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EUROPEAN MICROBIOLOGICALLY INFLUENCED CORROSION NETWORK (EURO-MIC): NEW PATHS FOR SCIENCE, SUSTAINABILITY AND STANDARDS

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ABSTRACT

Microbiologically influenced corrosion (MIC) is the corrosion of material caused or enhanced by microorganisms. It occurs directly or indirectly through their metabolic activities and can be accelerated 10 to 100 times, depending on the material. A wide range of materials can be affected by MIC, including metal, plastic, and concrete, impacting the entire infrastructure of society, including water and wastewater management systems, marine industrial facilities, and (on)offshore systems. One challenge of MIC common to all these sectors is the colonization of surfaces, where the presence of water is one of the basic requirements for biofilm to form. This phenomenon is a major global challenge caused by the growing world population and related industrial activities combined with climate change, and increasingly becoming a problem for our society [1] and [2]. The global cost of MIC is unambiguous and should almost certainly be underestimated. According to survey data, MIC is responsible for up to 20% of all corrosion found in aqueous systems, costing billions of dollars in rehabilitation costs alone [1]. In Europe, several research groups/ other industrial stakeholders are already dealing with MIC. Unfortunately, the discussions are fragmented, and the exchange of information is limited. A true transdisciplinary approach is hardly ever experienced, although this would be logical for this material/biology related challenge. Therefore, Europe needs to combine the efforts of experts in different fields and develop prevention measures according to the european rules, in close cooperation with industry, plant operators and owners of critical infrastructure to effectively contribute to this MIC challenge. In this context, our european MIC-network aims to provide the necessary interaction and communication, knowledge sharing, training of personnel and of researchers of different disciplines. Only in this Europe can get a leading role in this process, bringing ideas together on an equal level with other nations, and thereby considering the important values and attitudes for Europe (e.g., environmental protection) and resulting in a greater protection for people, property, and the environment. The working group structure of this Euro-MIC Cost Action, as well as specific objectives, ongoing activities, and expected impacts, will be presented.

Keywords: Biofilm, Corrosion, Control, Monitoring, Diagnosis

1. INTRODUCTION

Since the 1930s when MIC was first recognized, and until the 1980s, almost no progress in MIC research was evident, most likely due to competing research priorities or limited microbiological capabilities [2]. Subsequently in the past two decades, scientific and technical publications on MIC became more frequent and the focus changed over time. Researchers first tried to determine the cause, then understand the mechanisms and since the year 2000, studies have focused on diagnosis, monitoring and mitigation of MIC [1] and [2]. This type of corrosion found in all societal infrastructures (Fig.1), is associated to drastic consequences. A representative example is a MIC failure, attributed to methanogenic archaea (www.cpuc.ca.gov/aliso/), that caused the release of more than 100,000 tons of methane that leaked, in October 2015, from a natural gas storage field in Aliso Canyon (USA), exerting a dramatic impact on the climate and causing a total cost to the utility of more than $1 billion. However, only direct costs are included here, as production losses and consequences to the environment are difficult to quantify. Prudence would dictate that behaviours to avoid both MIC damage and consequences must have a high priority in modern societies, becoming crucial to deal with it in a proactive rather than reactive manner. Prevention of MIC requires expertise in multiple disciplines and industrial activities to determine root causes and develop ecological remediation and mitigation measures, ranging from materials science, process chemistry, microbiology, biochemistry, corrosion engineering, and integrity management [1] and [2], becoming a significant challenge. Moreover, the multidisciplinary knowledge and information among experts are fragmented, amplified by the weak bridge between research and industrial stakeholders, and lacking discussions and knowledge transfer, thus limiting MIC prevention measures better adjusted to the industry needs, and the accomplishment of the European values of protecting the environment, people, and property.

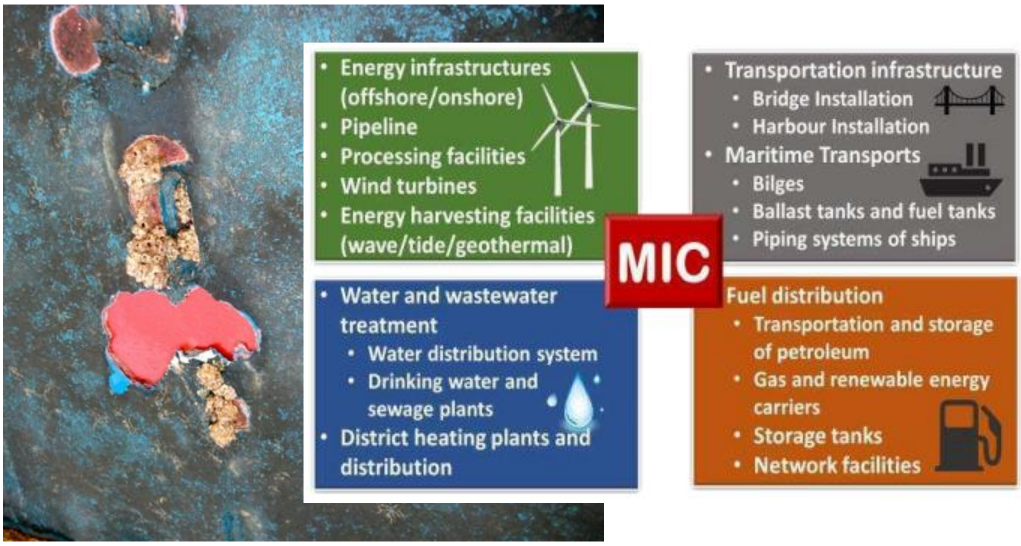

Fig. 1 – Critical infrastructures affected by Microbiologically Influenced Corrosion (MIC).

2. DESCRIPTION

The management of MIC is an integral part of the larger corrosion management framework for assets and facilities. At its core, corrosion management essentially consists of three primary activities: assessing corrosion threats, identifying preventive and mitigative barriers, and monitoring the effectiveness of those barriers (Diagnosis, Monitoring and Mitigation). The Euro-MIC network is joining efforts in a transdisciplinary, multi-sectoral network, promoting discussions, knowledge transfer, collaborations, and training, intending to make

Europe a leader in this MIC challenge. This network is founded on five pillars with which the challenge of MIC can be substantially influenced: 1) definition of a common language for a productive exchange across different disciplines, 2) construction of a research roadmap for a meaningful and economic perspective, 3) training of scientists or personal staff, 4) definition of standardisation protocols for diagnosis, monitoring and mitigation in the context of MIC, and 5) ensuring sustainability to protect the environment and future generations. The pillars of training and common language are the cornerstones of the three subsequent pillars, forming the basis for achieving the overall goal. The main tasks allied to these pillars, are organised in five working groups (WGs), Fig. 2. Two WGs will cover eight cross-cutting capacity building and research coordination objectives. Three WGs will serve as research coordination objectives focusing on the three MIC strategic areas "Diagnosis, Monitoring and Mitigation". The eighteen specific capacity building and research coordination objectives, the goals, and tasks of the WGs, are described in detail in the Euro-MIC MoU [2].

This COST Action will advance the MIC state-of-the-art in several crucial aspects: 1) for the first time, a common terminology of MIC will be developed across disciplines and sectors, 2) a common approach to failure analysis using standardized test procedures will be developed and agreed upon, enabling industry to assess MIC cases, 3) a European based training program will be established and, 4) several research proposals will be initiated in the context of the European Green Deal and Sustainability Agenda. In the long-term, this Euro-MIC will contribute to the establishment of standard protocols, the improvement of environmental simulations, as well as the holistic approach to the assessment of MIC-related failure. In all pillars of the COST Action "Diagnosis, Monitoring and Mitigation", the joined efforts will lead to new technological solutions benefiting all stakeholders. It will also train the next generation of researchers with an interdisciplinary approach and focus, able to initiate and continue productive and collaborative knowledge transfer cycles between different sectors and disciplines in Europe and beyond. This Cost Action will also contribute to transforming Europe and the whole world into a greener, more sustainable, and circular economy, in line with the EU Green Deal objectives and the UN Sustainable Development Goals.

Fig. 2 – Vision, Working Groups, and measures of Euro-MIC.

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