NISTM

National Institute for Storage Tank Management

How VCI's Can Prevent Corrosion for AST and UST System Components

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NTI®

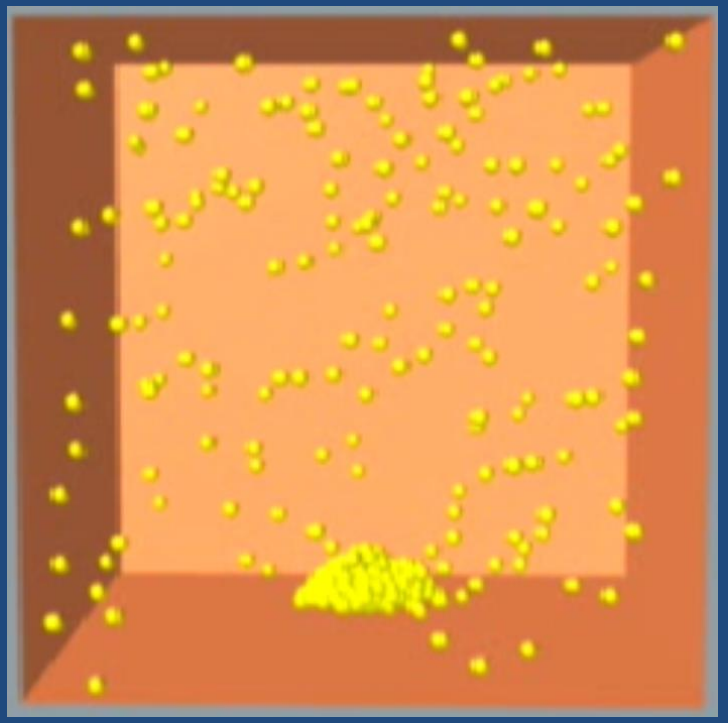
Zerust® OIL & GAS

Topics For Discussion

1. VCI Background
2. Problem definition
3. Corrosion protection of storage tanks
4. Corrosion protection UST Sumps
5. Conclusions

What are VCIs?

- A class of corrosion inhibiting compounds which have vapor pressures higher than that of air.
- This results in the release of vapor molecules of inhibitor into the air.
- These molecules will adsorb to the surface of steel and block other molecules from coming in contact with the steel.



- Can protect immersed surfaces
- Not a ‘coating’
- Does not change metallurgy
- Not permanent

- Can be painted/welded
- Non-toxic
- Can be designed for specific service exposure

Many forms of VCI

What's the difference?

1. Self-fogging Flash Corrosion Inhibitor (FCI™) technology
   - High vapor pressure, low vapor density
   - Fast acting flash corrosion inhibitor
   - Fills vapor spaces immediately
   - Highest volume of protection per weight of active ingredient
   - Navigates complex systems
2. Long-term Vapor Corrosion Inhibitor (VCI) protection
   - Slower evolving, long-term vapor corrosion inhibitor
3. Long-term Soluble Corrosion Inhibitor (SCI) protection
   - Contact corrosion inhibitors activated when water present
   - Chloride "neutralizer"

Automotive industry – 30+ years

Not "NEW" Technology

- Thousands of machined parts must remain pristine during transport and storage.
- Clean, environmentally friendly, requires no cleaning prior to assembly.

VCIs have been sold through major retailers for years

Several 'consumer market' products you can try

- Lowes
- Cabellas
- Flambeau
- Kobalt
- …others

Long Term Corrosion Protection

Shipping, Storage, Mothballing

Low Temperature Flanges

Flange Savers™

NTIC/Zerust uses a proprietary material impregnated with a Vapor Corrosion Inhibitor (VCI) to enclose the flanges, bolts and weld joints

Mitigating Corrosion

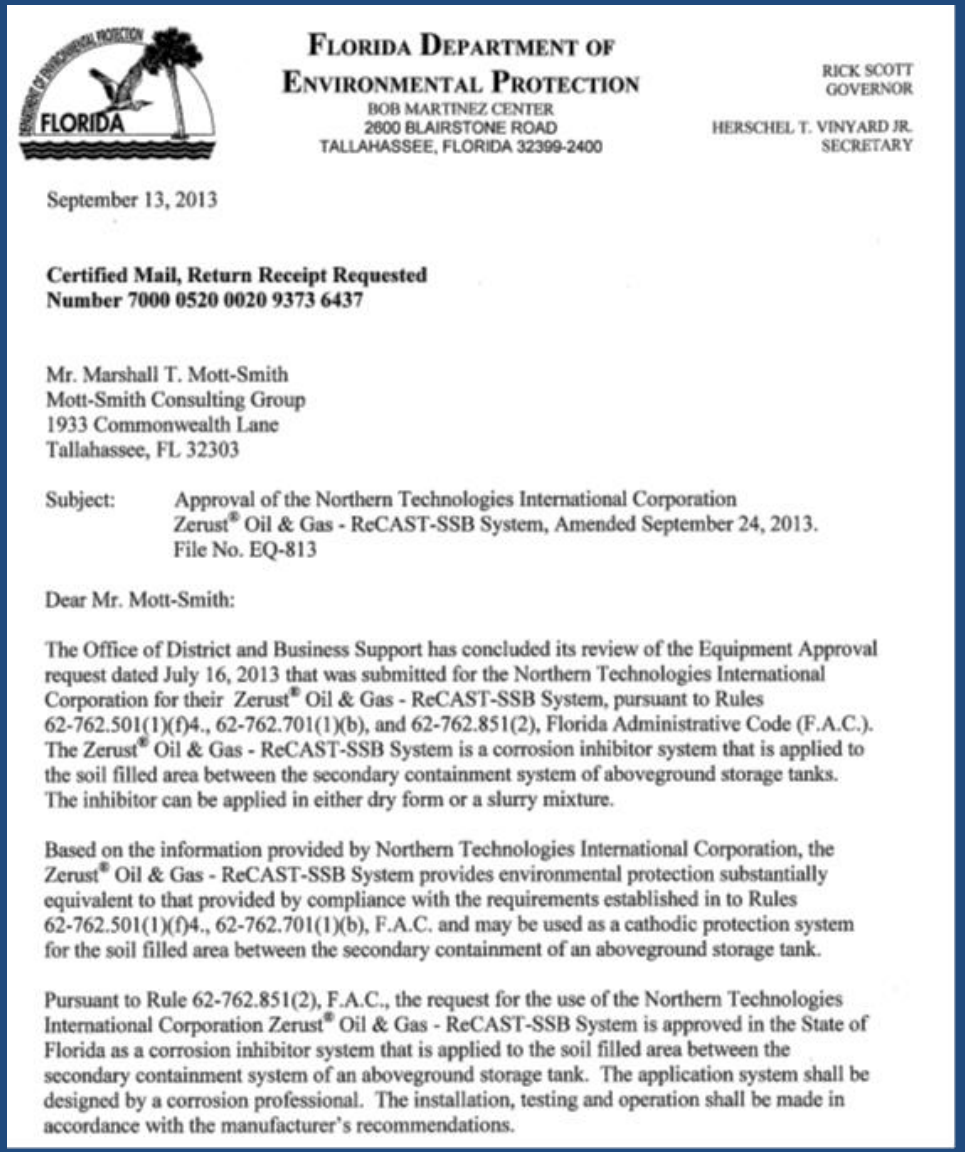
Corrosion cannot be eliminated, it's mechanism can only be retarded

Applications!

How can VCI be used in AST's?

State of Florida

"ReCAST-SSB System provides environmental protection substantially equivalent to that provided by compliance with the requirements established in Rules 62-762.501(1)(f)4., 62-762.701(1)(b), F.A.C ***and may be used as a Cathodic protection system…*** *Pursuant to Rule 62-762-851(2), F.A.C. … is approved in the State of Florida as a corrosion inhibitor system that is applied to the soil filled area between the secondary containment system of an aboveground storage tank."*



FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
BOB MARTINEZ CENTER
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TALLAHASSEE, FLORIDA 32399-2400

RICK SCOTT
GOVERNOR

HERSCHEL T. VINYARD JR.
SECRETARY

September 13, 2013

Certified Mail, Return Receipt Requested
Number 7000 0520 0020 9373 6437

Mr. Marshall T. Mott-Smith
Mott-Smith Consulting Group
1933 Commonwealth Lane
Tallahassee, FL 32303

Subject: Approval of the Northern Technologies International Corporation Zerust® Oil & Gas - ReCAST-SSB System, Amended September 24, 2013. File No. EQ-813

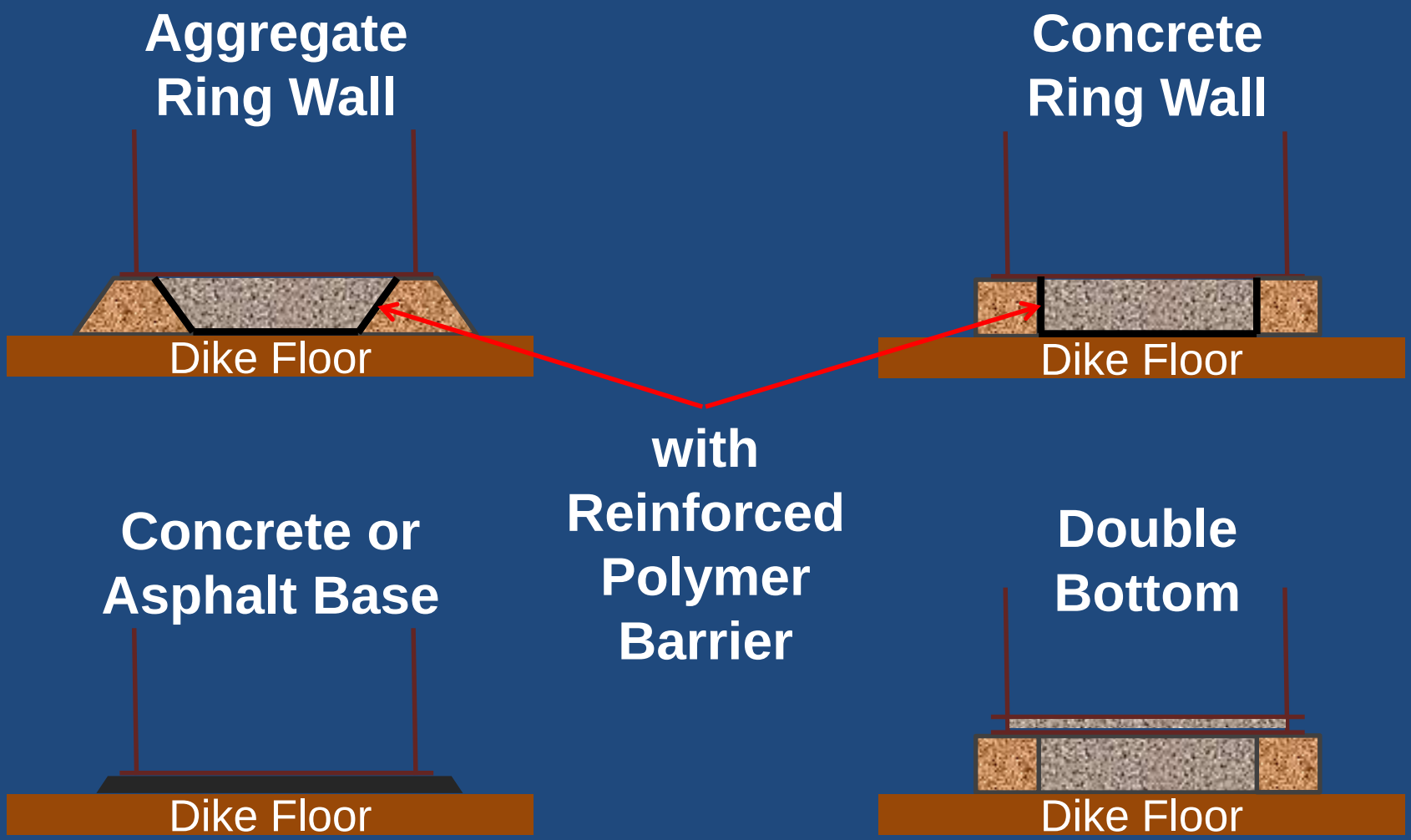
Dear Mr. Mott-Smith:

The Office of District and Business Support has concluded its review of the Equipment Approval request dated July 16, 2013 that was submitted for the Northern Technologies International Corporation for their Zerust® Oil & Gas - ReCAST-SSB System, pursuant to Rules 62-762.501(1)(f)4., 62-762.701(1)(b), and 62-762.851(2), Florida Administrative Code (F.A.C.). The Zerust® Oil & Gas - ReCAST-SSB System is a corrosion inhibitor system that is applied to the soil filled area between the secondary containment system of aboveground storage tanks. The inhibitor can be applied in either dry form or a slurry mixture.

Based on the information provided by Northern Technologies International Corporation, the Zerust® Oil & Gas - ReCAST-SSB System provides environmental protection substantially equivalent to that provided by compliance with the requirements established in to Rules 62-762.501(1)(f)4., 62-762.701(1)(b), F.A.C. and may be used as a cathodic protection system for the soil filled area between the secondary containment of an aboveground storage tank.

Pursuant to Rule 62-762.851(2), F.A.C., the request for the use of the Northern Technologies International Corporation Zerust® Oil & Gas - ReCAST-SSB System is approved in the State of Florida as a corrosion inhibitor system that is applied to the soil filled area between the secondary containment system of an aboveground storage tank. The application system shall be designed by a corrosion professional. The installation, testing and operation shall be made in accordance with the manufacturer's recommendations.

Tank Bottom Geometries



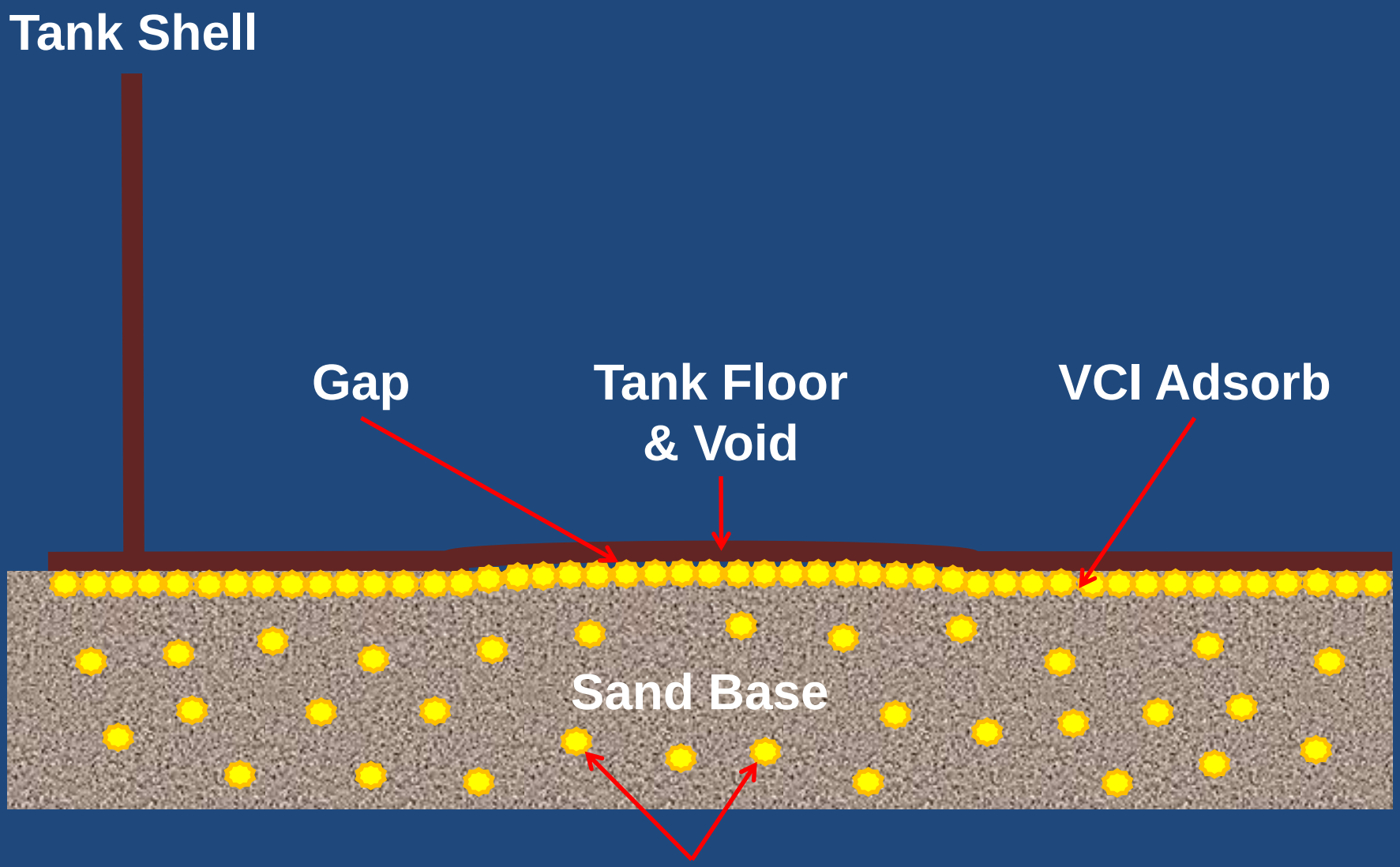
Cone Up - Flat - Cone Down

Examples of Problems

Penetrations due to tank bottom corrosion

Are they from topside or bottomside?

How Do VCIs Work Under Tanks?

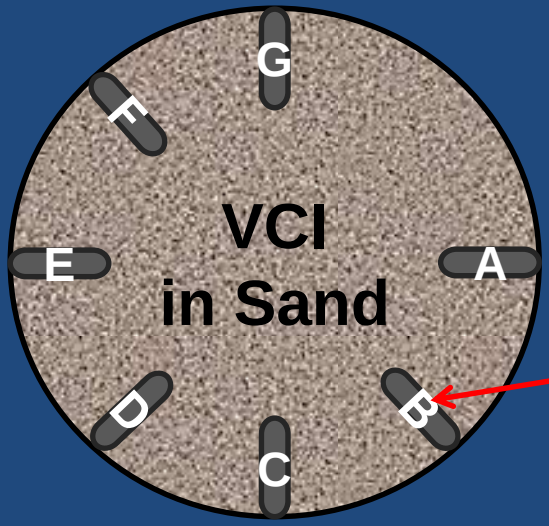


Case Study – Double Bottom

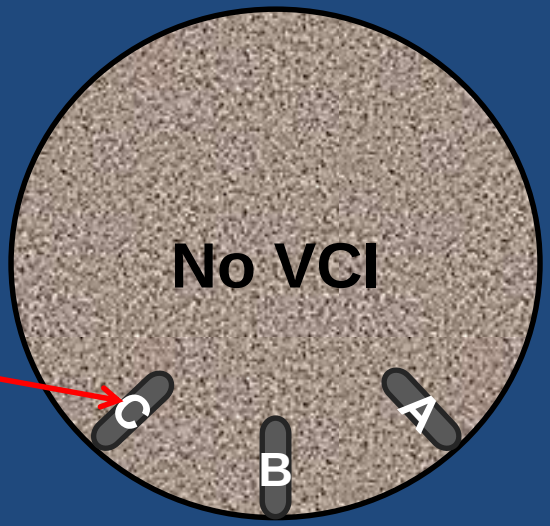
Soil Side Bottom (SSB) Protection

Test

Control

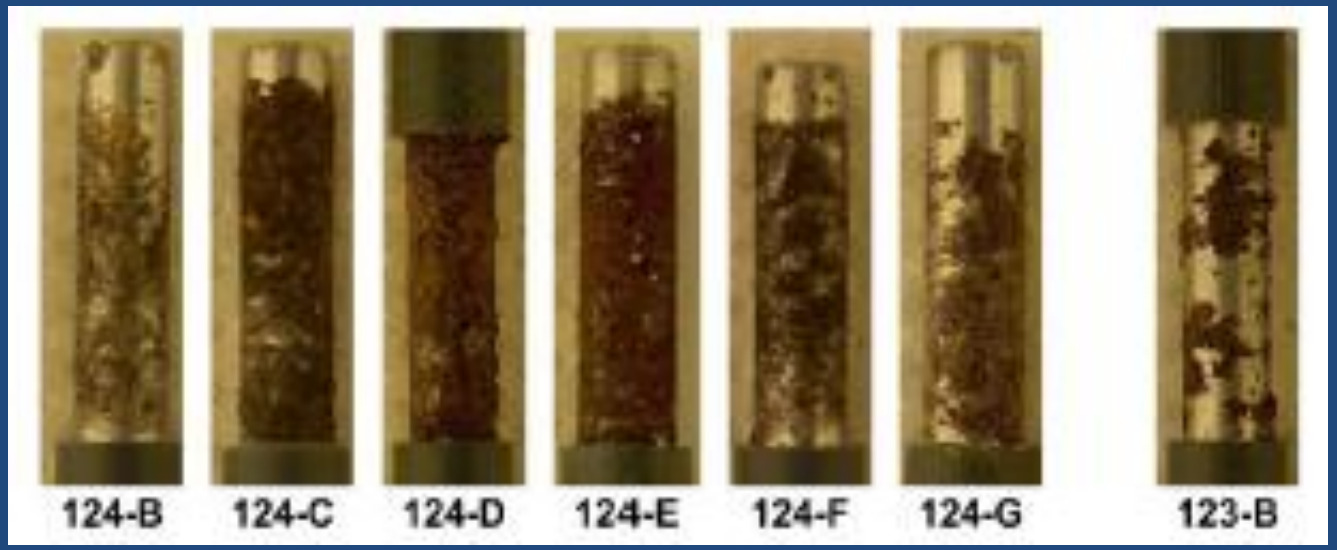


Test
Coupons



Coupon Tests

Coupons were removed in 2007 and 2011 for corrosion rate evaluation according to ASTM G1-03



1018 Carbon Steel

Surface Area Results

Surface Area Affected by Corrosion - 2007 Specimens

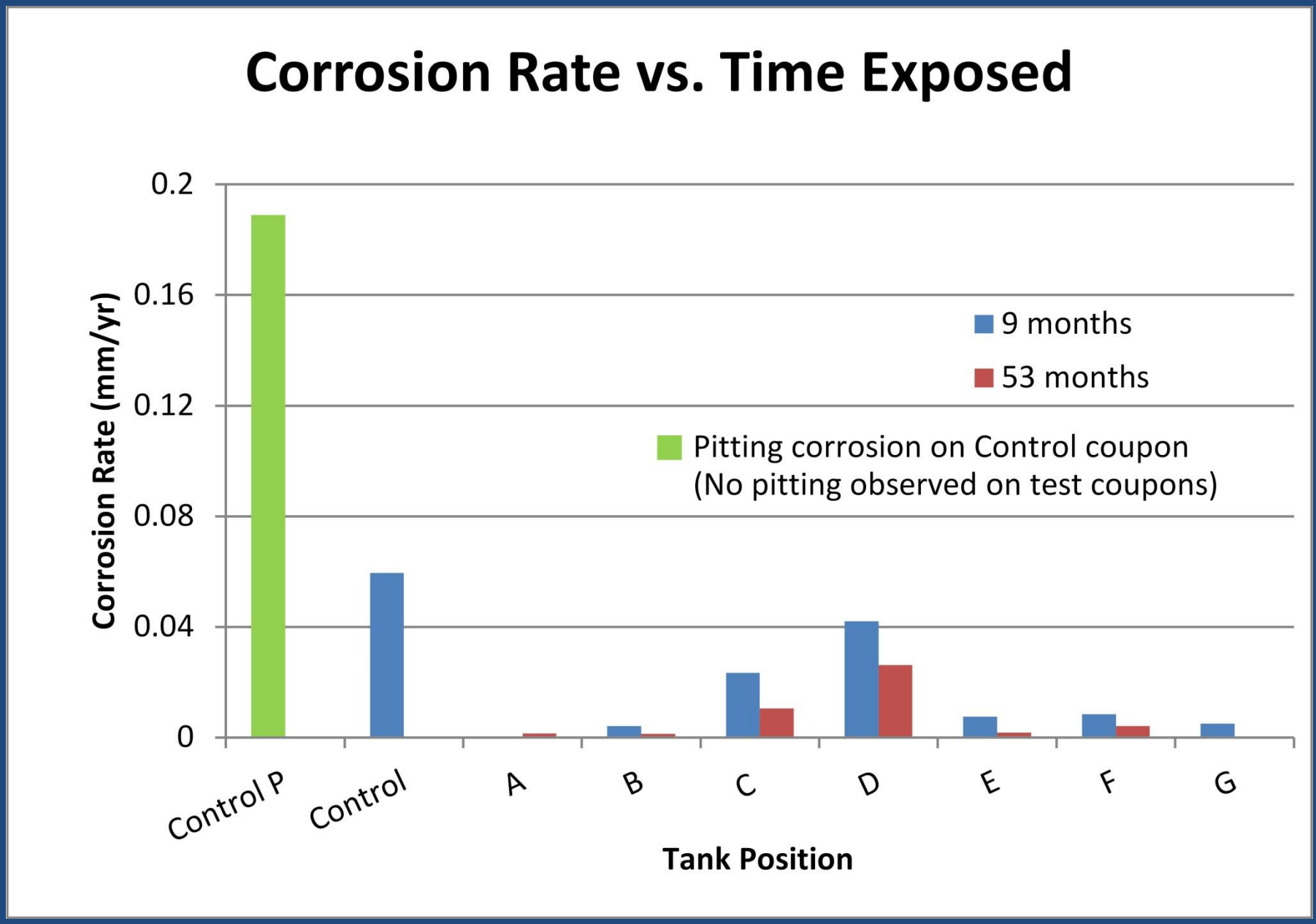
Specimen Type	Specimen ID	% Corroded Surface Area	Predominant Type of Corrosion
Test Tank	B	86	Uniform / General
	C	81	
	D	85	
	E	57	
	F	61	
	G	43	
Control Tank	Control	22	Pitting

Corrosion Rate Results

Specimen Type	Specimen ID	Corrosion Rate (mm/year)	
		2007 Specimens	2011 Specimens
Test Tank	A	--	0.0014
	B	0.0041	0.0013
	C	0.023	0.010
	D	0.042	0.026
	E	0.0075	0.0017
	F	0.0085	0.0041
	G	0.0050	--
	ALL (Avg)	0.015	0.0075
Control Tank	Control	0.059	--
	Control P*	0.19	--

* Control P is the measured maximum pitting depth

Results Continued



Soil Side Bottom - Conclusions

1. **VCIs can work in conjunction with other forms of corrosion protection or stand-alone.**

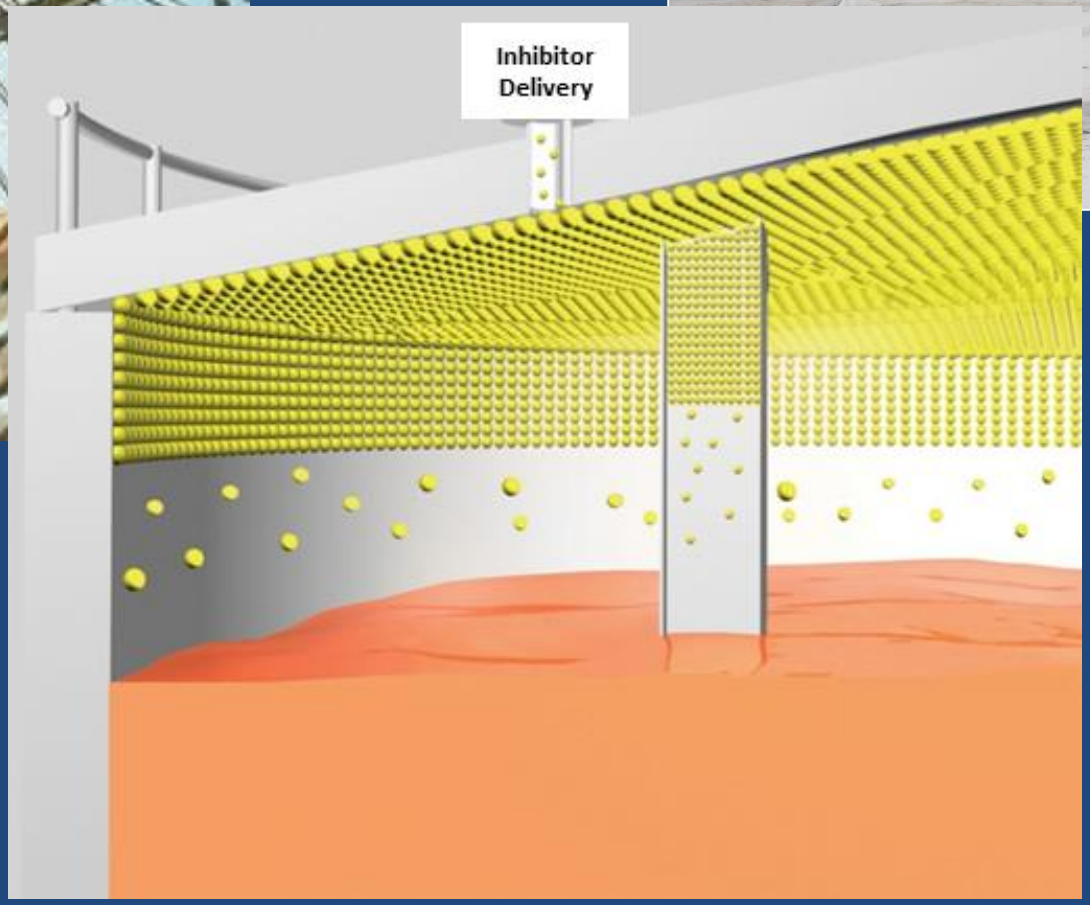
2. **Can be installed under almost any tank pad design.**

3. **Tank pad design determines whether the original VCI installation can be accomplished while the tank is in service, or if it needs to be out-of-service.**

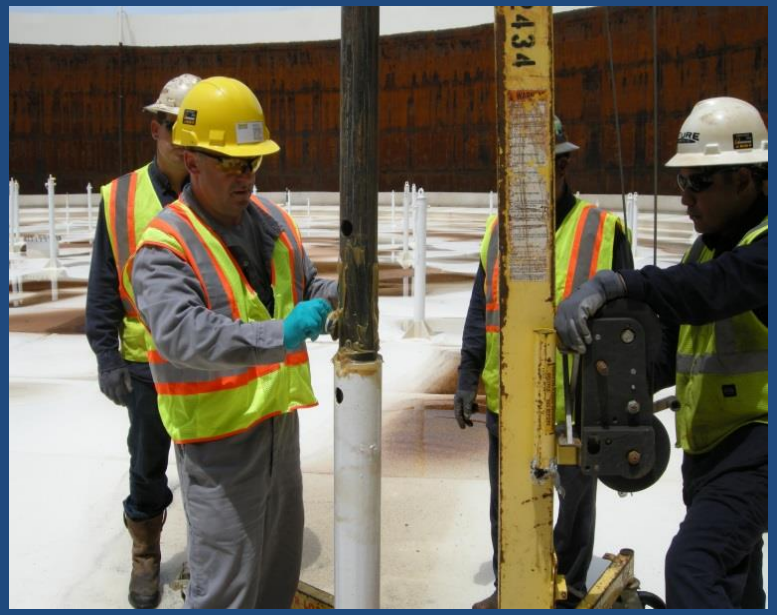
4. **VCI can be replenished as needed over time without taking the tank out-of-service, in any of the scenarios mentioned above.**

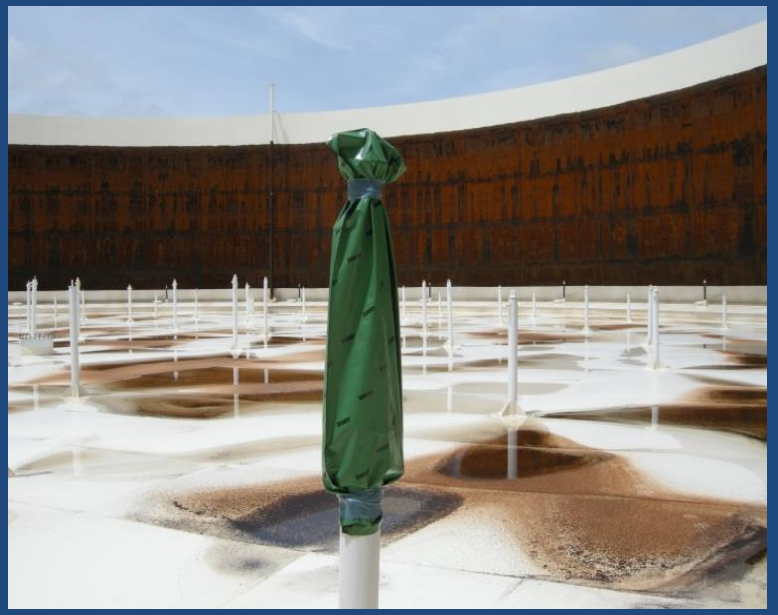
5. **Reduction in corrosion rates extend the life of the asset and the maintenance interval.**

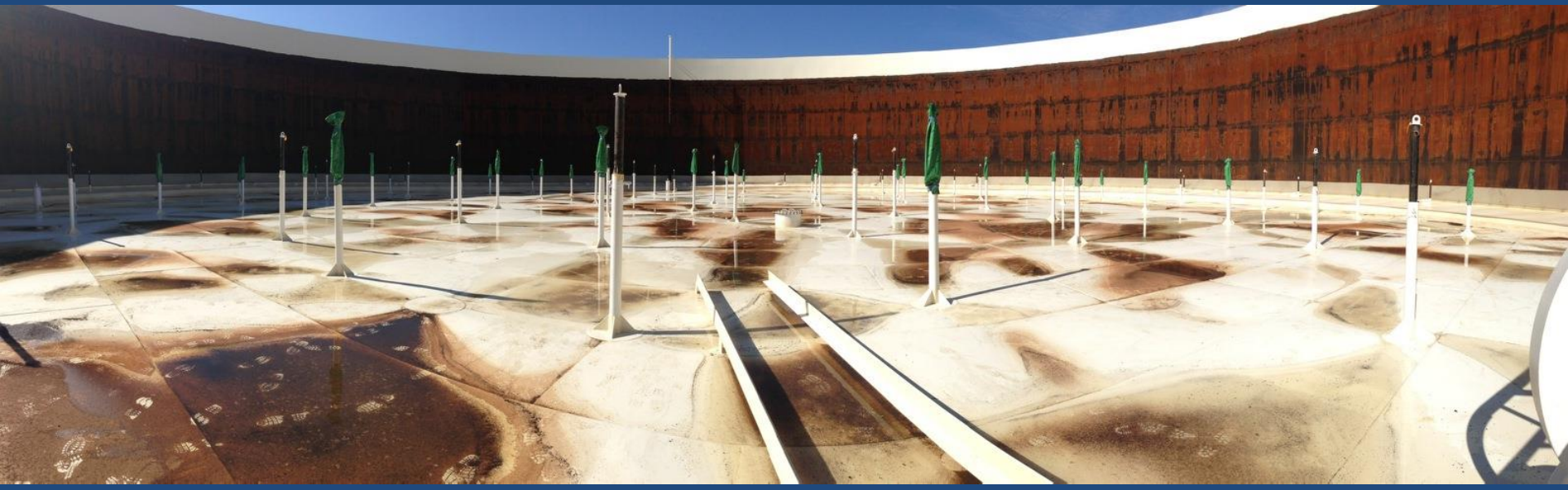
Tank Roofs



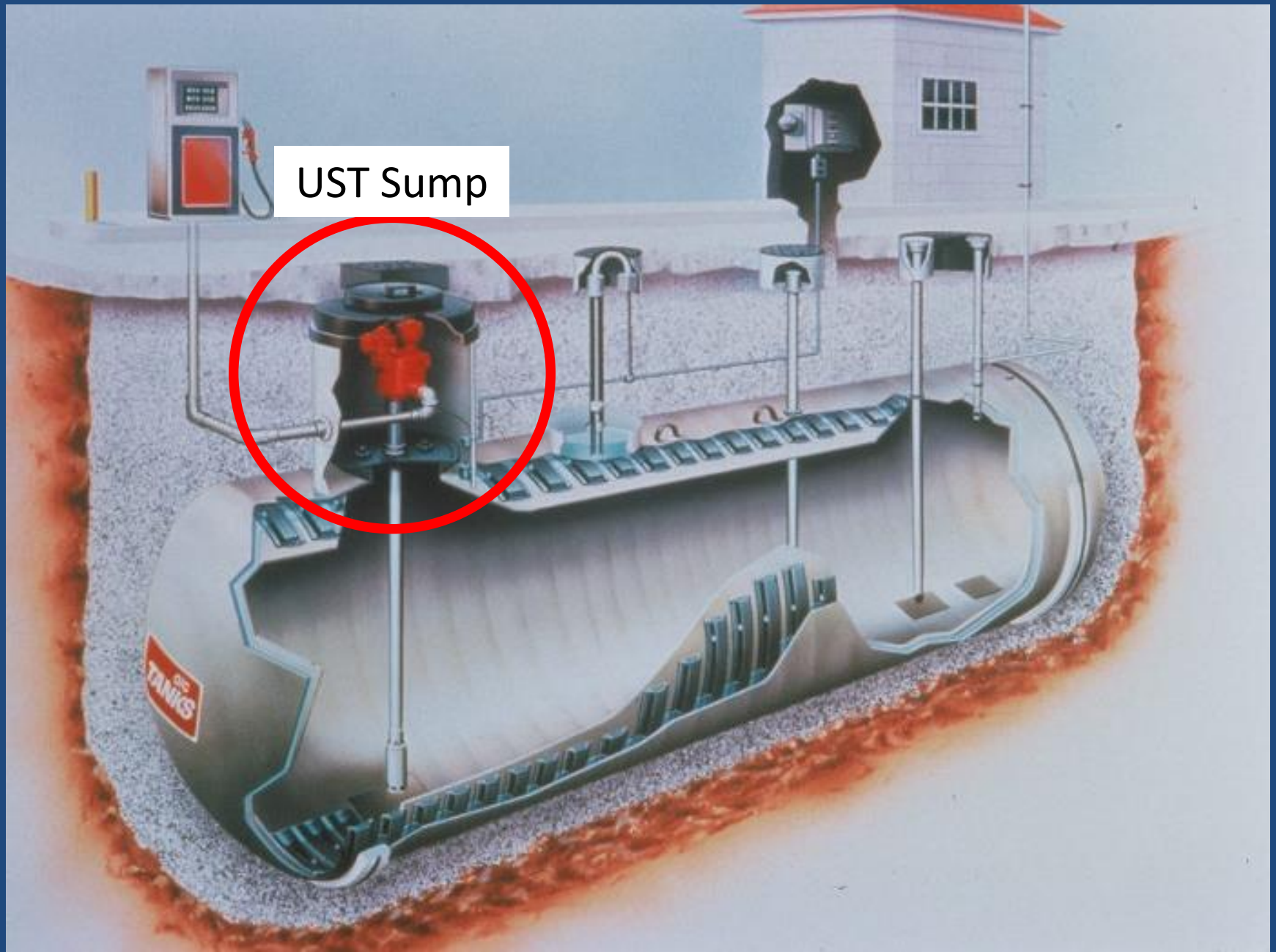
Floating Roof Legs



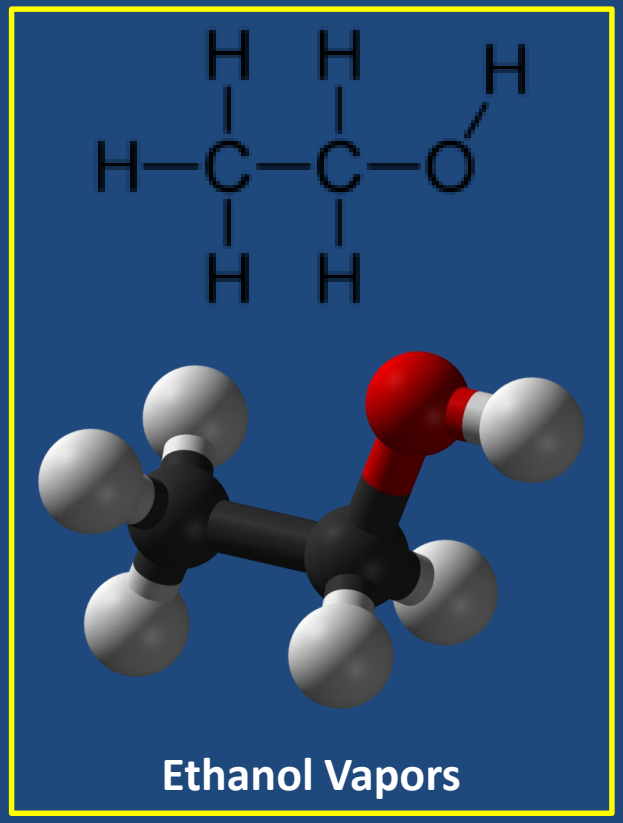




UST System Components

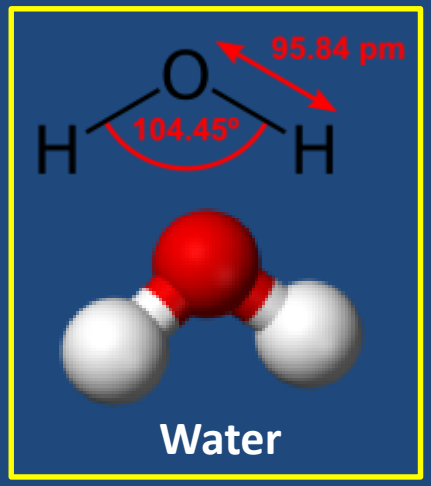


UST Vapor Space Chemistry



Ethanol Vapors

+

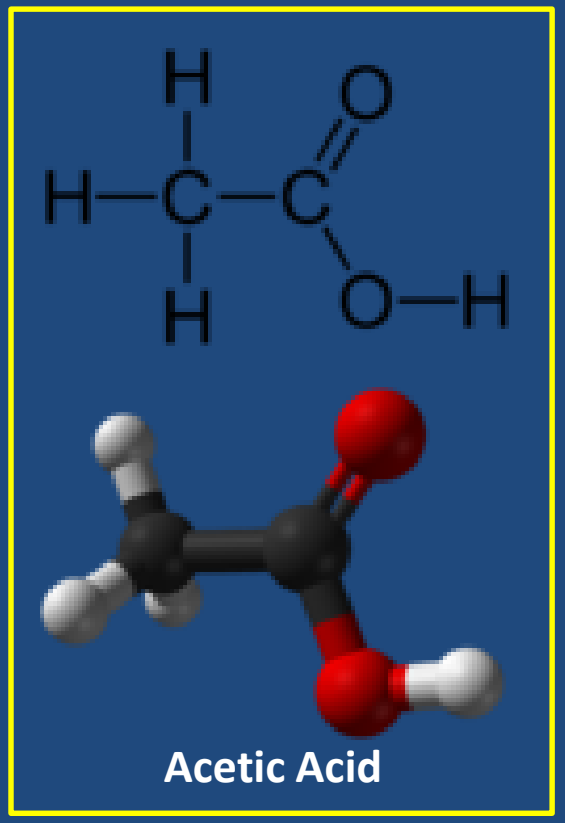


Water

+

Bacteria

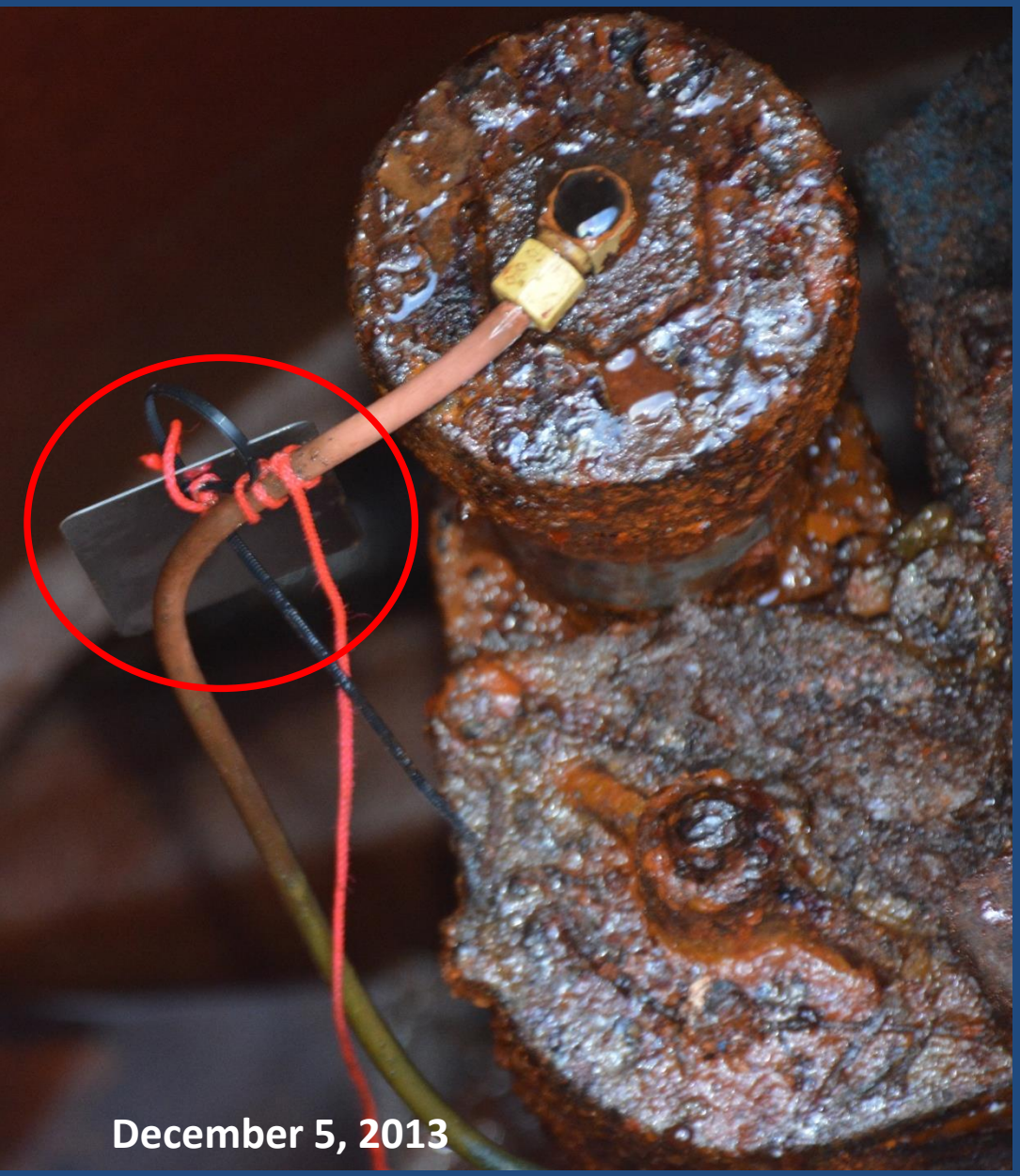
=



Acetic Acid

Zerust® OIL & GAS
WORLDWIDE CORROSION SOLUTIONS

No Inhibitor



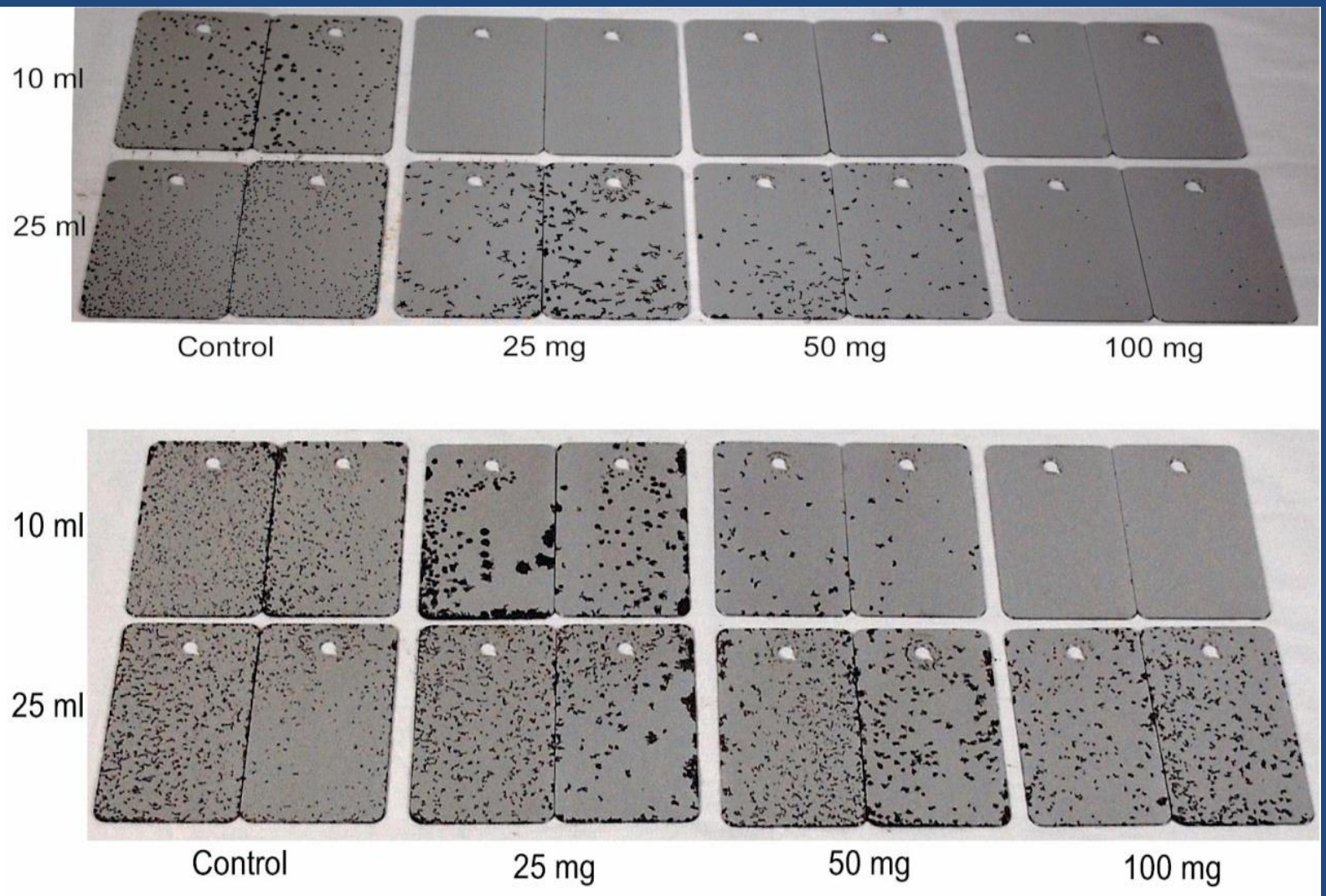
December 5, 2013

February 20, 2014

UST Lab Test

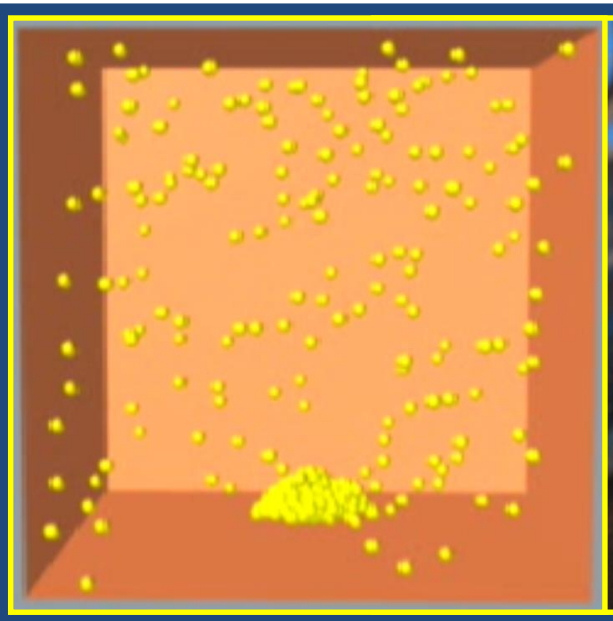

Inhibitor Packet
Stand and Panels
Jar and Lid
Film Gasket
Stand and Jar

UST Lab Test


0.05%
Acetic
Acid
10 ml
25 ml
Control
25 mg
50 mg
100 mg
0.1%
Acetic
Acid
10 ml
25 ml
Control
25 mg
50 mg
100 mg
mg of Inhibitor

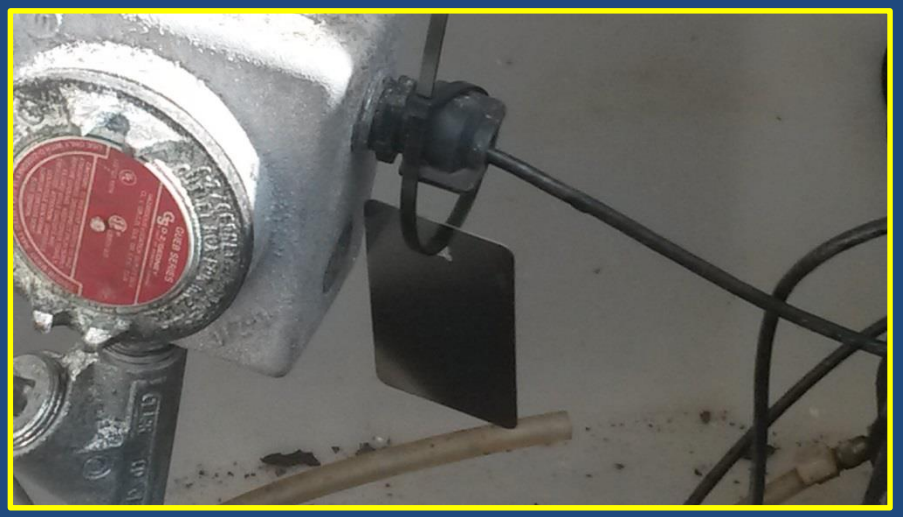
UST Trial Components

Sample Sump



VCI Volatizes in Enclosure

Packet of VCI



Coupon

Florida (e10)

UST Test Sites

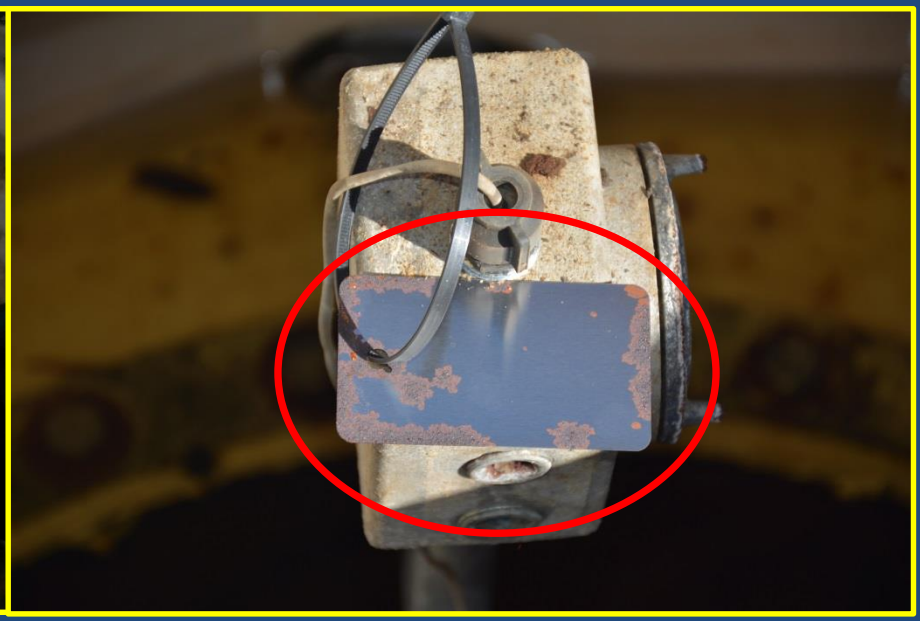
Install Date: December 5, 2013

Client Sites in South Florida				
Owner	Location	Sump Description	Coupon	VCI
#1	A	RUL - South	Yes	Yes
#1	A	RUL - Middle	Yes	Yes
#1	A	RUL - North	Yes	No
#2	B	RUL - SE	Yes	No
#2	B	PUL - SW	Yes	Yes
#2	C	RUL - SW	Yes	Yes
#2	C	PUL - Middle	Yes	No
#2	C	RUL - NE	Yes	No
#2	D	PUL - NW	Yes	No
#2	D	RUL - NE	Yes	No
#2	D	RUL - SE	Yes	Yes
#2	E	RUL - NW	Yes	Yes
#2	E	PUL - SW	Yes	Yes
#2	E	RUL - NE	Yes	No
#2	F	PUL - NW	Yes	Yes
#2	F	RUL - NE	Yes	Yes
#2	F	RUL - SE	Yes	No
#1	F	RUL	Yes	Yes
		Total	18	10
* RUL	Regular Unleaded			
*PUL	Premium Unleaded			

UST Control Sump

Coupon Only

December 5, 2013



January 16, 2014

Some Visible Surface Corrosion

UST Control Sump

Coupon Only

December 5, 2013

January 16, 2014

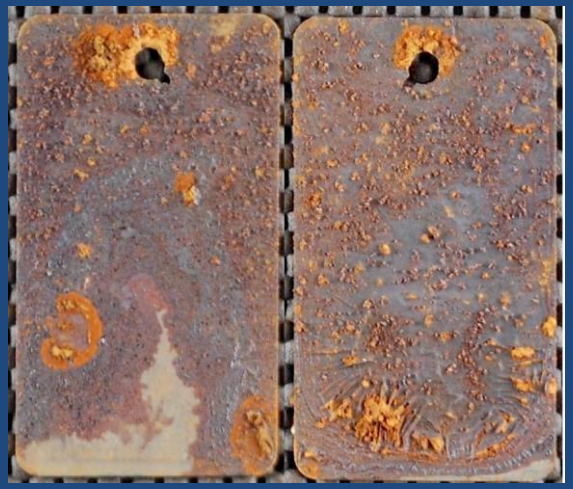
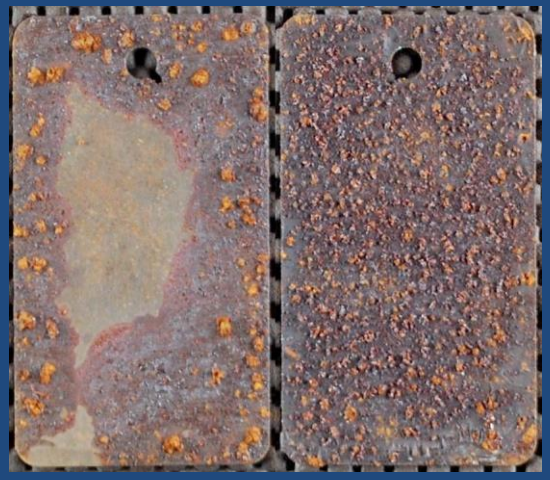
Significant Surface Corrosion

UST Test Sump

VCI Packet and Coupon

No Visible Corrosion

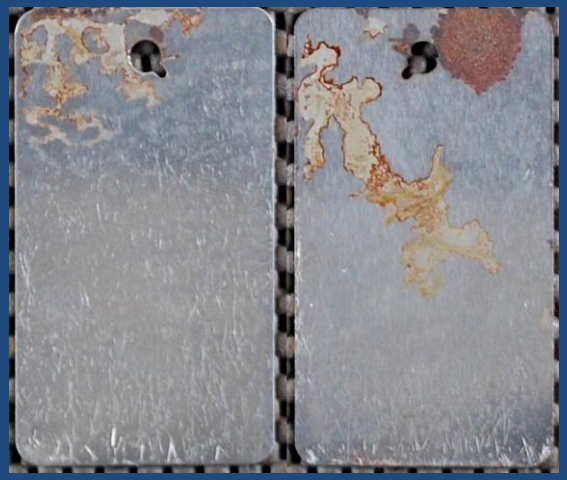
UST Test Sump

Site	March 2014 Packet Only	April 2014 Front Side Spray Only	May 2014 Front Side & Sump Spray
A			
B			

UST Test Sump

Site	March 2014 Packet Only	April 2014 Front Side Spray Only	May 2014 Front Side & Sump Spray
C			
D			

UST Test Sump

Site	March 2014 Packet Only	April 2014 Front Side Spray Only	May 2014 Front Side & Sump Spray
E			
F			

UST Sump - Conclusions

1. Acetic Acid can form in the sumps, due to Ethanol vapors, bacteria and moisture.

2. Absence of any of the three seems to result in a much lower corrosion rate.

3. Vapor Corrosion Inhibitors can reduce corrosion rates.

4. Sump condition is a factor in the effectiveness of the VCI.

5. Tests are on-going.

Thank you!
Questions?

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