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Exterminating Attribute of Microbial Community in Oil and Gas Pipeline Network

Priyanka Basera, Meeta Lavania* and Banwari Lal

The Energy and Resources Institute (TERI), India

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***Corresponding author:** Meeta Lavania, The Energy and Resources Institute (TERI), IHC, Complex, 110003, New Delhi, India, Email: meetal@teri.res.in

Abstract

Present research illustrates the destruction of pipeline infrastructure via a microbial community which is also referred as Microbial Influenced Corrosion (MIC) and how alarming it can be if it's overlooked. Network of pipelines are considered as the safest mode of transporting oil and gas, but due to microbial deterioration pipeline industries facing difficulties. This investigation concise the significant facts of microbial corrosion in pipeline sector.

Keywords: Microbial influenced corrosion (MIC); Pipeline; Oil and gas

Introduction

Corrosion in metals is the most atrocious problem for pipeline sector. The network of Oil and Gas pipeline is majorly distributed in worldwide for delivering the energy resources [1]. NACE data set illustrate that $7 billion annually spends on Oil and Gas pipeline industries for control and repair of corrosion. Several factors are responsible for metal corrosion, among which micro-organisms plays a significant role and they have been associated in the accelerating corrosion and cracking of a wide range of industrial system. Corrosion caused by microbial community is referred as Bio-corrosion or Microbial Influenced Corrosion (MIC). MIC is not a distinct type of corrosion form, but rather is the synergistic interaction of microorganisms, with resulting bio films and metabolic products that enhances corrosion processes as depicted in Figure 1.

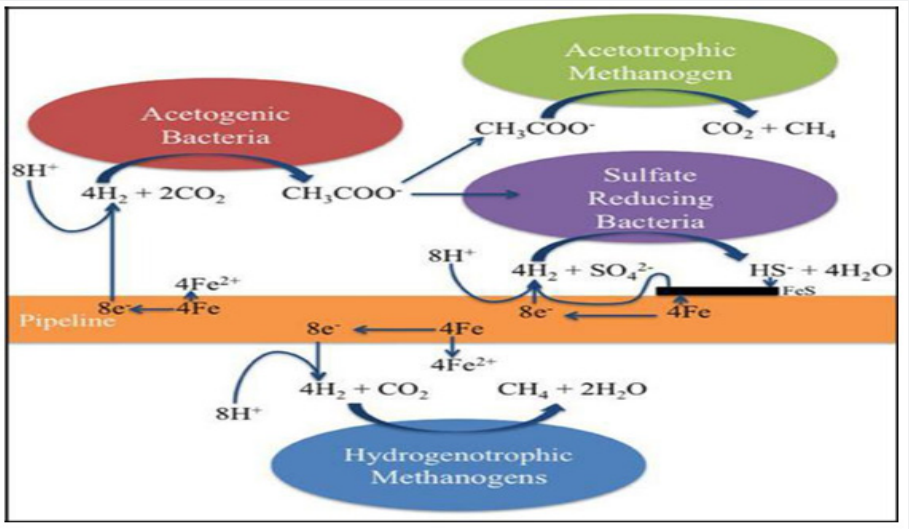

Figure 1: Mechanism showing acceleration of corrosion rate in presence of interaction of different bacteria.

Corrosion in pipelines can be externally or internally as describe in Figure 2 MIC is responsible for 40% of internal pipeline corrosion and about $2 billion annual cost is accounted for this corrosion [2]. In dry pipelines usually moisture converted into liquid or many water droplets as soon as the system temperature reaches below the dew point [3]. For microbial survival four components play major role: water, carbon source, electron acceptor and donor, for this pipeline serves as suitable environment as hydrocarbons act as carbon and electron donor source [4]. MIC brings the change in electrochemical reaction at metal-solution interface, important changes like; change in concentration of ions, pH values and oxidation-reduction potential, alteration in active or passive behavior of metallic substratum. Bacterial community associated with MIC are anaerobic sulfate reducing, iron reducing, iron oxidizing bacteria and methanogens as mentioned in Figure 3. Souring in petroleum reservoirs is referred with the accumulation of sulfide. Sulfate utilizing bacteria that is SRB produces hydrogen sulfide, which is the main reason behind biogenic souring [5]. SRB considered as the main culprit behind MIC in pipelines, they create pitting corrosion or localized, biofilms and leaking [6].

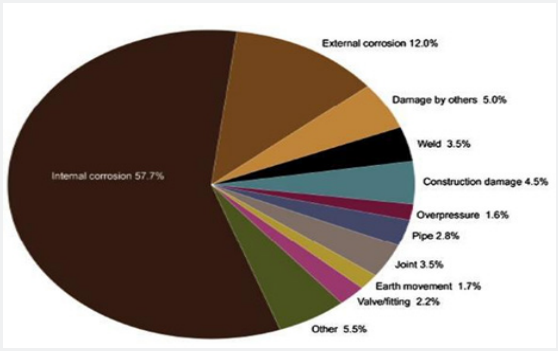

Figure 2: Millions of dollars are spent annually to maintain hydrocarbon pipelines free from any operational breakdowns. In most cases of such breakdowns, the cause is internal corrosion.

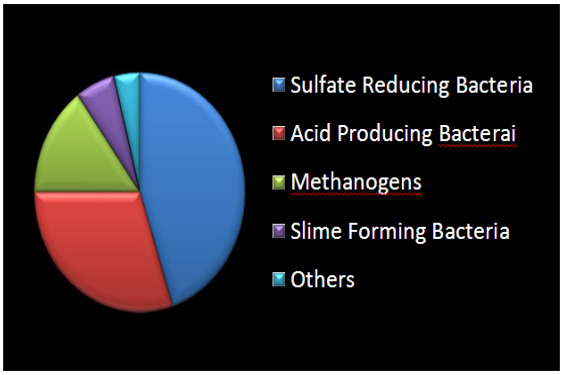

Figure 3: Proportion of corrosive bacterial community playing significant role in Microbial Influenced Corrosion.

Mechanism Involve in Bio-corrosion

Microorganism changes the rate controlling reaction for which they are responsible for corrosion acceleration. They can directly participate in chemical reaction and help in flow of electron as by shown below equations.

Anodic reaction:

$4Fe \quad 4F_e^{+2} + 8_{e-}$

Cathodic reaction:

$8H^+ + 8e- \quad 8H$

$8H_2O \quad 8H^+ + 8OH^-$

Microbial reaction

$SO_4^{2-} + 8H \quad S^{2-} + 4H_2O$

$S_{2-} + 2H \quad H_2S$ (Production of Corrosive gas through SRB)

$Fe^{+2} + s \quad FeS$ (Corrosive Product)

$Fe^{+2} + 6O^{H-} \quad 3Fe(OH)_2$ (Corrosive Product)

Overall reaction

$4Fe + 4H_2O + SO4^{2-} \quad 3Fe(OH)_2 + FeS + 2OH^-$

Cathodic depolarization of SRB results in removal of sulfide (S2-), which further reacts with hydrogen ions present in surrounding pipeline and from a corrosive gas (H2S). Other term for H2S is corrosive gas in pipeline industries which very harmful and hazardous to environment and responsible for economic catastrophe in pipeline infrastructure [7]. Though MIC is a synergistic effect of microbial community SRB's plays the major role in deterioration. Various bacteria including iron utilizing and reducing, CO2 reducing, manganese-oxidizing are involved in MIC [8].

Conclusion

It can be concluded that pipelines play an extremely important role throughout the world as a means of transporting gases and liquids. Microbial deterioration in pipeline sector is the emerging issue which needs to be taken seriously? Several investigators have isolated SRB from the microbial communities involved in MIC in gas and oil-transporting pipelines and lots of corrosion control programs has been established depending upon the damage in pipeline like biocides against microbial community and corrosion inhibitors.

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