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# The Chemical Corrosion in Pipelines in Petroleum Production Processes Causes and Methods of Treatment

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**Abstract:**

Corrosion is the deterioration of a material as a result of its interaction with its surroundings and can occur at any point or at any time during petroleum and natural gas processing and causes huge economic losses. In this study we have discussed the chemistry, types and consequences of corrosion. Corrosion fundamental corrosion is the degradation of materials properties due to interactions with their environments and corrosion of most metals is inevitable while primarily associated with metallic materials, all material, types are susceptible to degradation. The corrosion of steel by natural and industrial oil is a complicated and many sided phenomenon, due to three main considerations involved the composition and surface condition of the steel, the quality of the production and the operating conditions.

## Introduction

Corrosion is the main problematic system affecting the pipeline structure in the world. Corrosion refers to the damaging reaction of a metal with its environmental.it takes place in the attendance of a supportive intermediate, which is referred to as, an electrolyte. Corrosion, leads to problems such as leakages, that lead to disasters, such as fires, and explosions(1). Therefore it effects, the safety concerns, and standards held in oil, and gas pipelines. There are different, countries are used different sources, of energy such as fuels, natural gas and oil. Oil, and gas are the dominant, sources of energy for production, and supporting, life in world, over. Just like any other product, there is need. to enhance, the efficient, distribution of oil and gas, from the production, centers to different

users through intermediaries . in this case efficient distribution of both oil as well as gas to the users ensures that they are safe(1).

1-1causes of corrosion

1-1-1oxygen

In oil production corrosion, attack of internal surfaces, by oxygen is, very aggressive normally, oxygen is not present, at depths greater, than approximately, 100m-330ft below surface. Oxygen contamination, is more likely to, occur in facilities used for processing, and handling of produced oil that operate nearby ambient pressure.

Oxygen entrance could occur through leaky pump seals, casing and process vents, open treatment as in mud pits and throughout drilling. Oxygen has some unique properties. It is a robust oxidant with relatively fast discount kinetics according to resulting reaction as example

1/ 2O2+ H2O +2e- 2OH

Oxygen has low solubility in water and brines and this describes why the mass transport of oxygen is the rate warning step in the corrosion reactions of carbon and low, alloy steels in non-acidic, environments. This also explains, the localized attacks in gaps and under deposits, that are attributed to the limited, mass transport in oxygenated, system(2).

1-1-2Hydrogen sulfide polysulfide and sulfur

H2S weak acid willingly soluble in water and is a source, of hydrogen irons

1-1-3Strong acids

Strong acids are pumped into wells, for dissolving balances, increasing formation penetrability normally, HCl(15and 28wt%)is used for limestone formations, while addition of hydrofluoric acid(HF, 3wt%)is necessary for sandstone, formations. in situations, where corrosion inhibitors are not effective in minimizing, attacks by HCl formic acid (HCOOH,12wt%) is used especially, in deep, sour gas wells. In addition, to chemical, inhibitors corrosion control, of these, strong acid solution, is achieved by limiting, exposure, time to 2-12hours(3).

1-1-4Concentration brines

Concentrated brine also called completion brines, are dense halide solutions used to equilibrate formation, pressures during production operation examples include halides, of calcium, zinc and magnesium. Concentrated brines can, be corrosive due to dissolved oxygen entrained air. They can also be corrosive, due to hydrolysis of metallic irons as shown in the following reaction

Zn + H2O = ZnOH+ + H+

To avoid exposure to zinc chloride, (ZnCl) brines, calcium bromide (CaBr2) brines with densities above 1.7g/cm3 are also, used but these are more expensive(4).

1-2The causes of corrosion in materials are as following

1-2-1nature of metals

1-2-2purity of metals

1-2-3the physical state of metal

1-2-4position in Galvanic series

1-2-5position in electrochemical series

1-2-6nature of the oxide film

1-3nature of environment in which the material is kept

1-3-1PH

1-3-2temperature

1-3-3pollutants in atmosphere

1-3-4humidity

1-2-1Nature of metals

Concentration of corrosive effect, on material when electrode, potential of the material is high. Gold, silver, platinum, noble metals like magnesium, zinc, aluminum with low electrode, potential undergo corrosion faster. The high difference in electrode potential, between two metals that are in contact with each other have a greater, chance of corrosion. For example when iron corrodes, rapidly. Taking this into consideration the same metals should be used, and usage of dissimilar metals shouldn't be taken, into consideration(5).

1-2-2Purity of metals

The content in molecular level of a metals, is very important in the case of corrosion pure metal have less chance, of corrosion. But in the case of impure metals due to the presence of minute, electrochemical cells, there are high chances of corrosion(5).

1-2-3The physical state of metal

Physical state of metals plays a major role in faster, corrosion rate metals with less stress corrodes at a slower, rate. But in the case where there is excess stress in metal the rate of corrosion, will be high(5).

1-2-4Position in electrochemical series

Metals with higher reaction, rate will show more corrosion rate on the other hand less reactive metals exhibit, less corrosion rate. The electrochemical series is used to find the reactivity of, the metals(5).

1-2-5Position in Galvanic series

Metals that are placed at a high position, in the Galvanic series show greater oxidation power thus have more tendency to become anodic and thus exhibit more corrosion rate(5).

1-2-6Nature of the oxide film

Specific volume ratio is the term used to find the amount of metal oxide to the metal. If the specific volume, ratio is more in metal there are less chance of oxidation and therefore less chance, for corrosion(6).

1-3Nature of corroding environment

1-3-1Moisture and dew

It is one of the most important factors which causes, corrosion of metals. When metals are exposed to areas that contain high amounts, of moisture and dew it results in the formation of rust or corrosion, rapidly. Dry and non humid conditions are the ideal setup, for metals, especially non-alloy metals. It is impossible to use metals, only in dry and non-humid condition. We will have to use metals other than, dry and non-humid condition as well. Painting and using alloy, metals can be useful for preventing corrosion or rusting(6).

1-3-2Temperature

Temperature also plays, as important role in the corrosion, of metals. High temperature is a significant issue, in the industries like automotive, pulp and paper, mineral and metallurgical, processing, refining and petrochemical and other.at high temperature most, of alloys and metals

corrode and oxidize. the acceleration of the corrosion, when exposed to higher temperature is because of the rise in the temperature, results in the increase of the active center of corrosion in material, or metals(6).

1-3-3Pollutants in the atmosphere

Metals that are near to sea and industries are seen, corroding faster. This is due to pollutants present in the atmosphere, like carbon dioxide, hydrogen sulphide, Sulphur dioxide and HCl which comes, from the industries. On the other hand, NaCl present, in the atmospheric air of coastal areas comes in contact with the surface, layer and increase the liquid presence on the surface of metals. Due to these, problem oxidation and rate of corrosion increase(6).

1-3-4Humidity

The corrosion rate is seen more, in the places with more humidity. This is because moisture content will increase the rate, of oxidation and corrosion rate of metals(6).

1-4Prevention of corrosion

Corrosion is an undesirable event that happens to metals and other materials the phase of corrosion may be slow but it will affect, the core of the metals and decrease, its stability. There are different methods to overcome corrosion some of them are(6).

-painting

-enameling

-tarring

-Galvanizing

-electroplating

-tin plating

1-5Types of corrosion inhibitors

A corrosion inhibitors is a material that attaches, to a metal surface. Providing a protective barrier against, a corrosive reaction developing.

1-5-1Anodic inhibitors react

Anodic inhibitors usually act by forming a protective, oxide film on the surface of the metal causing a large anodic shift, of the corrosion potential. This shift forces the metallic surface, into the passivation region. They are also sometime referred, to as passivate. Chromates ,nitrates , tungstate. Molybdates are some, examples of anodic inhibitors(7).

1-5-2Cathodic inhibitors

Cathodic inhibitors act by either slowing, the cathodic reaction itself or selectively precipitating on cathodic areas, to limit the diffusion of reducing species to the surface. The rates of the cathodic, reaction can be reduced by the use of cathodic, poisons. However cathodic poisons can also increase the susceptibility of a metal, to hydrogen induced cracking since hydrogen can also be absorbed by the metal, during aqueous corrosion or cathodic charging. The corrosion rates can, also be reduced by the use of oxygen scavengers that react with, dissolved oxygen(8).

1-5-3mixed inhibitors

Mixed inhibitors work by reducing, both the cathodic and anodic reactions. They are typically film forming compounds, the cause the formation of precipitation on the surface blocking, both anodic

and cathodic sites indirectly. Sodium silicate and phosphates, used in domestic water softener salts, to prevent rust water are examples(9).

1-5-4 volatile corrosion inhibitors

Are compounds delivered to the, site of corrosion in a closed environment. The form a protective film only, a few molecules thick. For example, in boilers, volatile compounds, such as morpholine or hydrazine are transported with steam, to prevent corrosion in condenser tubes(10).

In shipping wrapping metals, in volatile corrosion inhibitors coated paper is a common short-term protecting against corrosion, during transit. The chemicals in the paper humidity(10).

1-5-5water soluble corrosion inhibitors

Water or aqueous solution are mixed, with corrosion inhibitors so that metals that come into contact with water are protected, against corrosion. A typical application for this product type is pressure, baths that test the tightness of certain components(11).

Certain water-soluble corrosion inhibitors, are used instead of a neutral cleaner. The cleaned metal surfaces are subsequently, protected against corrosion for several month(10),.

That to achieve adequate protection, of pipelines from continuous corrosion inhibitor addition the deployed corrosion, inhibitor should be preferentially water soluble. It shows how the concentration, of a product in the water phase can vary dramatically with both, solubility and water cut. In addition two other important, parameters. Dissociation and adsorption are also discussed and shown to have, a significant impact on product performance(11).

1-5-6 oil soluble corrosion inhibitors

The foundation of oil soluble corrosion inhibitors, are imidazolines and amido amines these molecules become surface active, cations when combined with different acids. These cations, form a strong film on metallic surfaces. Thus inhibiting the metal from, corrosion. The addition of oil soluble fatty acids. Dimer and trimer acids, further enhance the filming characteristics of the base imidazoline, and amido amine products(12).

1-5-7 neutralizing imidazolines

Choosing the right acid is an important, step which will depend upon specific field conditions. The acid choose to use can, significantly enhance the corrosion inhibitor′s performance, as well as, improving solubility. Neutralizing imidazoline with both acetic, acid produces oil soluble/water dispersible corrosion inhibitors. This gives, the opportunity the right balance for your, requirements(13).

2-Material and methods

As a result of study it was noted that the main, destruction of the pipe samples occurred in the lower part where the largest number, of corrosion ulcers was observed. This arrangement of corrosion defects, is associated with the phenomenon of differential aeration. Air oxygen, unevenly enters the soil which causes area with different, cathode potential to appear on surface of the sample. in this case anode and cathode, sections appear. At anode sites metals dissolves and corrosive, ulcer appears. Depolarization occurs at the cathode site contributing to the development of the corrosion process(14). In order to determine, the influence of external factors on the corrosion resistance, of steels used in the construction of pipelines. An experiment of artificial, destruction of metals and a protective coating on a laboratory, bench was proposed for this samples of steel. Pipeline can be thought as part, of our life because they are underneath our building and streets. Therefore, the safety of pipelines is paramount in their design and engineering. Steel is the main material used in the construction of oil and gas, pipelines. The main reason for the use of steel is its characteristics of toughness, ductility and weldability. Toughness help in resisting cracks, which, would lead to

leakages. Therefore steel helps the pipelines in withstanding, the pressure of the load heat and changing weather patterns because, it is resistant to cracks. However stainless steel is not an effective, material in the construction of pipelines although it is the most, effective regarding the characteristic mentioned above.is a cost effective from, of steel that bears the characteristic of strength and ductility required for pipeline(15).

3-Results

Studies have shown a high hazard of corrosion, in operation of production and transformation of petroleum in many areas, or many fields. Corrosion is the degradation of materials, properties due to interactions with their environment conditions. The study, shown the corrosion happened during less time in steel pipes while take more than time in $90Mn_2Si$ steel pipes. In different condition that using in study.

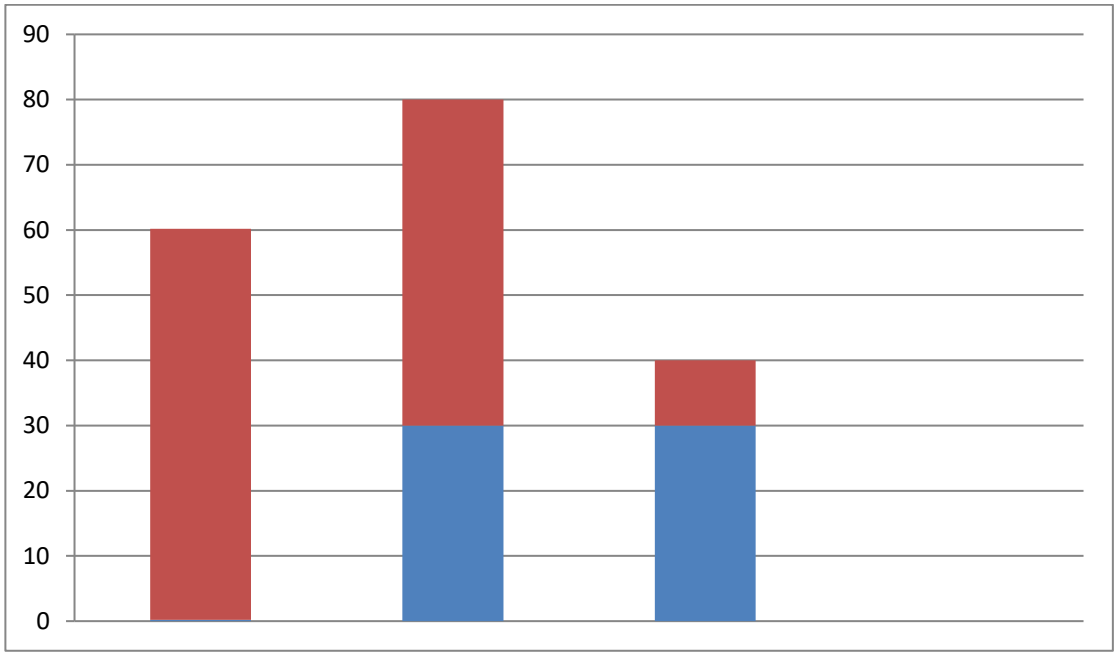


Figure (1) explain corrosion and loss of weight of steel sample.

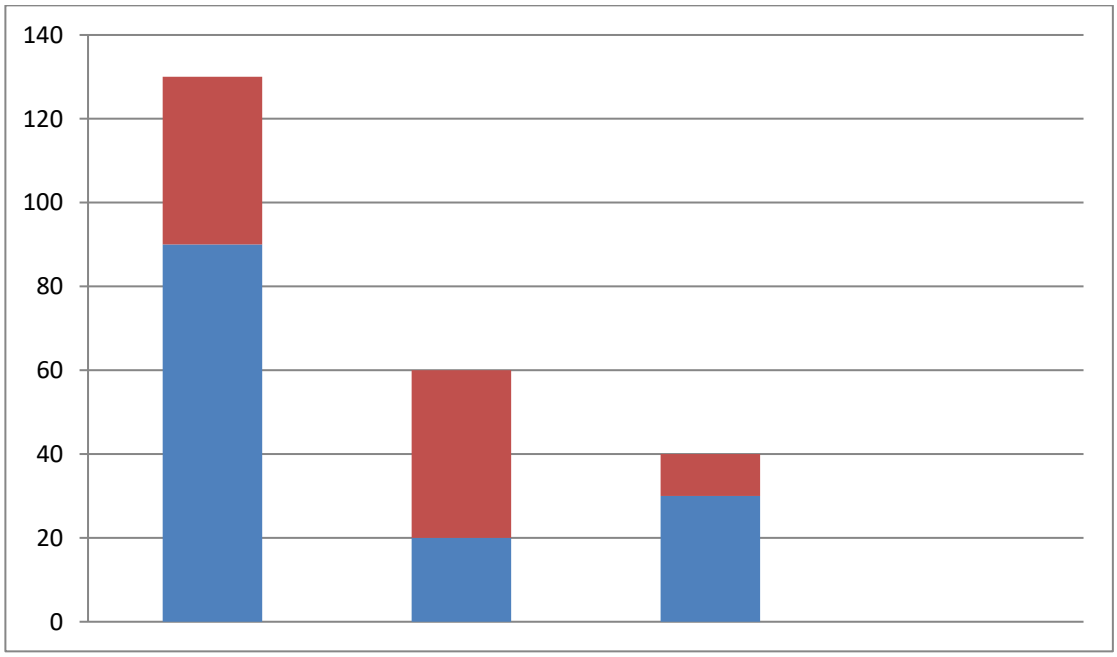

Figure (2) explain corrosion and loss of weight for sample 09$Mn_2Si$ steel.

## Discussion

The summary of this study, was to show that deterioration could lead to destruction of materials with chemical, or electrochemical reaction as corrosion. Corrosion is one of the most complicated, and costly problems facing in petroleum production operations. As a result, of study it was noted that the main destruction of the pipe samples, occurred in the lower part where the largest number of corrosion ulcers, was observed. The results of study is similar with results of study (15) that shown the corrosion increase in steel pipe in marshy soil more than$Mn_2Si$ steel pipe.

## Conclusion

Corrosion is an emerging issue that requires, urgent attention through the development of new designs and mechanisms, of prevention and control. The effects of corrosion have proven to be a threat, to the sustainability and efficiency of pipelines in the distribution of oil and gas, from the production centers to the users. Oil and gas are important, sources of energy in the world. Corrosion is a very serious problem to oil and gas industry. Oil and gas production operations consume, a tremendous amount of iron and steel pipe, tubing, pumps, valves, and sucker rods. Leaks cause loss of oil and gas and also permit infiltration of water and silt, thus increasing corrosion, damage. The petroleum and chemical industries contain a wide variety, of corrosive environments. Some of these many are unique to this, industry. Thus it convenient to group all these environments together. Corrosion problem occur, in these industries in at least three general areas production, transportation, storage and operations. The corrosion has so many bad, aspects and causes huge economic losses and other problems.

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