

Biocide Storage Tank Internal Corrosion and A Mitigation Strategy – A Case Study

Ayman A. Alabdullatif
Saudi Arabian Oil Company
Dhahran, 31311
Saudi Arabia

Rakan A. Al-Shebil
Saudi Arabian Oil Company
Dhahran, 31311
Saudi Arabia

Wakeel Ahmad
Saudi Arabian Oil Company
Dhahran, 31311
Saudi Arabia

ABSTRACT

Variability of operation and practices can lead to mechanical integrity issues of equipment. A similar case was observed when an external UT survey was conducted on a biocide storage tank that showed localized areas of metal loss in the tank wall. The tank was opened for inspection and extensive internal corrosion damage was observed mainly in the form of large isolated pits. Three potential corrosion mitigation options were evaluated: upgrading the tank material from coated carbon steel to 316 stainless steel, installing a non-metallic lining, or keeping using the coated carbon steel and changing the operation practices. Each mitigation option was evaluated based integrity, feasibility, and economic factors. It was found that keeping the coated carbon steel and adjusting the operation practices can ensure the integrity of the tank while lowering the required economical investment. As such, a new operation manual was issued for the biocide storage tanks that ensured that the corrosion inducing environments are avoided.

Key words: corrosion control, corrosion mitigation, oil field chemicals, operational practices, biocide, chemical storage tanks

INTRODUCTION

As facilities in the oil and gas industry age with time, corrosion mitigation and control become ever more important. Failure of any part of processing equipment is likely to entail production loss, loss of containment, environmental impact, and/or human risk. Internal corrosion failures represent one of the major risks to a process equipment and piping. Chemical treatment is one of the main corrosion mitigation methods that are used in the industry. These chemicals include corrosion inhibitors, scale inhibitors, oxygen scavengers and biocides. As these chemicals are used to mitigate corrosion, it is sometimes

forgotten that in their neat form, they can be corrosive if not used, stored, and maintained properly. As such, the concepts of corrosion management should be applied to chemical injection systems as well.

Corrosion management includes correct selection of materials, protection from corrosion, and corrosion monitoring and inspection. This should be carried out at the stage of design and then optimized and improved upon while under operation. In some instances, changes can happen to a facility that renders previous corrosion management practices ineffective. Under such circumstance, it is important to reapply corrosion management concepts and choose the most effective options to rehabilitate the system.

BACKGROUND

One of the company's major oil producing facilities is Khurais Central Processing Facility (KhCPF) which comprise of multiple different plants joined under one industrial complex. One of these plants is a water injection plant that delivers high pressure seawater which is used to maintain the reservoir pressure and continue oil production. After the water is received and pressurized, it is distributed to multiple injection wells scattered throughout the field through a massive water injection pipeline network.

Maintaining the integrity of the water injection pipeline network is essential for continuous operation of KhCPF. One of the major risks that threatens the integrity of water injection pipeline network is microbially induced corrosion (MIC). MIC is the deterioration of a material due to the presence of and activities of microorganisms (bacteria, archaea, fungi, algae, etc.) and/or the products they produce. The corrosion associated with bacteria is usually localized pitting.^{1,2}

The presence of microorganisms poses multiple threats. In addition to jeopardizing the integrity of water injection pipeline network, it also risks contaminating the reservoir with bacteria. As such, controlling bacteria is of utmost importance. In KhCPF water injection plant, microorganisms are controlled by regularly performing a biocide treatment in the injection water.

To ensure that the biocide treatment implemented is effective and sustainable in the long run, two different types of biocides are used alternately in batches: biocide A, and biocide B.³ Biocide A is a tetrakis(hydroxymethyl)phosphonium sulfate (THPS) based chemical (20-40% THPS by weight) with a solution pH of 3-5. Biocide B is glutaraldehyde based chemical (20-60% glutaraldehyde by weight) with a solution pH of 3-5.

The two biocides are stored in separate storage tanks to avoid mixing these two chemicals. As such, in KhCPF there are three biocide chemical storage tanks tank A, B, and C. Tank A is used as a spare tank, tank B is used to store biocide A, and tank C is used to store biocide B. As with all chemical storage tanks in KhCPF, the tanks are surrounded by a dike to manage any potential loss of containment during filling or pump adjustments. Figure 1 below showcases a simplified diagram of the biocide tank set up.

The three-tank set up is used to host two biocides and have a backup tank. Given the large amounts of water treated, the biocides used for treatment is also under high consumption. As such, unlike other chemical storage tanks in KhCPF, the capacity of the biocide storage tanks is very large and require a lot of material to construct. The tanks are constructed of ASTM A36 carbon steel and are coated with glass flake reinforced vinyl ester coating.

The tanks are filled through a common line with isolation valves to control which tank is filled. However, to ensure that the two biocides are not mixed in the filling line and cross contaminate the storage tanks, they are flushed with raw water after each filling. The water used for flushing is discharged in tank A. This leads to tank A serving as a dumping vessel to protect the other tanks in addition to being a spare tank. The dike drainage also discharges in tank A; meaning that the all liquids accumulated in the dike including

rain water and dust is also fed back to tank A. Unlike tank B and tank C, tank A is in contact with not only the biocide chemicals, but also water.

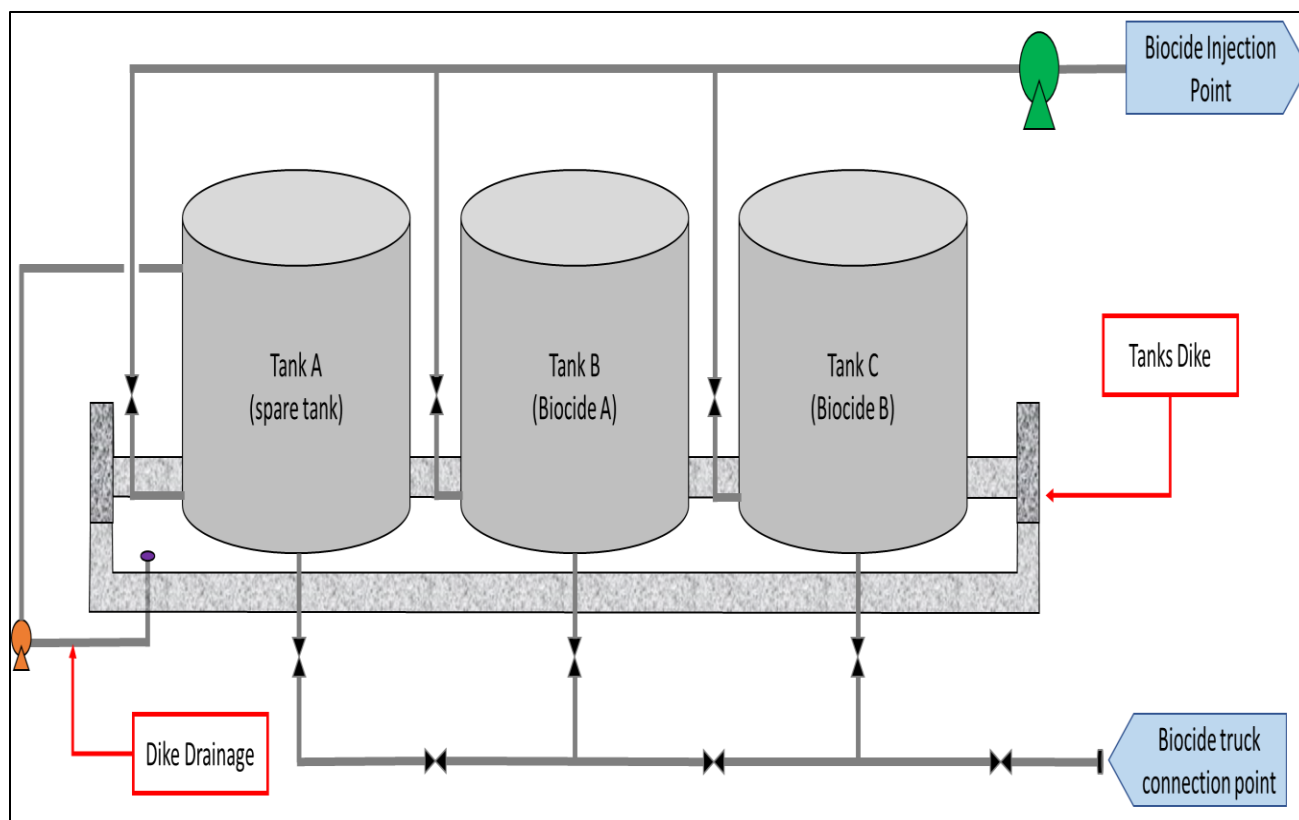


Figure 1: Simplified diagram of biocide storage tanks in KhCPF.

OBSERVATIONS AND FINDINGS

As a part of KhCPF inspection program, ultrasonic testing (UT) was performed externally on selected sections of the biocide tanks. The UT inspection revealed multiple internal corrosion anomalies in tank A's shell in the form of localized corrosion. Metal loss reduced the wall thickness from 6.50 mm to 5.3 mm. After observing the metal loss, the tank was drained, flushed, and opened for further inspection. After opening the tank, several internal corrosion anomalies were observed. In addition, as the tank is internally coated, all the metal loss anomalies were accompanied by coating failures. See Figure 2 below for visual inspection findings.

Seeing that the tank suffered multiple severe coating failures and internal corrosion anomalies, it was recommended to grit blast the coating for a more detailed inspection. Stripping the coating and conducting the further inspection, a total of nine (9) localized internal corrosion anomalies were found. The base metal of the tank did not suffer any general metal loss. The localized corrosion found, however, was severe with the worst metal loss of over 60% as highlighted in Table 1.