Some Literatures Based Corrosion Mitigation Experiences of Indonesian Oil and Gas Industry in the Last 3 Years *)

by:
Deden Supriyatman **)
Head of Technology Cooperation Coordination
TOTAL E&P Indonesie
Plaza Kuningan - Menara Utara, Jl. HR Rasuna Said Kav C11-14 Jakarta 12940
Tel. 021-5231956, Fax. 021-523195
e-mail address: deden.supriyatman@total.com

ABSTRACT

Among the experts, the technical corrosion cases studies in the Indonesian oil & gas industry were commonly discussed e.g. Microbiological Induced Corrosion (MIC), Corrosion Problem in Surface (Pipeline) and Downhole, Corrosion Inhibitor Selection for gas, oil and condensate.

It has been also found in the literatures about the unique type, namely top of line corrosion (TLC) in upheaval buckling natural gas trunk lines having high pressure and temperature (HP/HT). The CO2 and organic acid content in transported gas has driven condensation phenomenon. Such type of corrosion also happen at subsea line, and some might be due to fatigue corrosion.

This paper will briefly discuss the above case studies as well as some technology cooperation to identify and mitigate corrosion in oil and gas industries with local universities and research institution.

Keywords :

Pipelines, Condensation, MIC, Tubing Corrosion, Top of Line Corrosion (TLC), CO2, organic acid, inhibitor, cooperation with research universities and institutions.

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****)** *Corrosion Control Expertise's Moderator of Indonesian Oil & Gas Community (KMI).*

Introduction

It is common that in industrial sector, especially oil and gas industry, corrosion is one of operational problems to be properly handled. The financial loss due to corrosion from time to time is bigger and bigger. This must be integrally compensated with the protection of the problems. One must be aware that production efficiency improvement through maintenance cost reduction must be acquired. This could be proceeded by technology mastery, maintenance strategy application and proper corrosion protection.

The negligence to this effort would lead to greater risk that must be born by the companies e.g. production shortfall, safety and environmental problems, bad company images, etc

Rough statistics show that the financial lost due to corrosion would be 1.5 to 2.5 % of Indonesian GNP, this means quite significant amount of money. However, the cost for corrosion mitigation in hydrocarbon industry would be 4-5 % of total production cost for relatively new fields, or ~10 % for the old ones.

Each oil and gas company in Indonesia has its own specific and various problems. The corrosion taking place in West Natuna, East Kalimantan, Irian and Java and other blocks in Indonesia is also in various types. In Indonesia, the produced fluid contain CO_2 and H_2S that drove the corrosion more serious (**Figure-1**).

Microbiologically Induced Corrosion (MIC)

Several nutrition (sulfate, nitrate, phosphate,…) in produced water of oil and gas fields have driven microorganism growth. This could be originated from several chemical additives for well completion, demulsification effort etc. Microorganism abundance in produced water has been the culprit of what the expert called with ‘Microbiologically Induced Corrosion’ (MIC). ‘Sulfate Reducing Bacteria’ (SRB), both “planctonic” and “sessile” types are the most "wanted" bugs for oil and gas operators. Some parameters that affect to SRB growth are temperature, flow rate, pH, and oxygen content. SRB prefers to stay in anaerobic condition.

Most of oil and gas companies in Indonesia and around the world attempted to reduce SRB in action to the safe level for dedicated material. Corrosion experts must be involved in material selection, hydro-testing planning, commissioning’ procedure, proper utilization of the additive (biocide) and generally reliable maintenance.

Downhole or Tubing Corrosion

Generally, corrosion will happen for the tubing of more than > 5 years in operation having > 40 % “water cut”. CO2 content, bicarbonate count, temperature and pressure are the factors governed tubing corrosion.

The following strategy is worth implementing to reduce the corrosion (caliper survey is commonly necessary): (1) Do nothing, (2) Replace them before failures by carbon steel or coated steel or 13 Cr tubing for high WOR wells, (3) Corrosion inhibitor continuous injection or batch treatment with the products having high Corrosion Protection Efficiency (> 90%), and no detrimental/ problem downstream (say at Oily Water Treatment Unit) with emulsification difficulties.

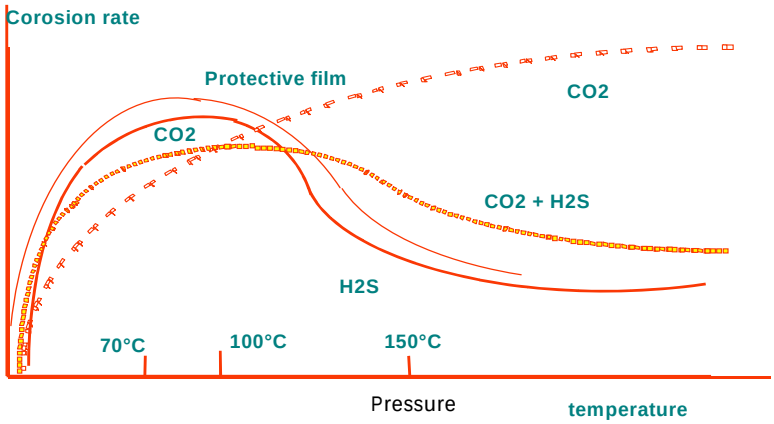

Fig-1 CO2 and H2S partial pressure vs corrosion rate in temperature variation

Top of Line Corrosion

This type of corrosion is relatively novel in the field of gas that that contains CO_2 and saturated water. This actually relates much with the "contour" (**Figure-2**) of HP/HT transport lines.

The study revealed that top of line corrosion is also due to water condensation happened at 12 o'clock position of the internal part of the pipe. Condensation made possible that the carbonic acid liquid is in contact with surface of the metal of pipe. The last finding denoted that organic acid in the liquid contributed (even accelerated) the top of line corrosion phenomenon.

More upstream dehydration unit installation (well head) might be worth considering, in avoidance of the phenomenon. However, cost, safety and 'technological sound' approach must be proven. One must also consider organic acid neutralization (e.g. MDEA) without bad impact downstream (at oily water treatment unit).

The effort to control the TLC rate for existing and new facilities were envisaged, considering the factors of, practicability application, availability of the materials, efficacy of the solution, possibility effect to the system, and accountability of the price.

Some methods and techniques are developed to deal with TLC attack, for existing and new pipelines. Different approaches are investigated starting by neutralising the corrosive effluent, classical batch treatment technique until applying thicker coating with low heat transfer coefficient and developing new pig design. Some were tested onsite and some are still under extensive study.

In an oil and gas company producing oil and/ or gas containing significantly higher CO_2 content, this phenomenon could happen due to pipe erosion with repetitive leaks at 9 to 3 o'clock positions. Pipe is then floating and due to significant sea current its concrete coating was damaged. This could be considered as fatigue corrosion.

TLC could occur also in subsea pipelines having 1,5 to 10 years in operation. Significantly mishandled wall thickness thinning might lead to possible production loss as the inspection survey using smart pig shows significant metal loss features.

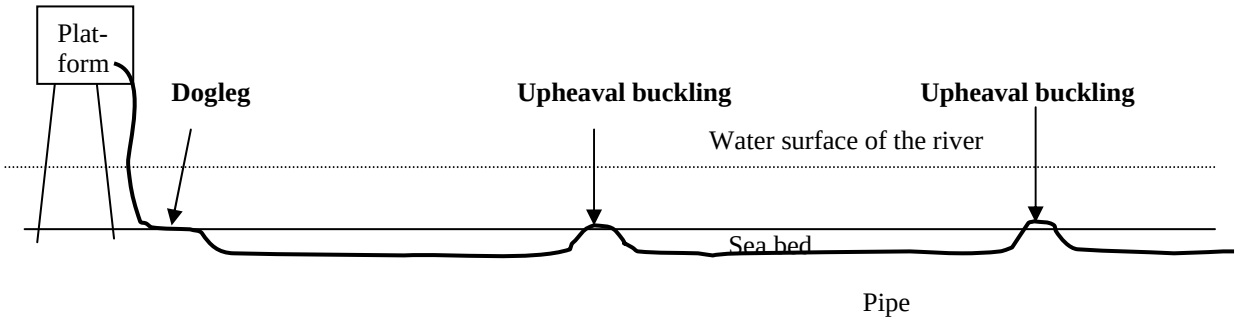

Figure-2 Gas pipe that corroded was previously buried in seabed (upheaval buckling)

Corrosion Inhibitor Selection: Could Strengthen an Industry - University Joint Research

Failure analysis on the removed samples was normally sent and performed by research university or research institution.

Say, in the case of the above TLC, one reason is due to unprotected lines by the corrosion inhibitor. The present corrosion inhibitor in use is not dedicated or designed for the case, so it will not be effective. However, one foresees that one day 3-phase type of corrosion inhibitor (volatile amine) could be one of the candidates for the purpose.

Thanks to the technology collaboration among industry, university and research institutes to study then identify the possible corrosion causes and their mitigation alternative being worth establishing.

In this respect several production sharing contractors entrusted some research to local universities and research institutes. As an example, TLC and upheaval buckling studies have been given to Institut Teknologi Bandung (ITB).

It is worth noting that the authority body and TOTAL E&P Indonesie donated equipment (a dynamic corrosion loop) to ITB for corrosion inhibitor selection in oil and gas industry. By this donation it is expected the following ‘multiplier effect’:

1. Corrosion experts in oil & gas industry could take scientific approach from faculty members on the subject to have more understanding of the phenomenon. On the other hand the faculty members could learn from the expert in the industry by acquiring the real data in the oil and gas fields that will be beneficial for technological transfer to their students. This might positively develop the competency of the researchers (faculty members) in science and engineering mastery by studying the real cases in action.

2. This could possibly assist in filling up "the financial problem hole" being suffered by university or research institute in the country by giving industrial services or the likes, especially with the university autonomy program initiated recently by the government. This actually has been a normal practice in overseas universities like the ones in Trodheim University of Norway, Ohio State University of the Unites States of America, etc.

3. For the authority body, this could expectedly reduce the budget due to properly corrosion handling, both in research cost that sometimes go to the company's head office overseas and/ or production operation itself in general.

National research institutes could also take a part in the above.

One example, it was reported by BPPT (requested by an oil and gas industry) to analyze the leak/ corrosion problems of horizontal pressurized vessel due to macro crack inside the SS-316L nozzle. They claimed that chloride and sulfur contents are significantly abnormal available in the material used, leading to Sulphide Corrosion Cracking (SCC) phenomenon.

Final Remarks

It is worth noted that Dr. R.S. Trijana Kartoatmodjo (BPMIGAS) and Prof Dr Rochim Suratman (ITB) repeatedly encourage the development/ multiplication of competent experts including in the corrosion area, whom in turn, they will be the experts not only to sufficiently fill up local needs in the country, but also could “speak up” in other hemisphere of the globe (go international), in such a way a bold confidence will be gained.

Some proposed actions are worth implementing, among others :

1. Convening corrosion seminars/ conferences/ forums in Indonesia (including the one held by KMI today, thanks to the committee) are suggested to frequently hold. This will create a communication link/ networking among corrosion experts, especially in oil and gas industry (this is considered urgent now) taking the guidance of faculty members of technical universities and research institutes and various professional institutions, in such a way the optimum advantages throughput could be achievable,

2. Doing an inventory of hardware (equipment/ workshop/ laboratories) as well as software and their optimisation at least the ones available in Indonesia, then overseas after,

3. Having solution in actual problems in the fields that could be stated in recommendations compared to standard policy that will be a corner stone of the actions to mitigate corrosion, both preventive and curative, hence the production efficiency is achievable. These could be as referenced solution in the some field cases,

4. Enhancing the practitioners awareness and attention to this effort, and understand that the industry failure corrosion mitigation are the paramount importance,

5. Corrosion database is badly needed starting from sub-surface up to surface (topside) facilities of the problem already handled, being studied, and for the foreseen ones.

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