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BOOK OF ABSTRACTS

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Early Biofilm Formation and Polyethylene Pipe Interactions: Impacts on Water Quality in Non-Chlorinated Drinking Water Systems

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Biofilm formation plays a crucial role in non-chlorinated Danish drinking water distribution systems, where it is recognized for enhancing microbiological stability. However, during the early stages of biofilm development in newly commissioned polyethylene (PE) pipes, the impact on water quality can be complex and multifaceted. This period, before the biofilm matures, can result in temporary declines in water quality due to elevated bacterial activity and limited diversity, a phenomenon that remains poorly understood (Figure 1).

Recent studies demonstrate that microbiological water quality parameters, including heterotrophic plate counts (HPC), ATP, and qPCR analyses, reveal distinct changes in water quality during the commissioning phase of new PE pipes. High bacterial counts (HPC 22°C = 870 CFU/mL) and low microbiological diversity (Shannon index 2.3) characterize the first 10 days of commissioning. However, these levels stabilize after approximately 20 days, aligning with upstream water quality benchmarks (HPC below 200 CFU/mL, Shannon index ~5). These findings emphasize the need for optimized commissioning procedures to reduce short-term disruptions and establish stable, beneficial biofilms that improve water quality for consumers.

Complementary research highlights the interaction between PE pipe materials and biofilm communities. Compounds migrating from PE pipes, including specific monomers and complex "PE-cocktails," can stimulate biofilm activity, particularly in biofilms from recently installed pipes. For instance, a “PE-cocktail” derived from crushed PE pipes enhanced biofilm growth in enrichments from both newly installed and older pipe sections. The results suggest that biofilm formation can act as a natural barrier, reducing the migration of potentially harmful compounds while supporting microbiological stability.

These insights are further explored in a recent project, which aims to determine whether biofilms in PE pipes can degrade leached monomers and serve as a protective barrier. The research underscores the importance of fostering diverse and functional biofilm communities in new PE installations, balancing the potential short-term impacts with long-term benefits to water quality and public health.

Together, these findings highlight the dual role of biofilms as both a potential challenge during pipe commissioning and a vital component of water quality management in non-chlorinated drinking water systems.

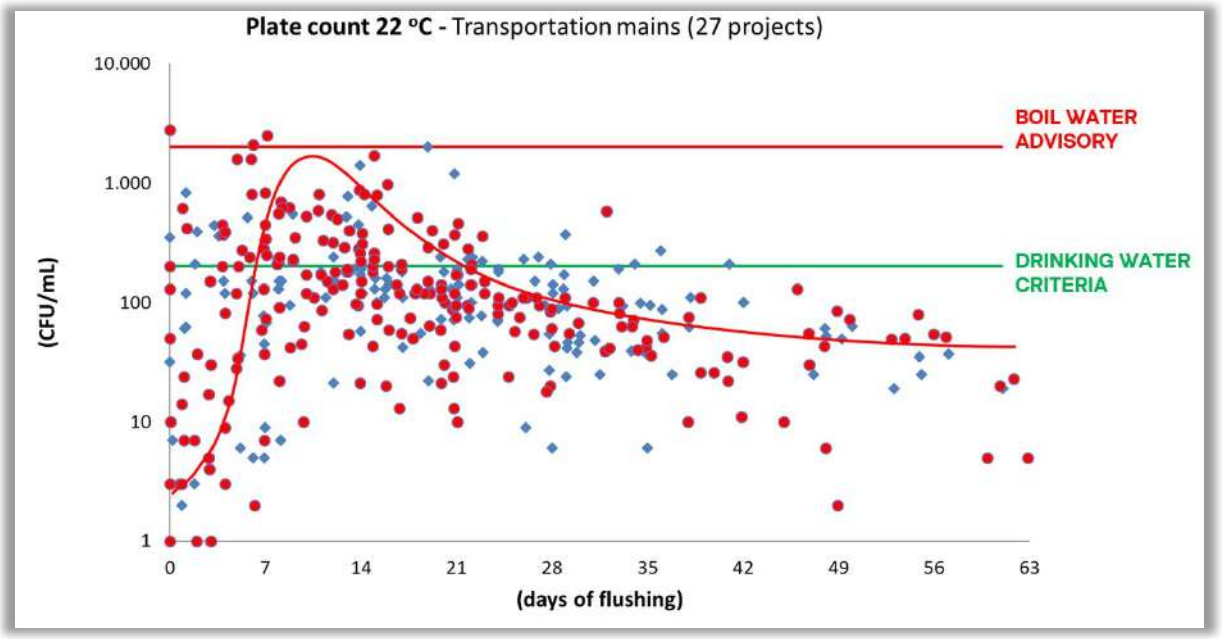

Figure 1. HPC at 22°C from previous measurements from Aarhus Vand, where it is possible to observe a peak between day 7 and 20.

Keywords: Beneficial biofilms; Drinking water distribution systems; Polyethylene pipes; Commissioning Guidelines; Migration of organics

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Current Status and Challenges of the Water Distribution System in Cyprus

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Cyprus faces severe water stress, ranking as the most water-stressed nation in Europe, underscoring the critical role its water distribution system plays in supporting the country's domestic, agricultural, and industrial activities.

This study aims to provide a comprehensive overview of the water distribution system in Cyprus, examining the challenges it encounters, primarily due to climatic variability, aging infrastructure, and growing demand for water, all of which threaten its capacity to deliver reliable water supply.

The country relies on a variety of water resources, including water from 108 dams, groundwater aquifers, and desalination plants. However, these resources are increasingly strained by factors such as low rainfall, overextraction, and climate change.

The Southern Conveyor Project, an integral component of the distribution system, facilitates water transfer from southwest dams to regions with higher demand, enhancing supply reliability across the island (WDD, 2022). Nonetheless, substantial water loss persists within the network, with non-revenue water estimated at 23% overall (EurEau, 2021), reaching up to 50% in rural areas.

Efforts to mitigate these losses involve pipeline upgrades, the implementation of digital monitoring systems, and improved maintenance protocols (Nikolaou, 2023). Additionally, the establishment of District Local Government Organizations represents a significant move towards centralized oversight and improved management efficiency. These initiatives reflect Cyprus' commitment to addressing current challenges and ensuring a sustainable, resilient water supply for the future.

Figure 1. Governmental Water Projects – Cyprus (WDD, 2022)

Keywords: Cyprus, water resources, non-revenue water, sustainability

Acknowledgements: The project CyMIC (CONCEPT/0823/0479) is financed by the Research and Innovation Foundation of Cyprus, under the Proof of Concept for Technology / Knowhow Applications RESTART 2016-2020 Programmes

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EOAL continuous improvement quality of life

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The District Local Government Organization of Larnaca (EOAL) is a public entity serving the city and district of Larnaca. EOAL provides essential services such as water supply, sewage collection treatment and management, urban planning, and issuance of building permits, along with the management of Green Points for sustainable waste handling. EOAL's vision is to become a modern, citizen-friendly organization, offering high-quality services in the sectors of water, sewage, and waste management to enhance residents' quality of life and protect the environment. EOAL is committed to addressing water scarcity through innovative resource management and sustainable practices. In line with this, EOAL has a track record of successfully applying for and managing European-funded projects. These projects are focused on making the organization smarter, more digital, and environmentally sustainable. More specifically, the organization has applied for and absorbed approximately €12.000.000 from the Recovery and Resilient Facility for implementing proposals for becoming more efficient as an organization through digital transformation and implement projects which will aim in adding environmental value by reducing gas emissions, with energy saving and with reusage of sewage derivatives. These efforts will contribute to enhancing the organization’s environmental impact, aligning with the broader goals of sustainability and circular economy practices.

Keywords: Water supply, wastewater management, solid waste managment (Green points)

MIC Involvement in Damaged Water Pipes – CyMIC

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Cyprus is among the 5 most water-stressed countries in the world (World Resources Institute, 2023), and combined extreme heat during the summer, droughts, and significant water losses from the distribution system altogether play a critical role in drinking water availability. Among some of the problems experienced within drinking water (DW) networks is distribution losses, grouped under non-revenue water. Cyprus' average non-revenue water in 2021 was about 23% and 4,000m^3/km/y, the latter being above the average in other EurEau member countries. The local district government departments have in place systems to detect leaks and programmed replacements of the obsolete water supply network. The Cyprus government approved, in November 2024, a comprehensive action plan aimed at strengthening water security and infrastructure to combat drought and water scarcity, which include, among others, network loss reduction initiatives, network upgrades with smart meters and installation of integrated monitoring systems. Damaged pipes are a significant source of water loss, and corrosion and aging of the existing infrastructure is a major cause of pipe damage. The CyMIC project, a first of its kind in Cyprus, aims to demonstrate the potential involvement of microorganisms in corrosion, a fact that is not usually considered by experts. Microbiologically influenced corrosion (MIC) refers to corrosion caused by the presence and activities of microorganisms, and while microorganisms do not produce unique types of corrosion, they can accelerate corrosion reactions or shift corrosion mechanisms. MIC has been demonstrated in about 20% of the cases corrosion in pipes. This project will promote awareness of possible MIC involvement in pipe damage, emphasize the need for a multidisciplinary approach to evaluate faulty pipes, and encourage collaboration among stakeholders that will support innovation in detection and mitigation strategies.

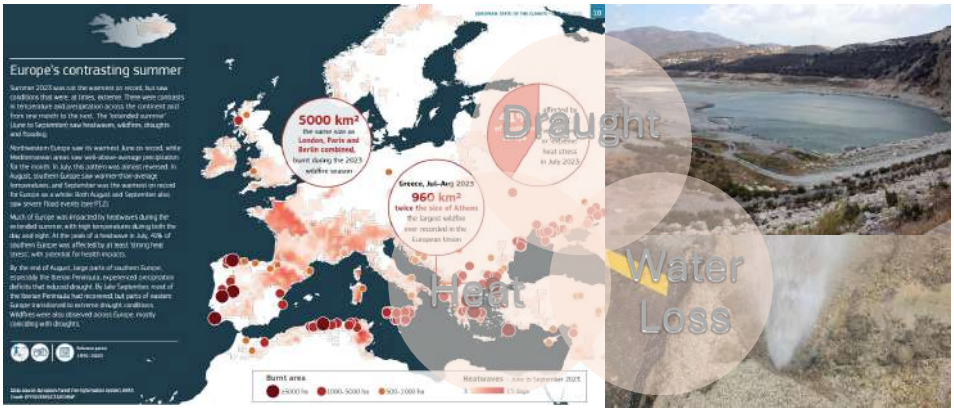

Figure 1. Factors impacting drinking water availability in Cyprus

Key words: drinking water, MIC, corrosion, water pipes

Acknowledgements: The project CyMIC (CONCEPT/0823/0479) is financed by the Research and Innovation Foundation of Cyprus, under the Proof of Concept for Technology / Knowhow Applications RESTART 2016-2020 Programmes

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How microbes maximize their life in biofilms

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Arguably up to 80 % of all bacteria and archaea on Earth live in biofilms. And biofilms represent the oldest and most widespread form of life on this planet, and this is for good reasons: they live in their matrix of extracellular polymeric substances (EPS) which allows them to develop emerging properties. Among the most important ones: the development of small-scale gradients, providing different habitats; the function of the matrix as a sponge for resource capture from their environment; the retention of extracellular enzymes, turning the matrix into an external digestion system; the formation of stable synergistic consortia for degradation of recalcitrant polymers; acting as a genetic archive with enhanced horizontal gene transfer and elevated tolerance towards antimicrobial substances and conditions. Biofilms are involved in the weathering of minerals and in microbially influenced corrosion (MIC) by colonizing interfaces and influencing corrosion-relevant parameters such as O2-concentration, redox potential, pH-value, conductivity or salt concentration. All these properties and abilities to make their living even in extreme environments turn biofilms into the most successful form of life.

The need of promoting effective communication to mitigate MIC - Examples of communication gaps between actors in the water utility sector.

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Microbiologically Influenced Corrosion, MIC, pose significant challenges in the water utility sector. Yet effective root course assessment and mitigation strategies are often impeded by communication gabs and misunderstanding between actors in the field. This presentation highlights specific examples of such challenges drawn from damage investigation activities. These examples underscore the ongoing importance of improving data accessibility and fostering effective communication to mitigate the adverse effects of MIC, such as for example further development of standardised protocols, best practices and improvement of high-quality data on MIC occurrences and mitigations strategies.

Figure 1. A pipe end covered by grease from the used cutting tool. How can the influence from this on the tread of MIC be evaluated during damage inspection?

Keywords: MIC; Communication; Inspection, Mitigation

Identification of microbiologically influenced corrosion (MIC) in industrial water distribution systems following the multiple line of evidence (MLOE) approach

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Many industrial water distribution systems use old mild steel pipelines that are, at best, only externally coated or cathodically protected. Microbiologically Influenced Corrosion (MIC) is a severe form of often highly localized corrosion that can occur at rates not predicted by most known corrosion models (Little & Lee, 2007). Due to the complexity of MIC, many cases are overlooked or misdiagnosed. Most instances are linked to the distributed water, leading to internal corrosion that is only detected when leaks appear. Diagnosing MIC involves collecting multiple lines of evidence (MLOE), which cannot be generalized and must be approached on a case-by-case basis (Knisz et. al 2023). This study aimed to evaluate the occurrence of MIC in an industrial water distribution system. This paper describes the investigation of MIC failure cases in industrial water distribution systems following the MLOE principle. Several leakages occurred in the industrial water distribution system. Water samples were taken and parts of the pipelines were exchanged from the system and further analyzed in the laboratory. After visual inspection, swab samples were taken for microbial analyses (DNA- and growth-based approach), cross sections were done and samples were analyzed by Scanning Electron Microscopy (SEM) coupled with Energy-Dispersive microanalysis (EDX) and Epifluorescence Microscopy (EFM). Water samples were analyzed by Ion Chromatography (IC) and Inductively Coupled Plasma-Mass-Spectrometry (ICP-MS). Surface-bound volatile sulfide was also determined using Draeger tubes.

Failure analyses clearly indicated that the primary cause of failure was internal corrosion manifested as homogeneous pitting. The pits that penetrated the pipe wall were consistently found beneath tubercles several centimeters in diameter. SEM/EDS analysis revealed that elements such as Ca, S, and Cl (with an image example for S) were localized in specific, layered regions within the corrosion products, while other elements were more evenly distributed. Microorganisms were observed growing as biofilms closely associated with the corrosion products and adjacent to the damaged areas. Surface-bound sulfide was detected in all analyzed samples. Corrosion relevant microorganisms were identified using both the most probable number technique (MPN) and quantitative polymerase chain reaction (qPCR).

It was concluded that the perforation of pipe fragments originated from the interior of the pipe; the loss of interior wall thickness corresponded with the location of tubercles. Typical corrosive microbial products were found associated with corrosion products, and an active biofilm community, likely dominated by sulphate-reducing bacteria, was located near the perforations. It is reasonable to conclude that MIC plays a significant role in this corrosion case.

Keywords: MIC, MLOE, failure análisis

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Metagenomic Insights into Microbiologically Influenced Corrosion in Drinking Water Distribution Systems

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Global population dynamics are affecting demand for water supply infrastructure and presenting challenges for water utilities, demanding adaptation techniques to satisfy demand. Due to limits on traditional supplies, some countries are turning to alternative water sources such as direct potable reuse. However, the use of such nonconventional sources complicates microbiological safety. Furthermore, the aging water infrastructure in many wealthy countries exacerbates these issues, with more instances of pipe breaks and water losses. Beyond the tangible consequences of water loss and infrastructure damage, there are significant implications for water quality. Contaminant entry into the network increases the risk of biofilm formation, corrosion, organoleptic concerns, and reduced flow efficiency. Addressing these difficulties necessitates not only large operational changes but also significant capital investments, emphasizing the urgent need for creative approaches to water management and infrastructure development.

Microbiologically influenced corrosion (MIC) - corrosion caused by the presence and/or activity of microorganisms - is a major issue in industrial pipeline systems and drinking water distribution systems (DWDS). Despite advances in our understanding of the microorganisms, methodologies, and contributing factors in MIC, many elements remain unknown.

Given the scarcity of data on MIC in DWDS, our work aimed to gain insight into the corrosion mechanisms and microorganism active in DWDS. We applied a test protocol developed by the Euro-MIC COST Action [1]. In short, C 1010 mild carbon steel coupons were used and incubated for 1-2 months in drinking water from a corroded DWDS with or without M9 minimum media; abiotic controls were also used.

Molecular microbiological, chemical, and metallurgical analyses were conducted to assess MIC. By applying the multiple lines of evidence (MLOE) approach, data obtained from ATP biomass measurements, shotgun metagenomic analyses, water chemistry assessments, scanning electron microscopy with energy-dispersive X-ray spectroscopy (SEM-EDX) analysis, and 3D optical microscopy were integrated and analysed.

The findings and insights gained from these experiments will be presented, shedding light on the mechanisms and implications of MIC in DWDS.

Key words: microbiologically influenced corrosion; drinking water distribution systems; shot-gun sequencing; molecular microbiological methods,

Acknowledgments

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Technical challenges for the investigation of Microbiologically influenced corrosion under laboratory conditions across several sectors.

Andrea Koerdt, Bundesanstalt für Materialforschung und -prüfung (**BAM), Germany**

Microbiologically influenced corrosion MIC occurs in different sectors, under various conditions and can significantly contribute to material degradation. The most convincing effect can be observed with sulphate-reducing bacteria (SRB). There are many stakeholders who do not need to be convinced of this as there is ample scientific evidence clearly showing that SRBs corrode metal. However, many believe this is solely due to the produced H_2S. Fewer people are aware that SRBs also have other mechanisms that can lead to corrosion, such as electrical MIC on metal (direct electron uptake from the metal used as electron donor). Despite this, many sectors or industries remain skeptical in several areas.

When considering other classes or species, the skepticism increases even more. The reason is simple: microbiologist cannot consistently prove MIC on laboratory scale for all corrosive microorganisms. In contrast to materials sciences, where experiments can be narrowed down to a limited number of parameters, microbiology is too complex to simulate simply in the lab. Several factors are mandatory for the growth of microorganisms, consequently increasing the number of parameters. Even when making the system more complex, there are still unknown species in the field, whose growth conditions are not yet understood. We know via 16S rRNA analysis that the species is present, but that is all we know. If these samples are enriched in the lab, many species will not survive and their impact on the whole community cannot be investigated. Therefore, lab tests related to MIC works only for a certain number of microorganisms. This means the key-result for other disciplines are missing, and important numbers for calculating the lifespan of a material can only be provided with limited accuracy. This is neither satisfying nor useful for engineers, material scientist or similar professionals, and it is understandable. However, MIC occurs, and we need to address it in our infrastructure or other important areas.

With this presentation, I aim to show the currently available techniques for testing on a laboratory scale. I will use SRBs and methanogenic archaea as examples to highlight the advantages and disadvantages of each method and point out where improvements are needed. The examples will be cross-sectoral and applicable to other sectors as well. This talk will highlight the currently existing challenges of testing MIC in the laboratory and may help generate creative solutions.

Effect of Flow Conditions on Microbially Influenced Corrosion

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While microbially influenced corrosion (MIC) is often associated with stagnant fluid conditions, there have been many cases reported of rapid microbial degradation of piping systems which have moving fluids. This presentation will provide some initial background on studies of the effect of shear stress due to fluid flow on bacterial attachment and microbially influenced corrosion. It will then discuss the development of a laboratory-based test rig designed to allow the study of MIC with well defined flow characteristics. Detailed computational fluid dynamic (CFD) simulations were performed to understand the shear stresses on the surfaces of test coupons in a test rig based on the design, which were subsequently validated by image analysis. The test rig was then used to study the initial attachment phase and longer-term MIC of copper by *Escherichia coli* and the sulfate-reducing bacteria *Desulfovibrio desulfuricans*. Bacterial attachement was found to be highly non-linear as a function of shear stress, while the biotic corrosion rates decreased with increased shear stress for the specific test combinations studied.

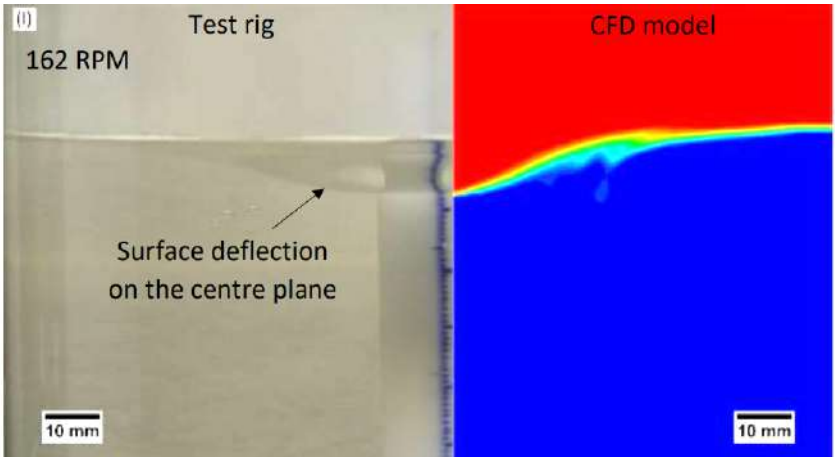

Figure 1. Example of surface deflection in MIC flow test rig compared to CFD theory.

Keywords: Microbially influenced corrosion, fluid flow, sulfate reducing bateria

Technological Protection Against Material Corrosion in Modern Industry

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ABSTRACT

Today, materials offer a wide range of applications due to their properties. Additionally, nearly every construction material is surface-protected. Numerous surface treatment and protection processes are utilized to prevent corrosion and to achieve desired surface properties, such as increased hardness and wear resistance. This article addresses a selection of material protection methods used in modern industry, with a primary focus on the protection of metallic materials, particularly steel and cast alloys. The technology of surface protection encompasses a variety of procedures and measures aimed at safeguarding materials from corrosion and achieving specific desired properties. Surface treatment processes are categorized into two groups: modification processes (mechanical, thermal, and thermochemical processes) and coating processes (mechanical, thermal, vapor-phase, electrochemical, chemical, and thermo-mechanical processes). The first section provides a methodological and systematic overview of the properties of various material groups used in technical applications. The second section explores corrosion, including fundamental concepts and corrosion-resistant steels. The third section covers material protection techniques (primarily for metals), with an emphasis on certain coating-based protection methods. The fourth section examines corrosion testing, including methods for detecting corrosion damage and determining corrosion rates. The fifth section addresses the environmental aspects of surface protection.

At the conclusion of this study, the importance of corrosion protection methods is emphasized. Corrosion primarily affects metallic materials, causing significant damage and costs while also polluting the environment. This underscores the importance of addressing the ecological aspects of corrosion, as environmental conservation and public health are critical concerns in modern society.

Keywords: technology, materials, pollution, ecology, industry

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Turning Harm into Opportunity: Metallic Iron Corrosion Catalyzing CO_2 Utilization via Anaerobic Microbial Integration

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Keywords: Methanogens, homoacetogens, Zero-valent iron mechanism; Hydrogen; pH buffering,

Anaerobic digestion (AD) converts organic waste into biogas and is enhanced by adding zero-valent iron (ZVI) (Charalambous et al. 2023, Charalambous and Vyrides 2021). ZVI is believed to assist both methanogens and acetogens in CO_2 reduction by directly transferring electrons from ZVI, a theory supported by changes in microbial communities and higher CH_4 production compared to H_2 in biological reactions (Wang and Lee 2021). ZVI is also thought to facilitate Direct Interspecies Electron Transfer (DIET) in AD, where electrons move directly between bacteria and methanogens, (Wang and Lee 2021). The role of DIET in anaerobic processes is debated, with Van Steendam et al. (2019) highlighting its importance, while Wang and Lee (2021) criticize the reliance on indirect methods like 16S rRNA gene sequencing and note the lack of direct proof in AD. They argue that accelerated methanogenesis from conductive materials does not conclusively prove DIET due to challenges in using genetic tools in environmental samples. Xu et al. (2023) propose investigating DIET using non-H2 producing SS316, though its effectiveness in mixed anaerobic cultures is untested. Additionally, Constantinou et al. (2023) found that ZVI produces H_2 faster in aquatic anaerobic environments with high bicarbonate concentrations than without bicarbonate (Equation 1).

$Fe^{(0)}(s) + HCO_3^-(aq) + H_2O \rightarrow FeCO_3(s) + H_{2\,(g)} + OH^-(aq)$ (Eq. 1)

In anaerobic processes, CO_2, which constitutes approximately 40% of biogas, can be captured by ZVI, thereby reducing CO_2 levels and increasing pH (Equation 1). ZVI serving also as a buffer to pH decrease due to VFAs generation and the H_2 produced during this reaction is utilized by hydrogenotrophic methanogens and homoacetogens along with CO_2 for CH_4 production (Vyrides et

al. 2018; Andronikou et al. 2022). However, research on the strategy of ZVI feeding additions in anaerobic digestion (AD), whether in-situ or ex-situ, remains limited.

The study focuses on four pivotal areas: First, investigating hydrogen production from ZVI in high bicarbonate environments and its effects on biogas production. Second, examining the generation of acetic acid from CO_2 and ZVI, with a focus on inhibiting methanogens and enhancing homoacetogens. Third, assessing the potential of Stainless Steel (SS316) to facilitate electron transfer without generating hydrogen in mixed anaerobic cultures. Finally, comparing in-situ and ex-situ strategies for ZVI addition in anaerobic processes for treating cheese whey to identify the most effective approach for improving efficiency and achieving biogas upgrading.

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Safeguarding subsea critical energy-related components

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Offshore installations, subsea equipment and subsea critical connectors experience severe working conditions. Potential failure of such critical connectors constitute environmental hazards notwithstanding the loss of human lives. This study proposes an approach for elucidating the corrosion mechanism affecting underwater components. The service conditions of subsea applications were simulated as part of a multidisciplinary system capable of recording various parameters such as the water temperature, the reference-electrode potential, and the electric current during five-minute intervals spanning 21 days of the experiment. A novel, small-scale, experimental and inexpensive impressed current cathodic protection (ICCP) system was developed using an "Arduino" computing unit and applied to actual ASTM A193 Grade B7 bolt screwed to an ASTM A105 flange at different torque levels (Figure 1). A finite element method (FEM) analysis was performed to predict the structurally vulnerable areas of the bolts. The combined effect of the prone location, the high subsea water current, and a large magnitude torque triggered a four-fold (4×) surge in the corrosion rate. Interestingly, the corrosion rate of bolts protected by the ICCP system was appreciably low compared to the bolts not safeguarded from corrosion. The unprotected bolts sustained a nine-fold (9×) increase in their corrosion rate than the protected ones. Thus, results confirm a direct relationship between the day-night water temperature profile and the cathodic protection performance. More specifically, the ICCP performance declines with rising water temperature. When the ICCP system was activated, gas bubbles were liberated on the metal surface. Closer inspection of the bolts under a scanning electron microscope has indicated the presence of hydrogen embrittlement cracks at the bolt cross-sections.

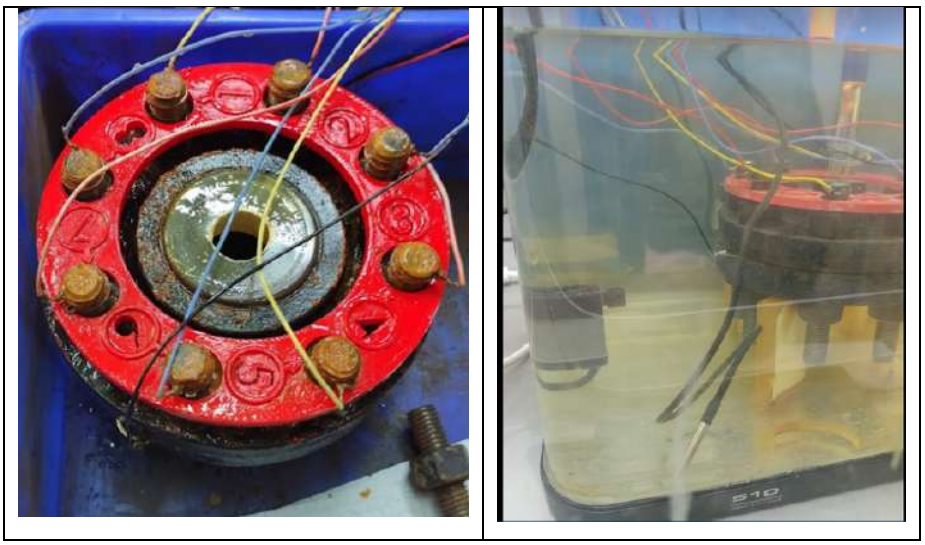

Figure 1. The flange and bolt configuration during the experiment with the ICCP system.

Keywords: Stress corrosion cracking, corrosion rate, impress current cathodic protection, subsea critical connectors, failure.

Acknowledgements/Dedication: This abstract is dedicated to the late Dr Ofer Medlinsky.

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Microbially Induced Corrosion of Cementitious Materials In Sewer Systems

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Sewer networks (also called wastewater systems) include structures to collect and transport wastewater to disposal or treatment in dedicated facilities. These networks are essential infrastructures of our societies, and the size of these systems in terms of length as well as asset value is usually vast. Accordingly, the annual rehabilitation and replacement costs for sewer networks are very high in many countries. In addition, failures of wastewater systems can cause severe health and environmental problems, making the durability of these infrastructures an issue of crucial societal importance.

A substantial fraction of the deterioration of sewers is caused by microbially influenced corrosion (MIC) of concrete structures in the networks, and, thus, understanding the causes of this process is crucial to be able to effectively direct resources for rehabilitation, replacement and construction of sewer systems. Because of the importance of the problem, it has been studied for many decades, and significant progress has been made during this time. In recent years, answers to several previously underexplored questions, for example regarding the validity of the different test methods to assess the resistance of cementitious materials against MIC and the suitability of new cementitious materials for sewer repair, have begun to emerge.

The present contribution gives an overview over the processes involved in MIC of cementitious materials in sewers, and reviews recent findings concerning the resistance of cementitious materials against MIC. The data indicate that alkali-activated materials can exhibit exceptionally high resistance against MIC, while it is presently not fully understood which mix design parameters determine this resistance. Disagreement exists in the literature regarding the causes of the generally high resistance of calcium aluminate cements. Significant progress has been made in determining the deterioration rate of cementitious materials under strongly corroding conditions, but well-founded approaches to classify the severity of MIC attack in sewers seem not to be available at present.

Keywords: cement; repair mortar; sewer; sulfur-oxidising bacteria; Acidithiobacillus

Mitigation of MIC in Europe: Euro-MIC Network's Transdisciplinary Approach for Advancing Materials Sustainability

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Microbiologically Influenced Corrosion (MIC) poses a growing challenge for society as it leads to detrimental effects on a broad range of different materials due to the presence of microorganisms. While the United States, Canada, and Australia have made substantial progress in addressing MIC, Europe lags in cooperative efforts. Despite the existence of various research groups and industrial stakeholders grappling with MIC in Europe, the discussions remain fragmented, hindering the exchange of information. A comprehensive transdisciplinary approach is notably needed.

As a result, Europe finds itself compelled to adopt methods, prevention measures, and standards from other global networks, given the absence of similar standards within the European framework. This reliance not only makes Europe highly dependent but also, in some instances, renders potential measures and standards unusable due to conflicts with European laws, such as restrictions on the use of biocides. In response to these challenges, the "Euro-MIC" network was established in 2021 with financial support from COST – European Cooperation in Science and Technology.

Euro-MIC aims to address the issues associated with MIC by fostering collaboration, communication, knowledge sharing, and the training of industry personnel and researchers across different disciplines. The network is a crucial step towards achieving a more unified approach within Europe. Euro-MIC facilitates network activities, workshops, training schools, conferences, and mobility opportunities. The overarching goal of Euro-MIC is to elevate Europe to a leading position in combating MIC, aligning its ideas with global standards while upholding values important to the region and enhancing protection for people, property, and the environment.

During the initial grant periods, Euro-MIC utilized various networking tools, including meetings, workshops, conferences, mobilization grants, and support for young scientists to connect with experts globally. The presentation will provide updates on the current and future activities within the program and offer insights into how individuals and organizations can actively engage in these initiatives and benefit from them. Emphasis will be placed on the importance of selecting effective mitigative and preventive measures to combat MIC, contributing not only to the protection of infrastructure but also aligning with the broader goal of advancing materials sustainability.

Antibacterial Effects of Lactobionic Acid and Carvacrol on *Escherichia coli* Isolates

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Escherichia coli is one of the most common species involved in biofilm-associated diseases and it is vital in urinary tract infections, causing relapses or chronic infections. The existence of multidrug-resistant *Escherichia coli* bacteria is a global health threat imposing various disadvantages to humans, livestock, food processing units, and the healthcare and pharmaceutical industries. Bacterial biofilms are up to 1000 times more resistant to antibiotics than their planktonic counterparts and can evade the effects of the host's immune system. The rising resistance to various antibiotics and the high cost and lengthy process of developing new ones have intensified interest in natural compounds as alternative therapeutic options. For these reasons, our planned study aimed to investigate the antimicrobial and antibiofilm effects of natural products such as lactobionic acid and carvacrol on pathogenic *Escherichia coli* species.

The *broth microdilution method*[1] *was used to investigate the Minimum Inhibitory Concentration (MIC) of lactobionic acid and carvacrol against Escherichia coli* ATCC 25922 wild-type strain and fifty uropathogenic and catheter-associated isolates *of Escherichia coli from different hospitals. Also, the Minimum Bactericidal Concentration (MBC) of agents was determined.* The effects of lactobionic acid and carvacrol on eradicating mature *E. coli* biofilm structures were subsequently assessed using crystal violet staining[2].

The Minimum Inhibitory Concentration (MIC) of carvacrol ranged from 256 to 4096 µg/mL, while the MIC of lactobionic acid ranged from 2048 to 16,384 µg/mL. The findings revealed that carvacrol and lactobionic acid posed bactericidal effects in 98% and 100% of *Escherichia coli* isolates, respectively. The Minimum Biofilm Eradication Concentration (MBEC) of carvacrol and lactobionic acid was determined, and experimental results revealed that carvacrol posed a moderate (24.05%) antibiofilm effect on the samples. In contrast, lactobionic acid demonstrated a good antibiofilm effect with an average biofilm reduction of 56.77% on *E. coli* isolates.

This research aims to raise awareness about the critical importance of biofilm prevention and highlights the necessity to search for alternative natural therapies to overcome the growing challenge of antibiotic resistance.

Keywords: *Escherichia coli*; biofilm; drug-resistant; lactobionic acid; carvacrol

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Bridging the Gap: Advancing Regulatory Science Tools for Biofilm Research through Standardisation

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Abstract:

Regulatory science plays a critical role in enabling informed decisions on product safety, efficacy, and environmental impact. However, advancements in biofilm research have outpaced regulatory frameworks, creating a significant disconnect between academic innovation and regulatory guidelines. This gap limits the effective adoption of cutting-edge in vitro and in vivo models, research tools, and methodologies for product evaluation and approval.

This presentation highlights the urgent need for harmonisation in biofilm research, focusing on the development of a CEN/CENELEC Workshop Agreement (CWA) as a cost-effective, flexible approach to standardisation. A CWA provides a platform for collaboration among academic researchers, industrial stakeholders, and regulatory bodies to develop consensus-based frameworks that address validation protocols, ontology, and testing methodologies.

By establishing guidance documents, this initiative aims to:

- Accelerate the integration of validated tools into regulatory decision-making.
- Enhance product evaluation for public health and environmental safety.
- Foster alignment across academia, industry, and regulators in Europe.

Through this COST Action, we propose the creation of a multidisciplinary network to identify gaps and prioritise the development of pre-standardisation documents. The outcomes will lay the foundation for future formal standards, driving innovation while ensuring strong regulatory pathways for biofilm-related products.

Keywords: Regulatory Science, Biofilm Research, CEN/CENELEC Workshop Agreement, Standardisation

The influence of AR MiniBars™ on Mechanical Properties of Geopolymer Composites

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Abstract:

Many buildings generally use steel fibers to reinforce concrete and provide improved mechanical properties but over time, this advantage could be lost, due to corrosion of the steel. The high alkalinity of Portland cement conducts to corrosion of the glass fiber reinforced materials. The addition of big amount of zirconia (15–20 wt.%) [1, 2] to AR-glass fibers provides a higher resistance to corrosion compared to other glass fibers [3]. The polymer coating of the glass fiber surface AR MiniBars™ enhanced corrosion resistance to alkali degradation and the tensile strength of alkali-resistant filament yarns, the adhesion strength with cementitious matrices, and fracture energy of the composites

Geopolymer concrete reinforced with MiniBars™ could be an eco-friendly, innovative, durable, high strengthening material, substitute to common Portland cement for buildings. AR glass fiber MiniBars™ composites (AR MiniBars™) (ReforceTech AS, Royken, Norway) had 60 mm length and were utilized to strengthen the geopolymer matrix for the fabrication of unidirectional AR MiniBars™ reinforced geopolymer composites (AR MiniBars™ FRBCs). New AR MiniBars™ FRBCs were fabricated by adding different amounts of AR MiniBars™ (0, 12.5, 25, 50, 75 vol.%) in the fly ash geopolymer paste. Geopolymers were obtained by combining fly ash powder with Na_2SiO_3/NaOH 2.5:1, which served as an alkaline activator. AR MiniBars™ FRBCs were cured for 48 h at 70 °C and tested for different mechanical properties. Fly ash, AR MiniBars™, and AR

MiniBars™ FRBC were evaluated by optical microscopy and SEM. The addition of AR MiniBars™ showed increased mechanical properties for AR MiniBars™ FRBCs. The mechanical properties of AR MiniBars™ FRBCs heightened, then the geopolymer without AR MiniBars™: the flexural strength > 18.80–30.71 times, the flexural modulus > 4.07–5.25 times, the tensile strength > 3.49–8.27 times, and the force load at upper yield tensile strength > 3.6–7.72 times. The fractured surfaces and sections of AR MiniBars™ FRBCs were inspected by SEM and optical microscopy analyses and even though there was no chemical adhesion we had a good micromechanical adhesion of geopolymer to AR MiniBars™. These results obtained encouraged us to propose AR MiniBars™ FRBCs for construction application. AR MiniBars™ could replace in some applications the deformed steel bars, which are corrosive and more expensive.

Keywords: AR MiniBars; AR Glass Fiber; fly ash; geopolymer composites; mechanical properties

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