggressive zones of an amine purification plant for hydrocarbon gases and the selection of proposed corrosion-resistant materials.

I-gas for cleaning; II-purified gas; III-hydrocarbon condensate; IV- H2S; V-methyldiethanolamine solution; VI pairs; VII-water; VIII-inhibitor; IX - complex salt precipitate.

The composition of grade 20YCh steel consists mainly of 97% iron, in addition to aluminum, chromium, carbon, silicon, phosphorus, sulfur, and is used in the manufacture of the following parts:

- shells and flat flanges;
- corrosion-resistant oil and gas pipelines;
- parts and units operating in an aggressive environment containing hydrogen sulfide or carbon dioxide;
- Parts operating in the temperature range from -40°C to +475°C..

In addition to the above, 20YCh steel is used in the production of pipeline fittings and welded tanks for the oil and gas industry.

The saturated amine solution removed from the bottom of separator C-1 is heated by the heat of the reduced amine solution in heat exchanger T-1[4].

The T-1 heat exchanger is made of 09G2S steel. Contains 0.09% carbon, 2% manganese, up to 1% silicon and about 2.5% other additives. The most aggressive corrosive zone of the installation for amine purification of hydrocarbon gases is the T-1 heat exchanger, and the most vulnerable part of the installation to corrosion is the tube bundles. Their service life is 1.5-3 years, depending on the type of aggressive environment and temperature. The saturated amine solution removed from the T-1 heat exchanger is fed into the K-2 desorber at a temperature of 80 ℃. This device is made of steel 16GS-3 with a carbon content of 0.12-0.18%, silicon 0.4-0.7%, manganese 0.9-1.2%, containing up to 0.3% nickel, sulfur up to 0.04%, phosphorus up to 0.035%. , up to 0.3% chromium, up to 0.008% nitrogen, up to 0.3% copper, up to 0.08% arsenic and 97% iron. The reason for the corrosion process in the upper part of the desorber is explained by the high concentration of H_2S and CO_2. The corrosion process in the lower part of the stripping device, where the nozzles are located, proceeds faster than in the upper part of the device. The reason for this is due to exposure to high temperature and direct current[5].

The inhibitor is introduced into the system perpendicular to the MDEA-saturated pipe entering the T-1 heat exchanger. The high concentration of corrosion inhibitor in the T-1 heat exchanger blocks the corrosion process due to the formation of a complex compound with the metal surface in the corrosion-active zones of the device. The effect of direct current in the tubes of the T-1 heat exchanger causes the formation of a layer of complex compound formed by the metal surface over a certain period of time. In this case, instead of the migrated layer, the corrosion inhibitor constantly added to the medium creates a new layer. Extraction of the remains of the migrated layer containing complex salts is carried out in an O-1 quencher. The remnants of the migrated layer containing complex salts are removed from the tapered lower part of the O-1 clarifier, and the reduced amine solution, cleared of residues, is removed from the upper part.

The recovered amine solution is mixed with a new amine solution in container E-1 and sent to the absorption column. The purified gas is removed from the upper part of the absorber.

SUMMARY

When analyzing the corrosion process occurring in the equipment of a technological system for purifying hydrocarbon gases from acidic components, it was found that the corrosion rate is high in shell-and-tube heat exchangers.

When studying the corrosion process in a shell-and-tube heat exchanger, a certain number of saturated and regenerated MDEA samples were analyzed in the system and heat exchangers that failed due to corrosion. A number of experimental data have been obtained that reveal the reasons for the failure of heat exchangers.

In industry, shell-and-tube heat exchangers are used to transfer heat from one fluid to another. In this case, one of the liquids heats up and the other cools. The structure of the device is shown in Fig. 2. The device mainly consists of a housing and a set of tubes inside it.

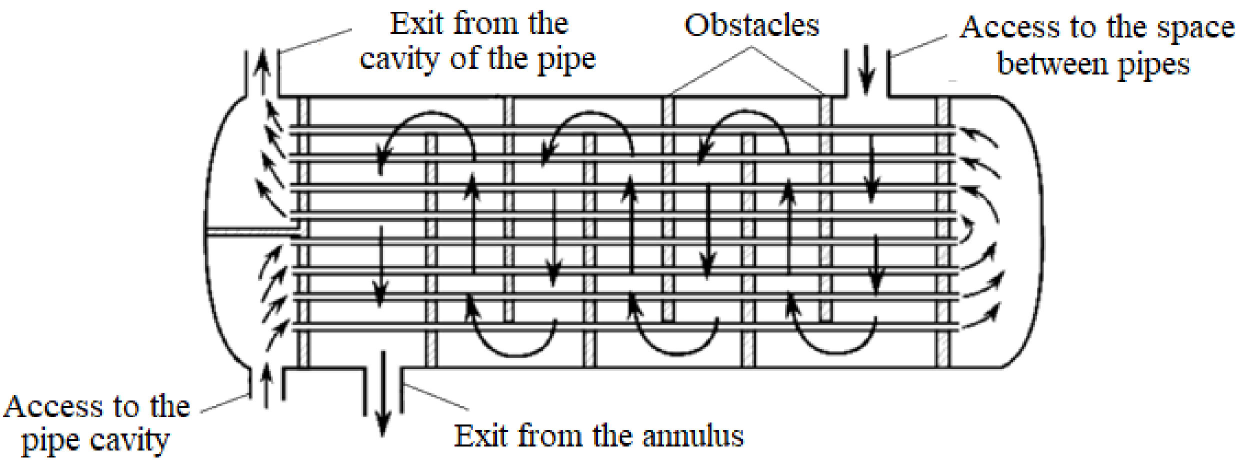

Figure 2. The principle of operation of the shell-and-tube heat exchanger

The reasons for the decrease in the capacity of the shell-and-tube heat exchanger are the accumulation of foam, oil, salts and tars on the heat exchange surface of the pipes, as well as metal corrosion.
Performance characteristics of the studied heat exchanger:
- environmental parameters inside the pipes: saturated amine solution, T = 50...80°C; P=490 kPa
- pipe size and material: Ø 20×2.0 mm, steel 09G2S;
- parameters of the environment between the pipes: the recovered amine solution, T=118...83°C; P=910 kPa
– pipe grid -12X18N10T;
– corrosion allowance: 3 mm.

There are three types of corrosion damage in shell-and-tube heat exchangers:
1. Corrosion of the connections between the network of pipes and barriers (Fig. 3)
2. Corrosion-erosive damage of the inner surface of the inlet and outlet nozzles of the heat exchanger
3. At first, uniform, uneven, pitting corrosion along the entire length of the heat exchange pipe (Fig. 4)

The most rapidly corroding part of the shell-and-tube heat exchanger is the tube set. Barriers are installed in order to make the device multi-way in the space between the pipes. Corrosion is observed at the junctions of pipes with barriers and pipe networks.

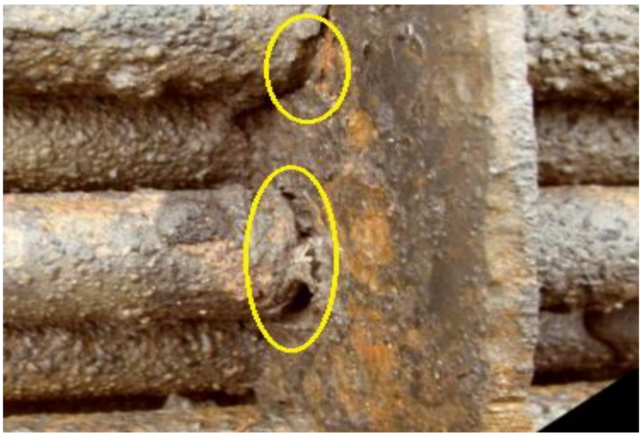

Figure 3. Corrosion of connections between pipes, piping network and barriers

There is completely uneven, pitted and pitted corrosion on the inner surface of the heat exchange tubes.

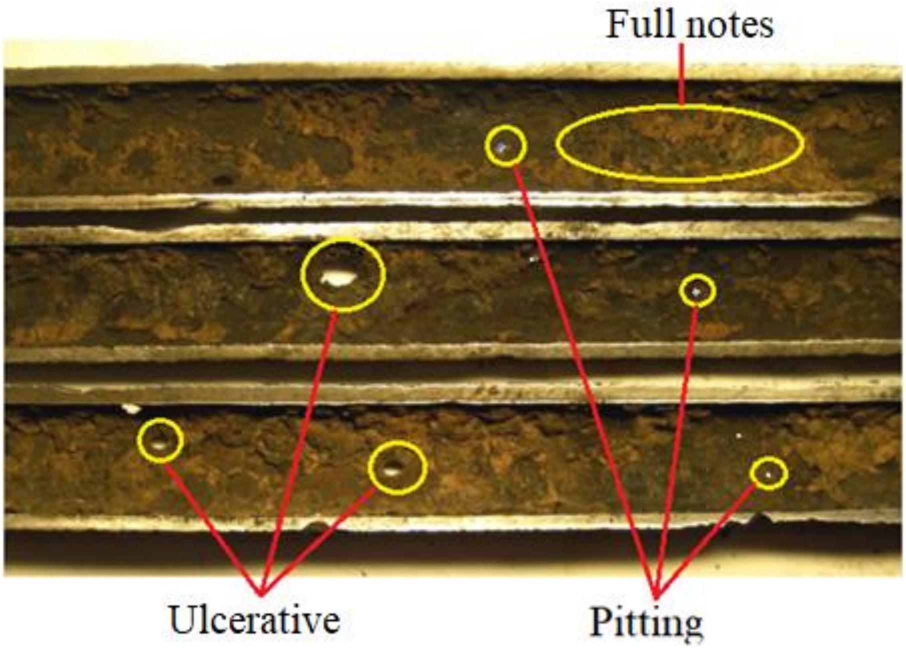

Figure 4. Corrosion on the inside of pipes

The intensity of corrosion processes occurring in shell-and-tube heat exchangers depends on the environment, temperature and flow rate.

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