Preface to the Second Edition

When I was writing the first edition of this book, what I had in mind were two ideal goals. One was to reach to a wider audience, both academics at research facilities and field engineers and professionals. It was an enthusiastic target but now, after the first edition of this book has been one of the best sellers in its category, I am glad that I have achieved my enthusiastic goal. In all MIC workshops that I have designed and run for various industries around the world, I have advised this book as the main course material and the very positive feedback that I received after more than 4000 h of teaching microbial corrosion to industry and academia has ensured me that this book has achieved the first goal I originally had in mind.

Microbiologically influenced corrosion (MIC), despite its relatively short life (initial academic research about MIC started in 1930s), has proved to become one of the most significant sources of confusion for both industry and academia. It is so complicated that in many cases it is mixed up with other corrosion phenomena and therefore wrongly reported and treated. In addition to "self-proclaimed" MIC experts that make the already blurred waters of research and treatment about MIC even more muddled, misunderstanding about MIC still exists, even among professionals. For example, it is still believed that MIC should be studied as a subject within the general topic of "internal corrosion". I would like to see how defenders of such classifications would define external corrosion of pipelines due to corrosion or ALWC (Accelerated Low Water Corrosion) induced MIC as examples of "internal corrosion"?!

The second goal that I had in mind and I am glad that my readers did appreciate was that I had decided to write my book in a language which is quite precise but simple and in a tone that would only pick up the essential elements of the topic without too much details about it. This new edition will still with both of these goals: reaching a wider audience with a simple yet precise and right-to-the-point language.

This edition has some features that will put it a head and shoulder above its first edition. I have added, as much as I could, the following:

- A discussion about a relatively unknown corrosion-related bacteria, that is, Clostridia,
- A full chapter about mathematical modelling of MIC, in particular fuzzy logic,
- A comparison of culture-independent methods with culture-dependent methods and also a quick reference in comparing pros and cons of various culture-independent methods with each other,
- Further practical strategies for dealing with MIC in terms of combination of CKM and CM in the context of MIC,
- A brief introduction to natural biocides and especially neem tree.

My reasons for feeling the need to add the above topics were basically the following:

– Corrosion professionals must hear more about what had been hidden within pure academic research papers and discussions, particularly with regard to mathematical modelling by using fuzzy logic and calculations because the possibility of applying mathematical thinking into the prediction of MIC is certainly an important issue: this is a feature absent from corrosion prediction models so far —or at least the famous ones this author knows,
– while SRB and its possible impact on corrosion is yesterday's news to many corrosion professionals, knowing about "the sometimes contradicting corrosion features" of Clostridia is certainly a must that so far has been largely overlooked by many filed engineering practices.
– Culture-dependent methods seem to be slowly replaced by culture-independent methods thanks to recent advances in molecular biology. Using culture-independent methods are still far from being totally ideal but even now they are much superior to culture-dependent methods for diagnosing MIC.
– As one of my main target audiences has always been field engineers, I have tried to give much more practical clues about how to deal with microbial corrosion. I have applied this in two areas: first by talking about the "diplomacy: of dealing with MIC by redefining what I introduced as corrosion knowledge management (CKM), and second, having everyday growing conscience and concerns about what we are doing to mother Earth, I through a brief introduction into "Natural biocides", I mean those biocides that are both green (eco-friendly) and natural (*Directe a Natura*).

When I was writing the first edition of this book, I had wished that my elder daughter, Helya, who was 2 years old then, would become interested in this topic. I think my wish has been granted. Now I wish that her sister, Hannah, would also become interested in understanding what daddy is doing too!

I would like to thank all those who have supported me, directly or indirectly, by their comments, contributions and encouragements I also would like to thank Springer for giving me the chance of preparing the first edition of this book and supporting me for the second edition.

I have tried to “blow soul to the body” of this book to make it even much better than what it was and what may be available in the market today as its counterparts. I hope that I have succeeded!

I would like to dedicate this edition to the memory of Tesla, someone who showed with his life that dreams may come true…

Perth, Australia
March 2016

Reza Javaherdashti

Preface to the First Edition

A Few Words About the Structure of This Book

Let me be honest with you: I rarely read the prefaces of books! It is, I guess, because I think that I am interested only in the context of the book, not what the author wants to teach me about how to read the book. I have found very few books whose "introduction" has been interesting to me. But for this book, I strongly recommend that readers study this preface to understand why I chose the structure used in placing the chapters.

I have always wanted to write a book about microbial corrosion (there are some alternative names to address this type of corrosion; they're given in Chapter 4) that would have a rather wide audience, ranging from academics (lecturers, researchers, postgraduate students) to industry specialists (field engineers, design engineers, industry managers). This goal may seem very enthusiastic, to put it politely. There has always been an unseen, undefined gap between different disciplines of science (Videla has touched on this very meaningfully, and his paper is quoted in later chapters of this book), let alone between industry and research/university environments.

Despite these obstacles, I have tried to be fair to both of my target audiences, university/research and industry. In addition, I have tried to focus on a very important aspect of corrosion mitigation: the human management factor. With this in mind, readers must understand the structure of this book to gain the maximum advantage of reading a book with such a wide potential audience.

We will start our microbial corrosion journey by reviewing some basic corrosion – to put it more precisely, electrochemical corrosion, in Chapter 1. In this chapter, some basic facts regarding electrochemical corrosion are reviewed to a limited extent that may be useful to understand the logic behind using methods and techniques such as cathodic protection, coating and use of inhibitors which are explained in Chapter 2 in the section "Technical Mitigation of Corrosion". This much can be found in almost every book written on corrosion or microbial corrosion, where basic information regarding corrosion and its mitigation is given.

However, a very important part of mitigation methods against corrosion (and, therefore, against microbial corrosion) is the factor of human management; no matter how good the techniques are that we use in combating microbial corrosion, if there is poor communication between the technical staff (engineers, technicians, foremen, *etc*.) and the management, the resultant practice will have very limited impact on upgrading the performance of the system. If management cannot understand the importance of microbial corrosion, even the best corrosion engineer cannot justify the expense of microbial corrosion recognition and treatment. This may not be a serious matter for academic researchers, but it certainly is important for both industry researchers and field engineers. Chapter 3 deals with a very genuine and innovative concept called "corrosion knowledge management (CKM)" to differentiate it from what is normally known as "corrosion management". While the later refers to the technicalities involved in corrosion treatment (such as the best design and practice of cathodic protection, the choice of inhibitors and coatings and the like), corrosion knowledge management concentrates more on managerial aspects. Therefore, although a manager may not know what a reference electrode is for, or what the difference between an inhibitor and a non-oxidising biocide is, this manager will need to know how, economically and environmentally, microbial corrosion in particular and corrosion in general could be dangerous. A manager also needs to have a managerial system in place so that an organisational chart can be defined. Chapter 3 introduces the basics of such managerial needs.

Chapter 4 may be described as the heart of this book. It begins with a historical profile of microbial corrosion and definitions, followed by topics such as the "paradoxical" effect of biofilms on corrosion. The text continues with a review of some types of bacteria which are of interest in the microbial corrosion literature. Some of these bacteria, such as the sulphate-reducing bacteria (SRB) have been long known to researchers and industry. Some, like the iron-reducing bacteria (IRB) are not that well known, and I have dubbed them as "shy" as they seem not to get the attention of researchers the way SRB do. The possible role of magnetic bacteria in corrosion is stated for the first time in the literature of microbial corrosion, to the best of my knowledge. Magnetic bacteria are very interesting, and they form an "exotic" realm for further research. Chapter 4 also includes some important concepts regarding the possible impacts and effects of SRB and IRB on enhancing stress corrosion cracking.

Before closing this summary of Chapter 4, I want to add a few words about SRB. I do agree with Brenda Little and Patricia Wagner in calling the importance of SRB a "myth" of microbial corrosion research and practice. But, readers may wonder, if the importance of these bacteria has been naively exaggerated, why I am allocating so many pages to explain them? The answer is easy: the stronger a wrong belief is, the more you have to explain it to make it clear. I have tried to explain that although SRB are important, they are not so important as to cause us to forget other types of bacteria involved in microbial corrosion.

Chapter 5 considers what and how factors must come together to put a system in danger of microbial corrosion. This chapter studies the effect of water quality and velocity, oxygen, hydrotesting and other relevant factors in the initiation of microbial corrosion in *any* system that has the potential. It does not matter which industry the system may belong to. As long as the required factors are in place, the system will become vulnerable.

Chapter 6 studies the parameters required for “recognition” of microbial corrosion, factors such as the shape of the pits, mineralogical “fingerprints”, and the appearance of corrosion products. This chapter ends with a review of “detection” techniques which are basically microbiological and electrochemical. Thus, for example, culturing, molecular biological methods, and rapid check tests and their pros and cons are among the topics that are. An important part of this chapter for researchers is the review of electrochemical methods and their importance in microbial corrosion investigations.

In Chapter 7, I try to show that microbial corrosion can have more or less similar patterns despite different systems in which it is occurring. This chapter shows how microbial corrosion in fire water lines could be similar to that happening within the legs of a submersible off-shore platform, and how buried pipelines and steel piles of a jetty could experience almost the same scenarios of microbial attack.

Almost no engineering material is safe from or immune to microbial corrosion. In Chapter 8 the vulnerability and susceptibility of copper and cupronickels, duplex stainless steels and concrete will be discussed in a brief and informative manner. I had my reasons for picking these materials: copper and its alloys have the reputation of being poisonous to micro-organisms, duplex stainless steels are known for their high resistance to corrosion thanks to their duplex microstructures of ferrite and austenite, and concrete is widely used in both the marine and water industries because of its good performance and cost effectiveness.

Having said so much about microbial corrosion, in Chapter 9 I address a logical expectation: how is this type of corrosion treated? I go through only the physicalmechanical, chemical, biological, and electrochemical (including cathodic protection) means and factors that have been used thus far to treat and mitigate microbial corrosion. An interesting point, among others, could be the possible explanation of why cathodic protection could be effective (or sometimes ineffective) on microbial corrosion. Although principles of CKM are also applicable here, for reasons that I discussed briefly in the footnote of the opening page of Chapter 9, I did not include the principles in the contents of the chapter.

I have been careful to use language which is very precise, technically sound, and accurate, yet somewhat casual and not too technical. I believe that if there is a truth, it can be explained with accurate yet simple words.

These have been my aims and dreams, and I do hope that my readers will share them with me!

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