Enhanced Mitigation of Pipeline Biocorrosion Using A Mixture of D-Amino Acids with A Biocide

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Main Objective

Microbiologically influenced corrosion (MIC) is more prevalent nowadays because of aging infrastructures. Biofilms are the culprits of MIC in oil and gas pipelines. An effective, environmental friendly, and economical approach is highly desired. D-amino acids can trigger biofilm disassembly (Kolodkin-Gal et al., 2010). It has been reported that D-methionine and D-tyrosine can enhance tetrakis hydroxymethyl phosphonium sulfate (THPS), a popular green biocide, against the *Desulfovibrio vulgaris* (a sulfate reducing bacterium) biofilm (Xu et al., 2012 and 2013).

A project was awarded to Ohio University to develop a new biocide enhancer technology (from laboratory tests to field applications) for the mitigation of corrosive biofilms in pipelines. Experimental tasks will evaluate the two D-amino acids as well as additional D-amino acids in combination with THPS to treat field biofilm consortia.

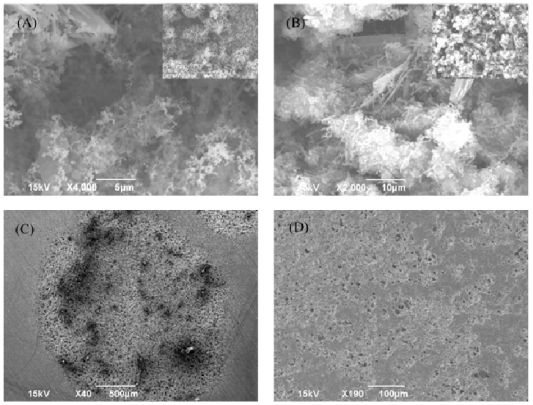

Figure 1. Biofilm images of (A) consortium I and (B) consortium II. Pits underneath (C) consortium I and (D) consortium II.

Figure 2. Experimental setup.

Project Approach/Scope

- Testing D-tyrosine and D-methionine against field biofilm consortia
- Screening additional D-amino acids
- Using D-amino acid mixtures as biocide enhancers
- Field testing

Two types of efficacy tests:

- Biofilm prevention test
- Established biofilm removal test

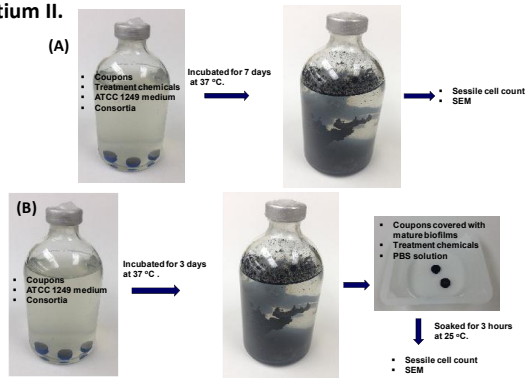

Figure 3. Procedures for (A) biofilm prevention test and (B) established biofilm removal test.

Results to Date

1. D-serine, D-threonine, and D-Phenylalanine promoted the efficacy of 50 ppm THPS in mitigation of *D. vulgaris*. Low concentration of individual D-amino acids such as D-tyrosine and D-methionine did not promote 50 ppm THPS in mitigation of tough biofilm consortia.

2. An equimolar mixture of D-tyrosine, D-methionine, D-leucine, and D-tryptophan (D-mix) was tested. It was found that the 50 ppm D-amino acid mixture promoted 50 ppm THPS in the mitigation of two field biofilm consortia in both prevention and removal tests.

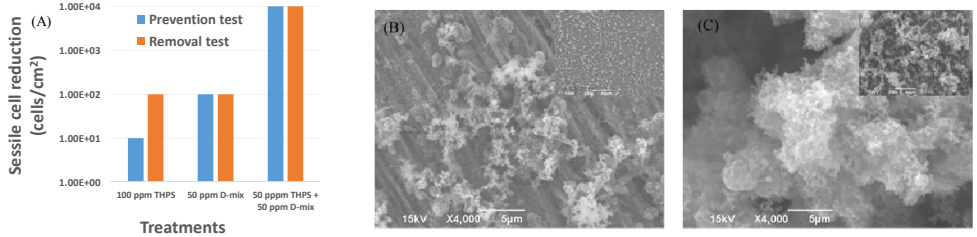

Figure 4. Mitigation of consortium I: (A) Sessile cell reduction and SEM images of biofilms after being treated with 50 ppm THPS + 50 ppm D-amino acid mixture in (B) prevention test and (C) removal test.

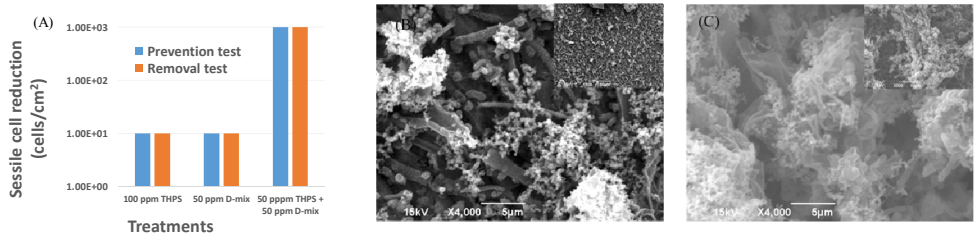

Figure 5. Mitigation of consortium II: (A) Sessile cell reduction and SEM images of biofilms after being treated with 50 ppm THPS + 50 ppm D-amino acid mixture in (B) prevention test and (C) removal test.

Acknowledgment

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References

Kolodkin-Gal I, Romero D, Cao S, Clardy J, Kolter R, Losick R. 2010. D-amino acids trigger biofilm disassembly. Science 328:627–629.

Xu D, Li Y, Gu T. 2012. A synergistic D-tyrosine and tetrakis hydroxymethyl phosphonium sulfate biocide combination for the mitigation of an SRB biofilm. World J. Microbiol. Biotechnol. 28:3067–3074.

Xu D, Li Y, Gu T. 2013. D-methionine as a biofilm dispersal signaling molecule enhanced tetrakis hydroxymethyl phosphonium sulfate mitigation of *Desulfovibrio vulgaris* biofilm and biocorrosion pitting. Mater. Corros. DOI: 10.1002/maco.201206894.

Public Project Page: http://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=512