

(INTRODUCTORY LEVEL)

Microbial Induced Corrosion (MIC), Hydrotesting, Hydrants: An Engineering Approach Towards Recognition and Treatment

There are two approaches towards microbial corrosion cases: “study of the case as per the system” and “study of the case as per the material”. In other words, if one knows under what conditions, for instance, carbon steel corrodes by microbes, it doesn’t matter if the system in which carbon steel has been used in, is a pipeline or a tank and whether it is in a power plant or a gas refinery. Therefore understanding the MIC mechanism is not dependent on the particular system of interest. It is only necessary to know under what conditions a certain material would corrode by MIC mechanisms and the particular working conditions and the system in which the material has been used would dictate the factors that would affect the severity of MIC.

Hydrotesting (or alternatively, Hydrostatic testing) is an industrial practice that is of frequent use in industry. The main characteristic of Hydrotesting is that it is a “leak” and “strength” test. There are many factors that can be involved in making a system vulnerable to microbiologically influenced corrosion (MIC). Of the four principle corrosion mechanisms that can be expected to see in a post-Hydrotest failure, MIC is the most probable/important one. More ever, when pigging is done (intelligent pigging for instance), it is quite possible that it will increase the risk of MIC as well. Water can enter into the pipelines in various ways, either at pre-commissioning phase (via Hydrotesting) or during commissioning. Even if the operating temperature may be above the dew point, one must not forget that due to factors, such as but not limited to, existing of low points and temperature fluctuation and operation age of the line, water can be collected inside the pipe. It is also interesting to note that as long as water exists (even as water pockets) within the line, the likelihood of both electrochemical and electrochemical-microbial corrosion in the form of internal corrosion, manifested as pitting, will highly increase. It follows that in emergency fire water lines (Hydrants) the same MIC mechanisms will also be operative due to the stagnant conditions of the water inside the ring. Dr. Javaherdashti’s workshop is practice-oriented and the emphasise is on applied aspects of corrosion fundamentals. It is this approach by Dr. Javaherdashti that, as a proven engineering approach towards MIC over his years of experience in different engineering disciplines and various countries, will enable the attendees to tailor make their own solutions for their existing specific problems and apply their solutions in a way that is both feasible and applicable.

In this workshop, after reviewing some underlying facts about electrochemical corrosion—as the basis of understanding MIC—the measures to recognise and control MIC with their pros and cons are explained. Then Hydrotesting in terms of its risk assessment to failure mainly by MIC is discussed. The MIC mechanisms in Hydrant systems along with practical measures in this regards will also be reviewed and explained.

Instructor Names

Reza Javaherdashti, (BSc, MSc, PhD)

Course Duration

Three Days

Why Should You Attend?

On the completion of this course the participants are expected to be able to:

- Learn failure mechanisms in hydrant systems and hydrotested systems
- Have a better understanding of the importance of routine recognition and treatment methods of MIC
- Understand corrosion (especially microbial corrosion) mitigation methods more efficiently
- Estimate the required resources and human factors necessary to control MIC in a more feasible manner
- Comment on limitations of corrosion prediction softwares about MIC
- Have learned the most sensible and trustful way of MIC treatment
- Recognize MIC from other types of corrosion manifestations

- Give advice on materials selection and biocide control
- Differentiate “myths” from “realities” in MIC mitigation
- Design/apply prevention/mitigation of MIC practices
- Assessment of the risk of corrosion in a post-hydrotest situation and how to deal with it
- Calculating the weight of factors that are of relevance in inducing post-hydrotest corrosion and failures

Some of the Topics Covered

How can a system become vulnerable to MIC?

Prevention and mitigation methods: How effective are they in practice?

Management of post- hydrotesting most likely corrosion scenarios by understanding pre-hydrotest risks.

Engineering design of solutions based on scientific and applied knowledge.

Day 1: A review of fundamentals of Corrosion-Theory of the practice and practice of the theory

- Introduction to the course and its methodology: System –approach vs. Materials-approach
- The role of corrosion management in getting a “desired” industrial future
- Technical and Non-Technical management of Corrosion: a brief introduction
- Economical, ecological and management importance of corrosion.
- Can microbial corrosion be always classified as a subclass of internal corrosion?
- Theory of corrosion and its relevance to microbial corrosion in pipelines
- Principles of inhibitors, Coating, Cathodic Protection and Anodic Protection and their role in integrity management plans

Day 2: Microbial corrosion & its patterns in integrity management

- Introduction to definition of MIC, its various names and its importance
- Definition of MIC, susceptibility assessment of engineering materials to MIC
- Classification of bacteria and its engineering importance
- How can microbial corrosion in different systems be similar? General patterns of MIC.
- Biofilm formation mechanism and its electrochemical importance
- Treatment and Management of MIC
- Corrosion prediction models and MIC
- MIC and standards: describing related standards and their applicability

Day 3: Hydrotesting and hydrant systems

- How MIC in hydrant systems and hydrotested systems can be so similar?
- A brief review of most likely post-hydrotest corrosion scenarios
- Group 1 & Group 2 Risks: Pre- and Post-hydrotest corrosion risks
- Factors that are important in carrying out a healthy hydrotest with no or minimum post-hydrotest problems
- Conditioning of the hydrotest water during wet parking
- Conditioning of the hydrotest water during wet lay-up
- How to assess the risk of Post-hydrotest MIC: a mathematical approach

Exercises

Pre-class test:

Day 1

- Four questions will be asked by Dr. Javaherdashti to the attendees (to be answered at the workshop)

Day 2

- Exercise: **Corrosion Theory**

Day 3

- Exercise: **Mitigation strategies Application-**

In addition to the exercises, brainstorming sessions will be organized about real case scenarios of MIC and mitigation strategies.

The course book for this class is:

Reza Javaherdashti, “Microbiologically Influenced Corrosion-An Engineering Insight”, 2nd edition, Springer, UK, 2017 (<https://www.springer.com/us/book/9783319443041>)



Short Bio

Reza Javaherdashti holds a double degree in Materials Science and Metallurgical Engineering. He has more than 20 years of industrial and academic experience. Dr. Reza is an approved instructor of ASME and SPE (Society of Petroleum Engineering). In addition, He has more than 5000 hours of training industries around the globe about corrosion and microbial corrosion. In addition to his many research papers and root cause analysis reports, he has authored some books such as, but not limited to:

- 1) **Reza Javaherdashti**, Farzaneh Akvan “Corrosion Management & Failure Modes, Effects, Causes and Analysis as related to Microbiologically Influenced Corrosion (FMEA-MIC)”, Elsevier, USA, under Press
- 2) **Reza Javaherdashti**, Kiana Alasvand “Biological Treatment of Microbial Corrosion (MIC): Opportunities and Challenges”, Elsevier, USA, under Press
- 3) **Reza Javaherdashti**, “Microbiologically influenced corrosion-an engineering insight”, Springer-Verlag, UK, 2nd edition, 2017.
- 4) **Reza Javaherdashti**, Farzaneh Akvan “Hydrostatic Testing, Corrosion, and Microbiologically Influenced Corrosion A Field Manual for Control and Prevention”, CRC Press, USA, 2017.
- 5) **Reza Javaherdashti**, Chikezie Nwaoha, Henry Tan “Corrosion and Materials in Oil and Gas Industries”, published by CRC Press/Taylor & Francis, USA, 2013.
- 6) **Reza Javaherdashti**, “MIC and Cracking of Mild and Stainless Steels”, (PhD Thesis). VDM Publishing, Germany, 2010.
- 7) **Reza Javaherdashti**- Hamid Nikraz, "A Global warning on corrossions and Environment: A new look at existing technical and managerial strategies and tactics", VDM Germany 2010