

## Investigation of microbial souring mechanisms and test of natural antibiotics for MIC prevention

Chaturvedi, Tanmay; Skovhus, Torben Lund; Thomsen, Mette Hedegaard

*Publication date:*  
2018

*Document Version*  
Publisher's PDF, also known as Version of record

[Link to publication from Aalborg University](#)

*Citation for published version (APA):*

Chaturvedi, T., Skovhus, T. L., & Thomsen, M. H. (2018). *Investigation of microbial souring mechanisms and test of natural antibiotics for MIC prevention*. Poster presented at DHRTC Technology conference, Copenhagen, Denmark.

### General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal -

### Take down policy

If you believe that this document breaches copyright please contact us at [vbn@aub.aau.dk](mailto:vbn@aub.aau.dk) providing details, and we will remove access to the work immediately and investigate your claim.

Tanmay Chaturvedi<sup>1</sup>, Torben Lund Skovhus<sup>2</sup>, Mette Hedegaard Thomsen\*<sup>1</sup>

1: Aalborg University, Department of Energy Technology, 2: VIA University College, Research Group for Energy & Environment

Corresponding Author\*: mht@et.aau.dk

## INTRODUCTION

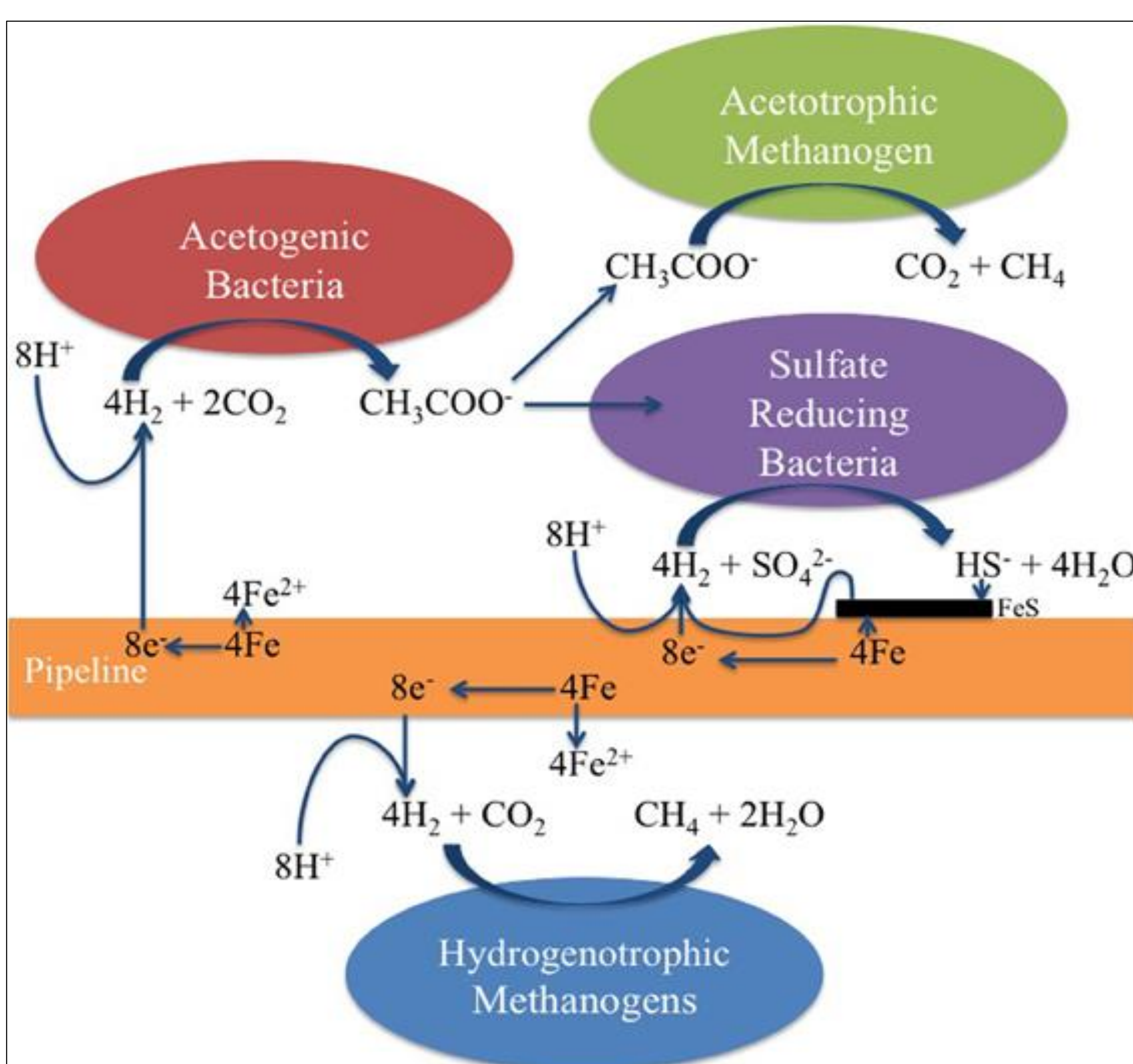
Offshore oil production facilities are subjectable to internal piping corrosion, potentially leading to human and environmental risk, and significant economic losses. Microbiologically influenced corrosion (MIC) and souring (sulphide production by Sulfate-reducing prokaryotes) from bacteria (SRB) or archaea (SRA) occur due to water flooding during secondary oil recovery, where the seawater used can contain large amounts of sulfate (25-30 mM). MIC is often seen as localized pitting attack that is generally associated with the presence of microbial communities embedded in a matrix (often with bioinorganic matrixes) referred to as biofilms. Active phytochemicals including strong antimicrobials from halophytes will be applied in this study to combat MIC by inhibiting MIC microorganisms such as methanogens and SRP. A bioreactor system for biofilm production was setup and inoculated with Wadden Sea sediments to emulated onsite MIC.

## MATERIALS AND METHODS

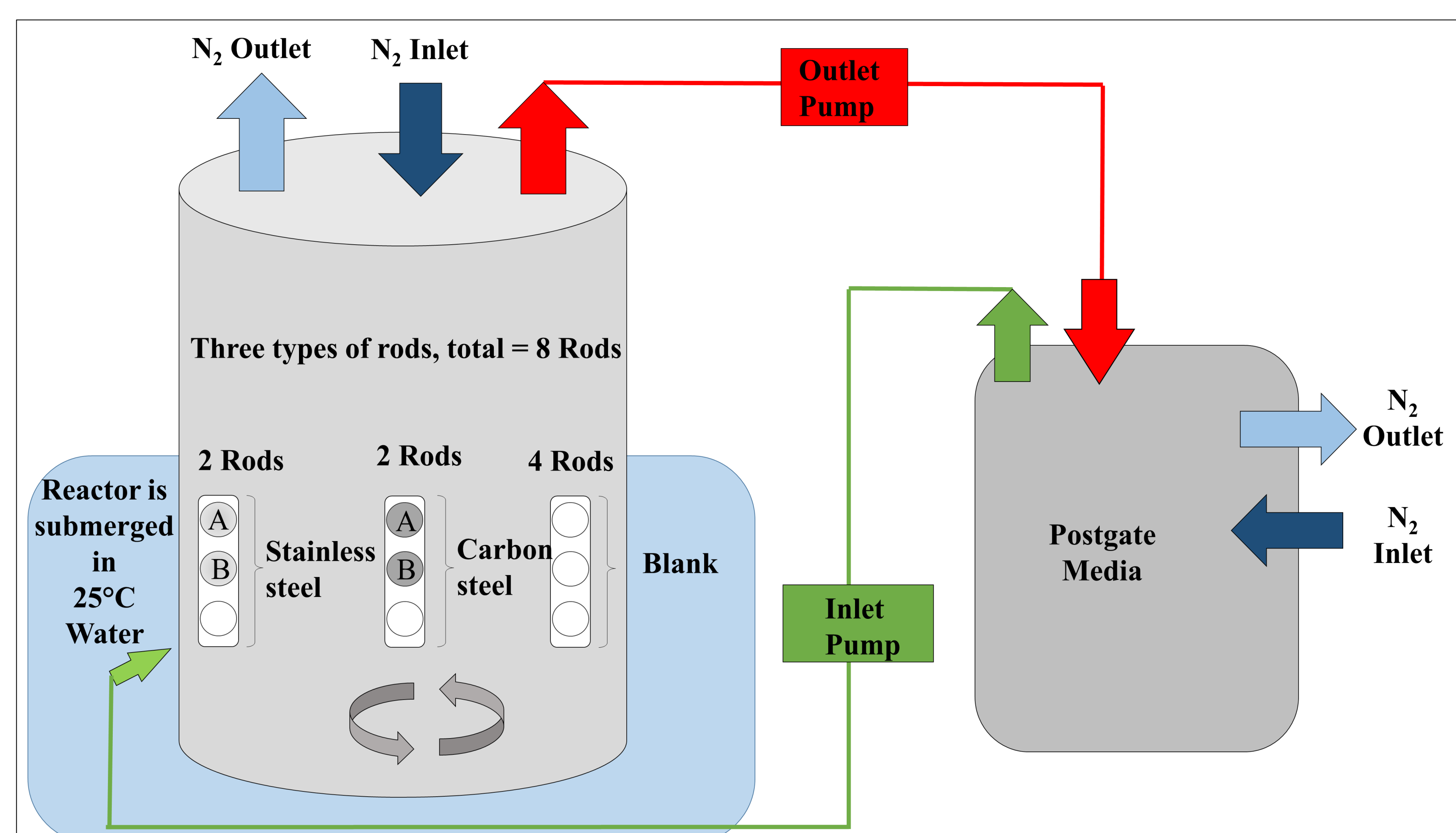
**PHASE 1 Formation of biofilm:** Three reactors were inoculated with sediments obtained from Wadden Sea and continuously circulated with Postgate media while maintained at 25°C. Each reactor has four stainless steel and four carbon steel coupon. The ATP, pH, and hydrogen sulphide levels were measured at regular intervals to monitor the microbiological activity in the reactors (results from which can be see in Fig.4). The experimental design is shown in Figure 2. Nitrogen was flushed through the reactor and substrate bottle to maintain anaerobic conditions.

**Phase 2 Treatment of biofilms with halophyte extract:** The three reactors will be tested with varying levels of halophyte extract.  $\alpha$  reactor will serve as the control,  $\beta$  reactor will have continuous 10% extract mixed with Postgate media, and  $\gamma$  will be pulsed every 3<sup>rd</sup> day with 5,10,15,20, and 30% extract directly in the reactor mixed with Postgate media (running for a total of 15 days). Upon completion of this phase, the coupons will be analyzed for DNA using next generation sequencing (NGS), 3D scanning of pitting corrosion, and analyzed for ATP of biofilm from coupon surface. Additionally the media will analyzed by high performance liquid chromatography (HPLC) to determine metabolic products.

**Figure 1: Mechanism of Microbiologically Influenced Corrosion [1]**



**Figure 2: Bioreactor Schematic**



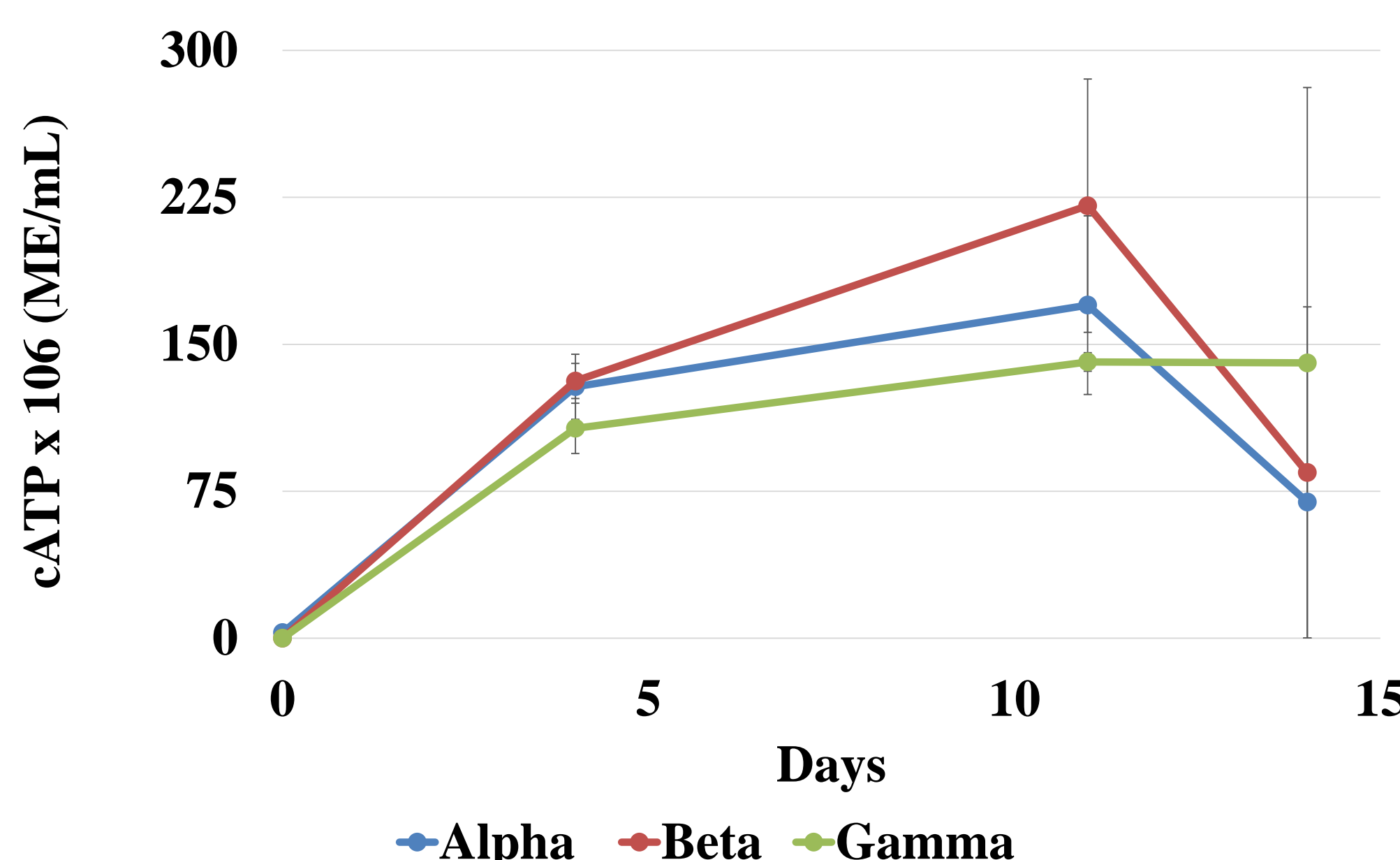
**Fig: 3a Biofilm**



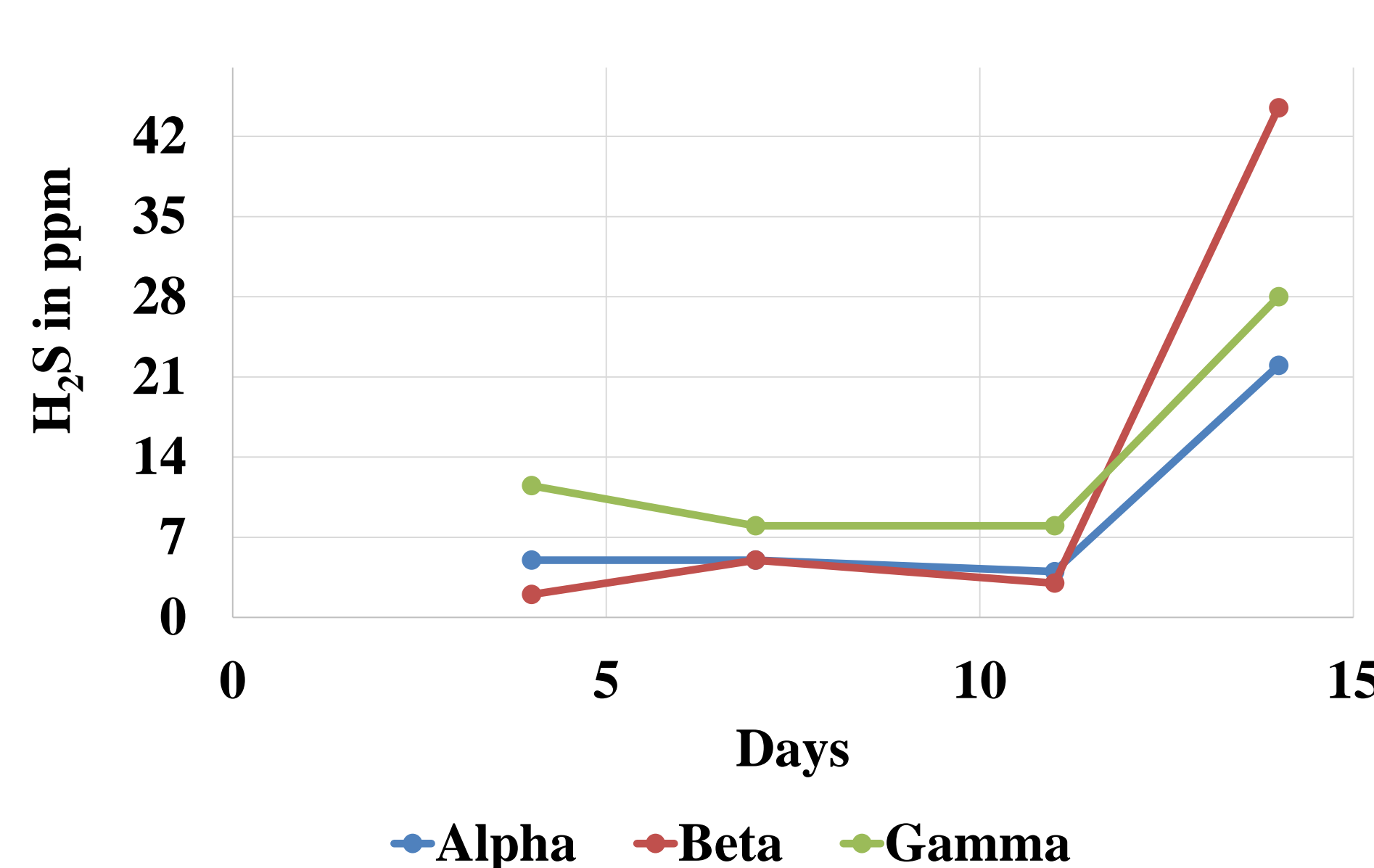
**Fig: 3b Corrosion in Pipes**



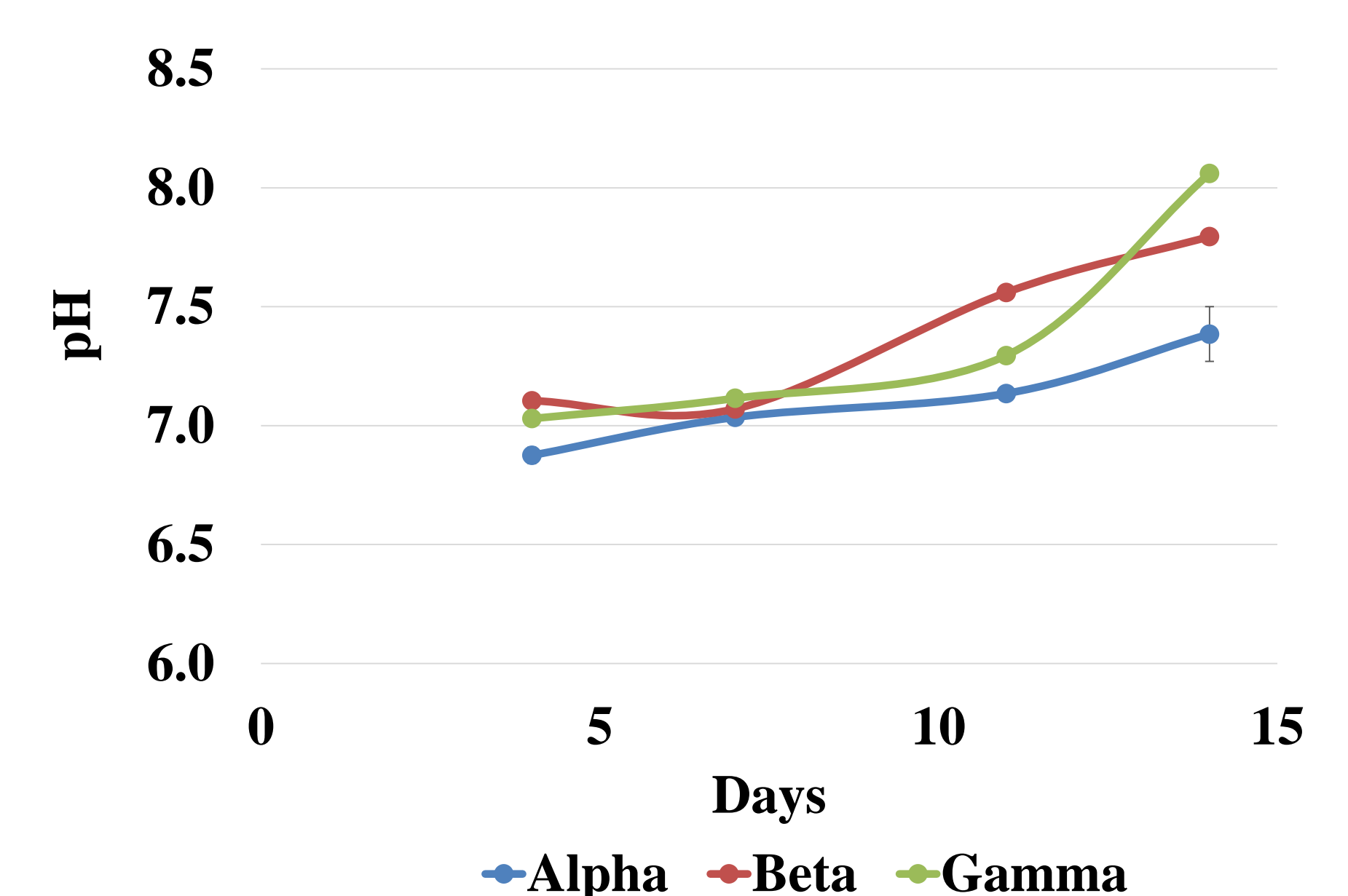
**cATP in microbial equivalent – Liq. Phase**



**H<sub>2</sub>S Variation in Gas Phase**



**pH Variation in Gas Phase**



**Figure 4: Graphs highlighting microbial activity and, thus the growth of biofilm formation in the three reactors**

Note: The three reactors have similar behavior during Phase 1 of the experiments as halophyte extract has not been added at this stage

## LONG TERM IMPACT

The petroleum industry today relies on biocides to avoid MIC, souring and biofouling. Huge savings can be achieved by switching to cheap and environmentally safe antimicrobials or alternative biofilm inhibitors. Halophyte extracts along with combination of phyto-chemicals would be a novel, biologically inspired, and lasting solution to MIC and souring. Next generation sequencing (NGS) of DNA from bacteria and archaea will help identify the strains and study the effects of antimicrobials on the microbial populations. The inhibitory effect of using selected halophyte plant extracts on SRB, SRA, and methanogens will be studied in the second phase of these experiments.

**Reference :** 1. Mand, J., Park, H.S., Jack, T.R. and Voordouw, G., 2014. The role of acetogens in microbially influenced corrosion of steel. *Frontiers in microbiology*, 5, p.268.

**Acknowledgement:** We thank the Danish Hydrocarbon Research and Technology Centre (DHRTC) for their funding and collaboration.