Corrosion Inhibition of Mild Steel Using Ethoxylated Free Fatty Acids

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Hypothesis

By altering nonpolar green corrosion inhibitors with a polar head, creating a surfactant, a more efficient corrosion inhibitor can be created

Background

- Corrosion causes billions of dollars in damage to gas pipelines every year [1].
- Traditional corrosion inhibitors are often hazardous to both human health and the environment.
- Green inhibitors offer a safer alternative, they are naturally derived, biodegradable, and environmentally friendly [2].
- Free fatty acids, which are long nonpolar carbon chains found in triglycerides (like those in cooking oil), can be extracted and used effectively as corrosion inhibitors.

Methods

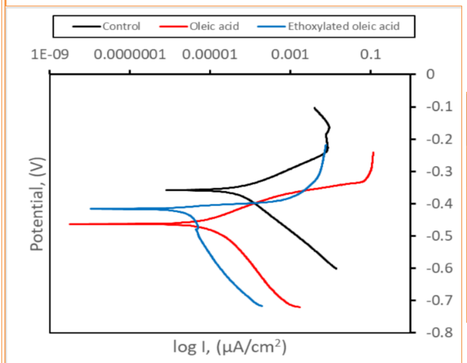
- Oleic Acid was reacted with polyethylene glycol (PEG) using sulfuric acid as a catalyst under a nitrogen environment
- Weight loss tests were preformed with samples being tested on mild steel in a 1M HCL solution
- Electrochemical tests were preformed in 1M HCL solution

Results

Weight lost test

oleic acid							
BC	3.77518	3.83983	3.82109	3.812033333	0.271506666	7%	47.92%
AC	3.45157	3.53332	3.63669	3.540526667			
Ethoxylated Oleic Acid							
BC	3.82622	3.8327	3.79062	3.816513333	0.064773333	2%	87.59%
AC	3.76449	3.72186	3.76887	3.75174			

Electrochemical test

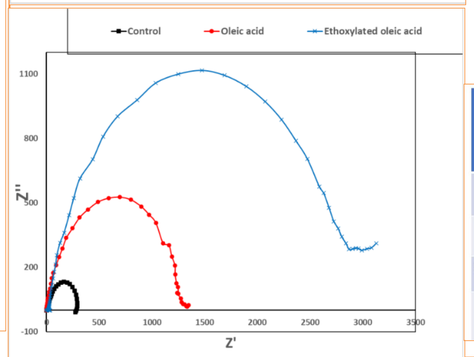


Sample	E_{corr} (mV)	Icorr (μA/cm²)	CR (mmpy)	Inhibition efficiency (%)
Control	-357	57.1	0.6603	-------
Oleic acid	-462.5	11.81	0.1366	79.3
Ethoxylated oleic acid	-417.3	9.2	0.1064	83.89

$$CR = \frac{I_{corr}.K.EW}{\rho.A}$$

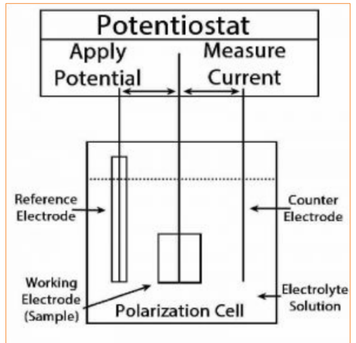
where K is constant defines the units of CR, for CR in mm/year (mmpy), K = 3272 mm/(A cm year), EW (the equivalent weight) 27.92 g for carbon steel, ρ (density) = 7.9 g/cm³ for copper, A (area) of the sample = 1 cm².

$$IE = \frac{I_{corr\_0} - I_{corr\_P}}{I_{corr\_0}}$$



Sample	Rs (solution resistance) (Ω cm²)	RP (Polarization resistance) (Ω cm²)	CPE (constant phase element) (F/s)	n	Inhibition efficiency (%)
Control	1.232	298.6	$8.8 * 10^{-4}$	0.83778	____
Oleic acid	0.98975	1189	$2.9 * 10^{-5}$	0.89824	74.9
Ethoxylated Oleic acid	21.5	2889.3	$1.43 * 10^{-5}$	0.86	89.66

$$IE = \frac{R_{P\_P} - RP_{\_0}}{R_{P\_P}}$$



Conclusion

- Ethoxylated oleic acid shows 40% higher inhibition efficiency than unmodified oleic acid in the weight loss test.
- Electrochemical tests show similar efficiencies for both.
- Ethoxylated oleic acid performs very well overall, and future work will aim to improve it further.

References

[1] Koch, G. (2017). Cost of corrosion. *Trends in oil and gas corrosion research and technologies*, 3-30.

[2] Harsimran, S., Santosh, K., & Rakesh, K. (2021). Overview of corrosion and its control: A critical review. *Proc. Eng. Sci*, *3*(1), 13-24.

[3] *Electrochemical Corrosion Testing | Electrochemical Corrosion Failure Analysis | Electrochemical Corrosion Material Analysis*. (n.d.). Retrieved April 6, 2025, from https://www.mee-inc.com/hamm/electrochemical-corrosion-testing/

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