
CORROSION PROTECTION WITH
FIELD APPLICABLE FLUOROSEAL®
100% PVDF COATINGS

Oil and Chemical Above Ground Storage Tanks are exposed to one of the most corrosive environments Outside and Inside of the Steel Walls

- Steel tanks <u>outside wall</u> suffers from UV damage to the protective coating and moisture-dissolved ions and corrosive gases corrosion
- Steel tanks <u>inside wall</u> suffer from direct salt-water-dissolved corrosive gases and salt ions along with microbial corrosion attacks

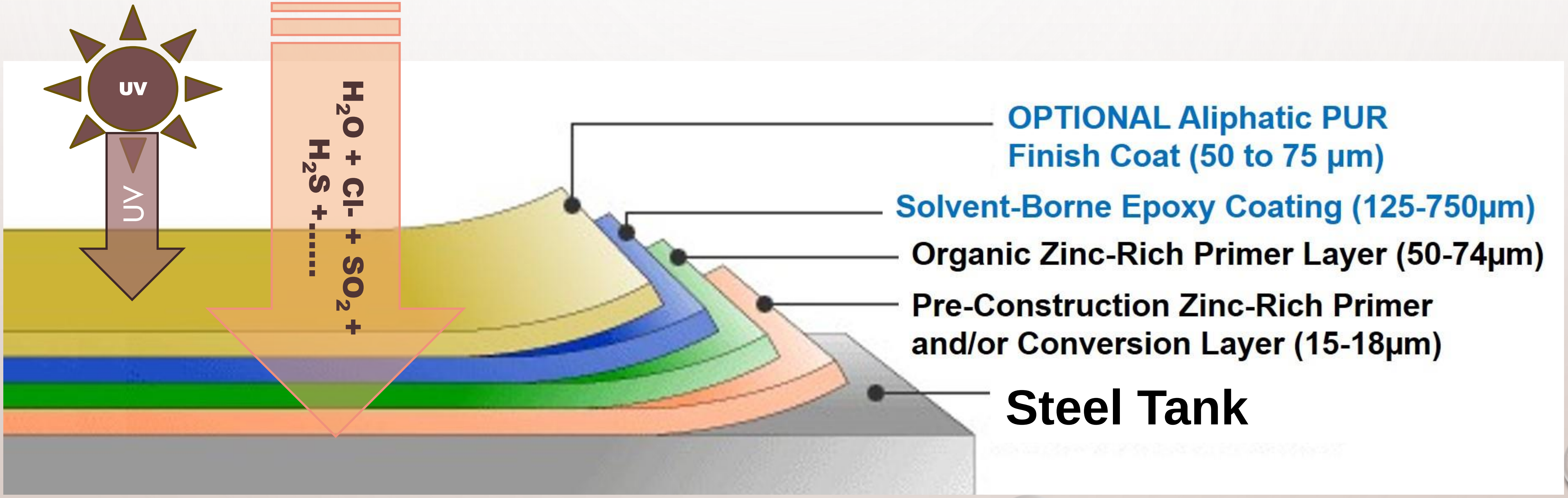
Elements that Causes Exterior Corrosion of Storage Tank:

1. Corrosive gases such as H_2S, NO, CO_2, SO_2, etc.
2. Moisture
3. Moisture laden with dissolved salt ions and corrosive gases

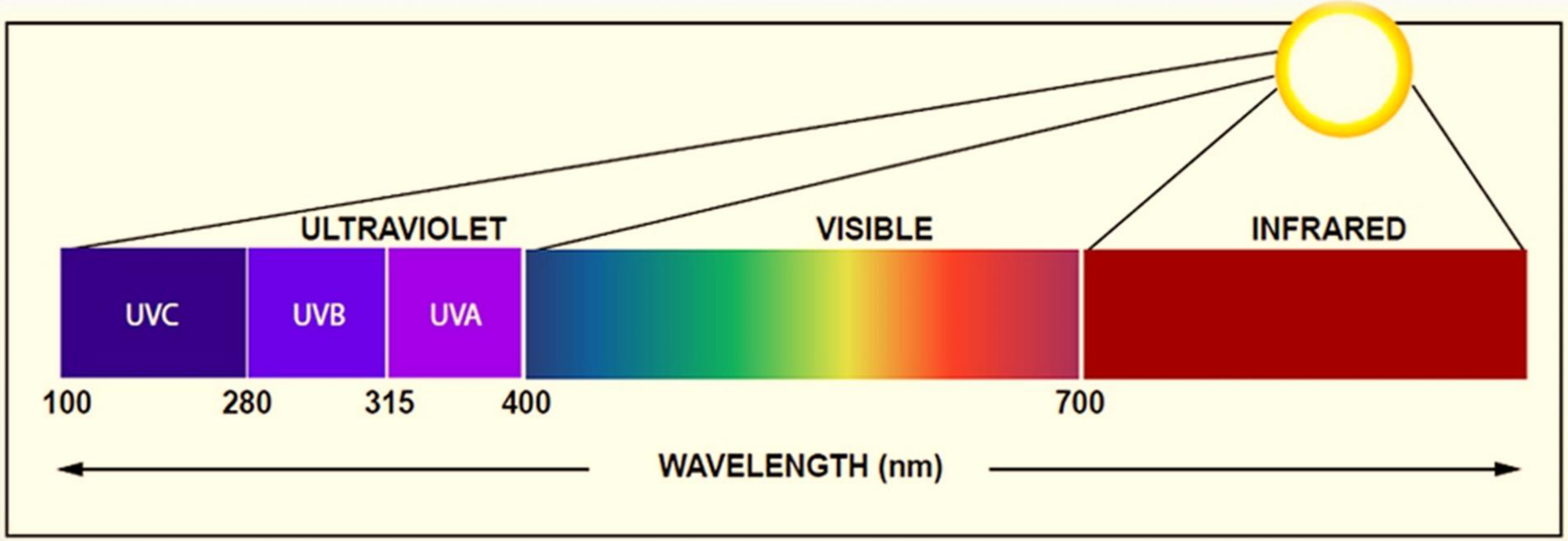
FLUOROSEAL® Top Coating:

- UV Resistance +UV Blocking
- >100X Less Moisture Permeability
- >1,000X Less Corrosive Gases Permeability

TYPICAL STORAGE STEEL TANK PROTECTIVE COATING STRUCTURE IS NOT SUFFICIENT IN UV RESISTANCE AND CORROSION PROTECTION



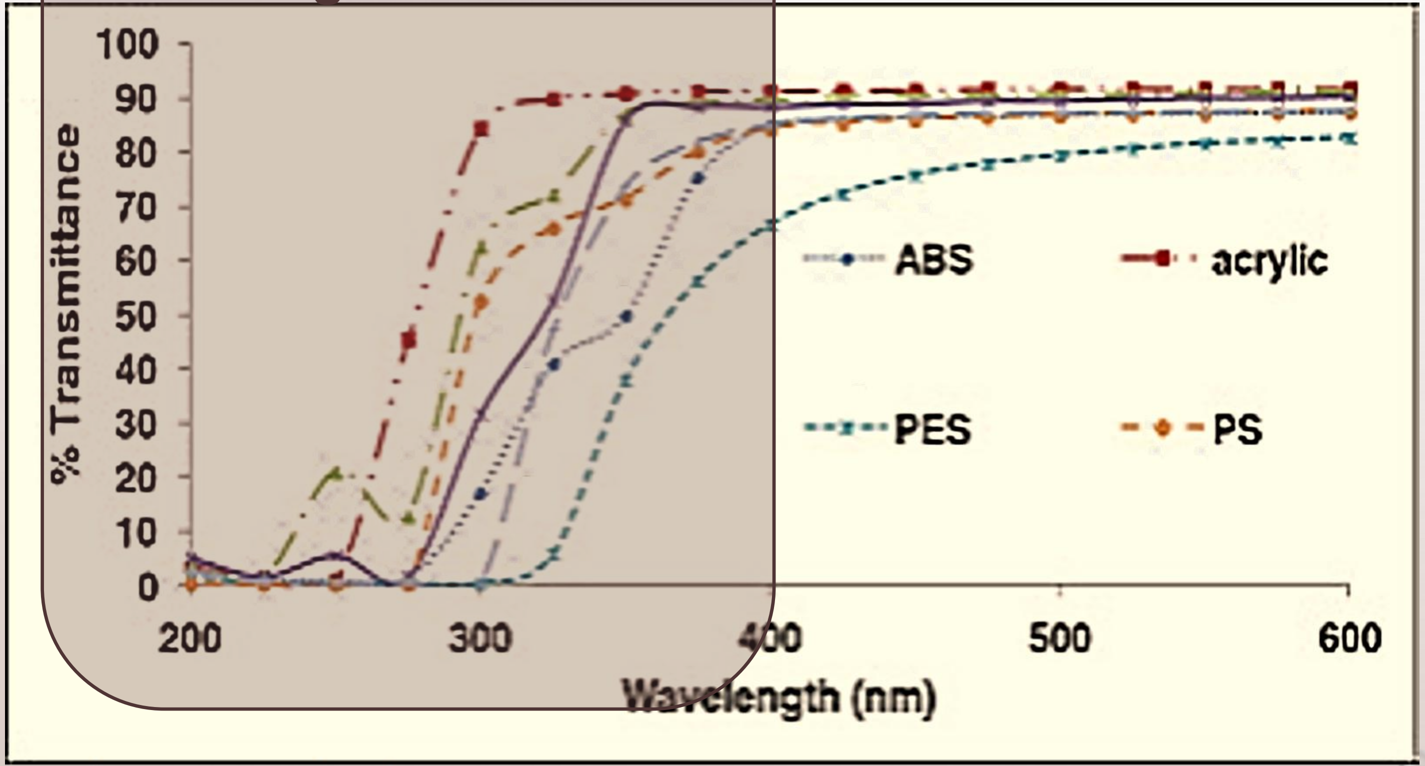
UV RADIATION ABSORPTION CAUSES PLASTIC (POLYMERIC) MATERIAL DEGRADATION



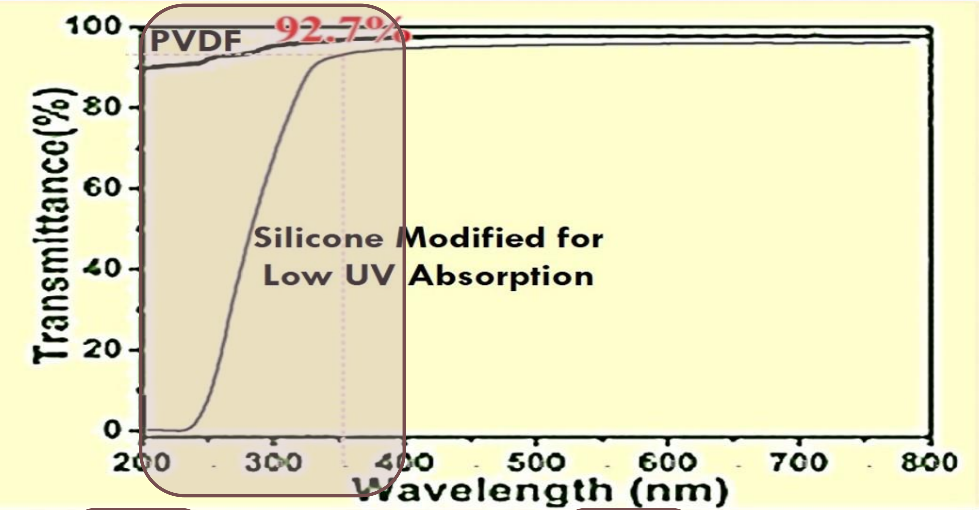
Exposure to ultraviolet (UV) radiation may cause the significant degradation of most plastic (polymeric) materials. UV radiation causes photooxidative degradation which results in breaking of the polymer chains, produces free radical and reduces the molecular weight, causing deterioration of mechanical properties and leading to useless materials, after an unpredictable time. (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4320144/)

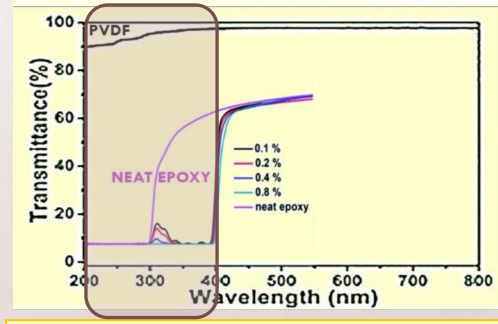
Acrylic, Polyurethane, Silicone, and Epoxy coatings are known to be vulnerable to molecular damage by UV exposure

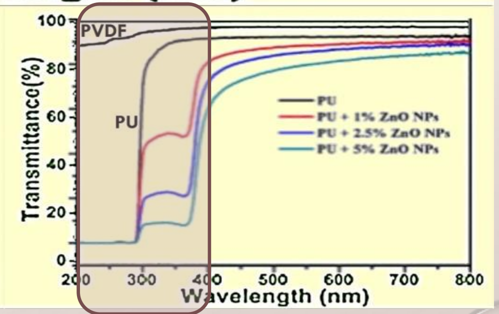
UV Absorption damages polymer bonds and caused degradation



https://www.researchgate.net/figure/UV-transmission-curves-for-some-PC-replacement-products-UV-Visible-spectroscopy-of_fig4_262788108

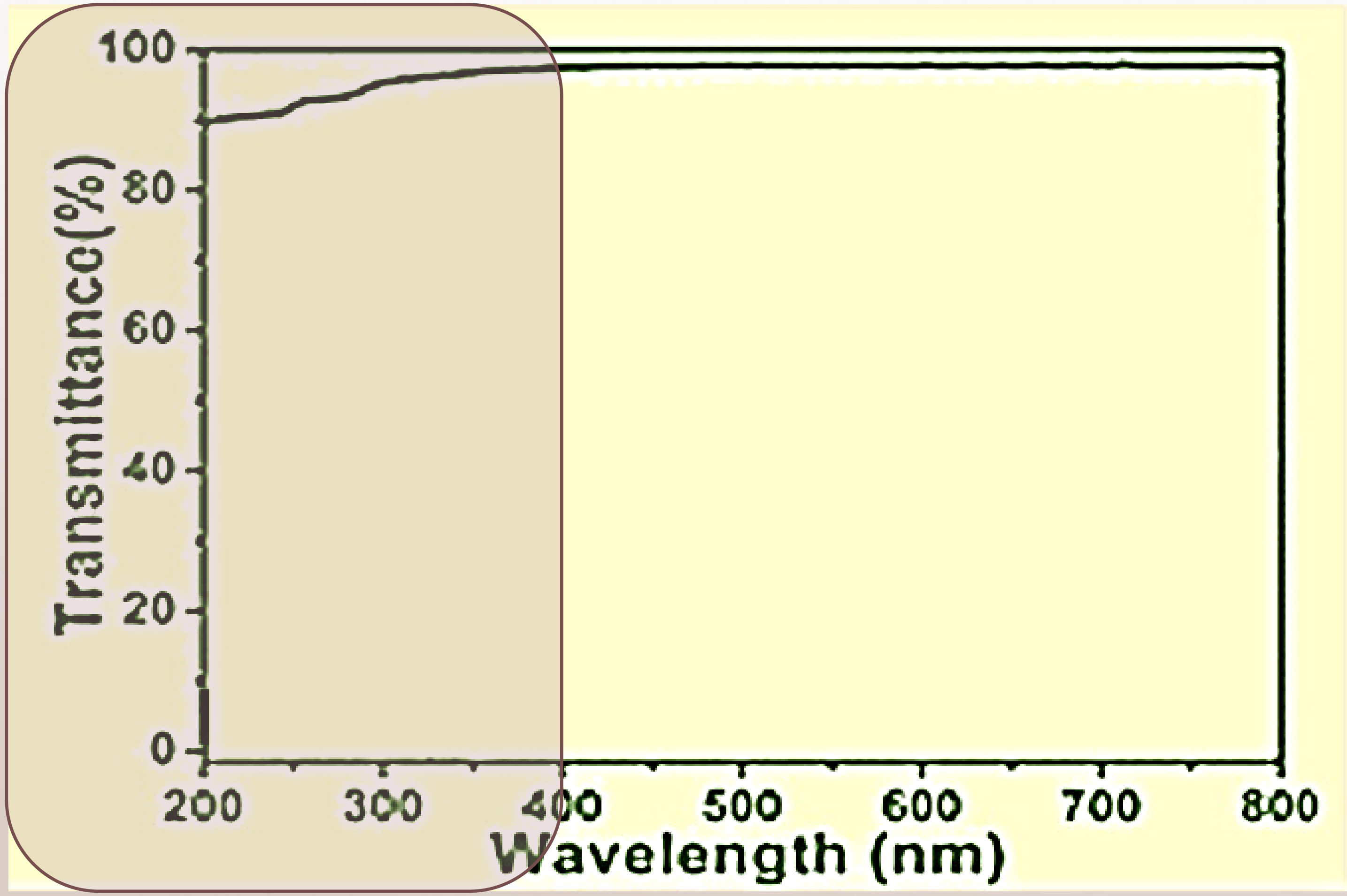






Silicones, epoxies, polyurethanes also absorb high amount of UV rays energy that induce the molecular degradation

PVDF MOLECULAR STRUCTURE HAS HIGHER BONDING ENERGY AND DOES NOT ABSORB MUCH UV RAYS ENERGY BUT LET THEM PASS THROUGH WITHOUT DAMAGE (UV RESISTANCE)



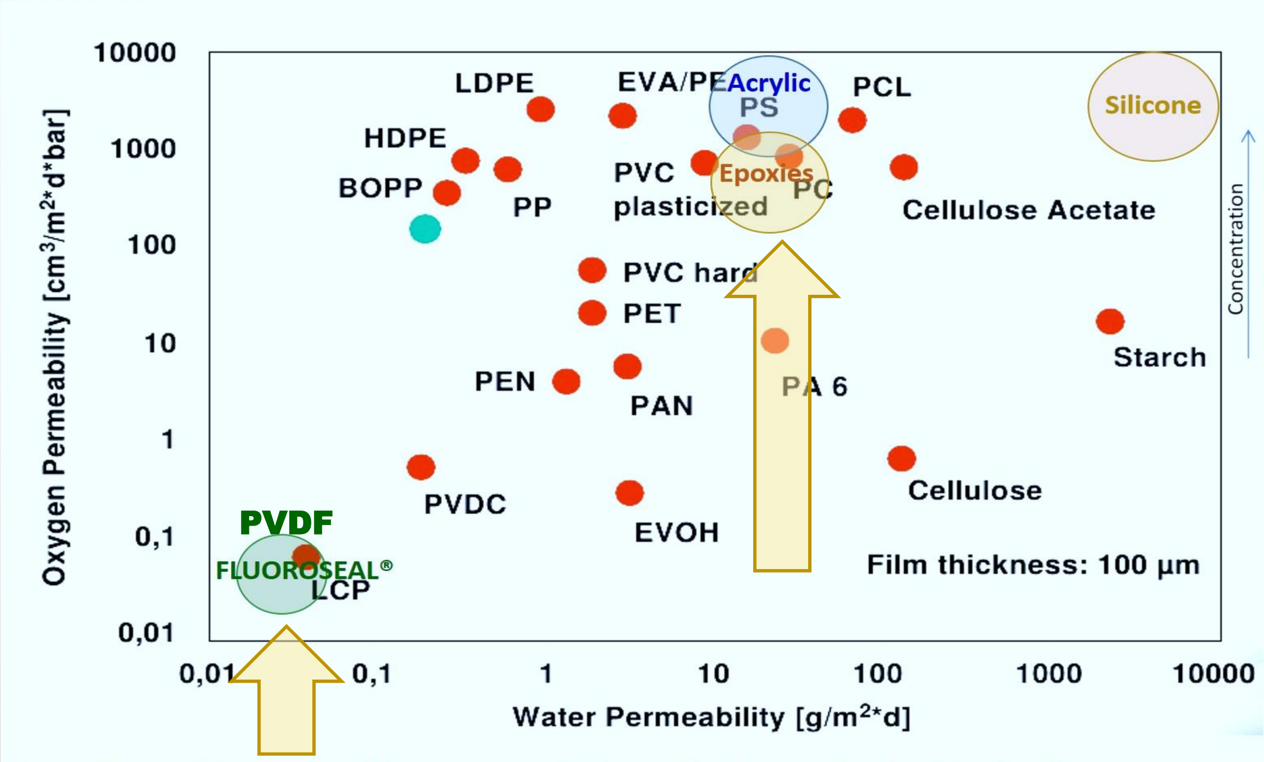
- **FLUOROSEAL® PVDF Coating is Specially Engineered with UV Blocking Capability**
- **FLUOROSEAL® is the only VOC-Exempt, Field Applicable Transparent PVDF Corrosion Protection Coatings today**

FIELD APPLICABLE FLUOROSEAL® PVDF COATINGS ARE HYDROPHOBIC

Field Applicable FLUOROSEAL® PVDF Coating

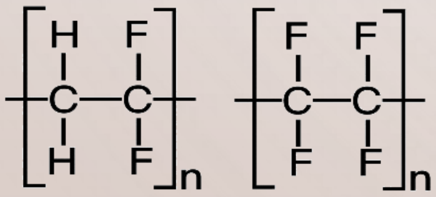
Corrosion Protection Coating-Sealant must be an Effective Barrier to Moisture-Water (and when Laden with Dissolved Salts and Acidic Gases):

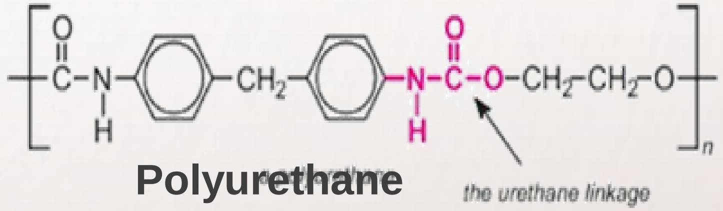
- **Acrylic, Epoxy, Polyurethane coatings are not good as moisture barrier**
- **PVDF is 4-orders of magnitude better in moisture-water permeability than epoxy**
- **That is, at 1/10 of the thickness, PVDF will be 100 times more effective in blocking off moisture than epoxy coating**



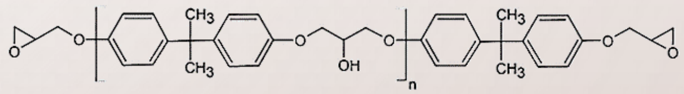
https://www.slideshare.net/TopasAdvancedPolymers/high-aroma-barrier-films-for-food-packaging

PVDF PTFE

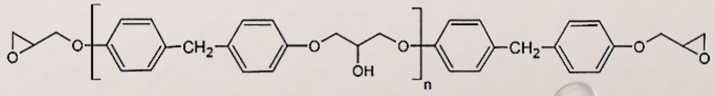




Bisphenol A Epoxy Resin (DGEBA)

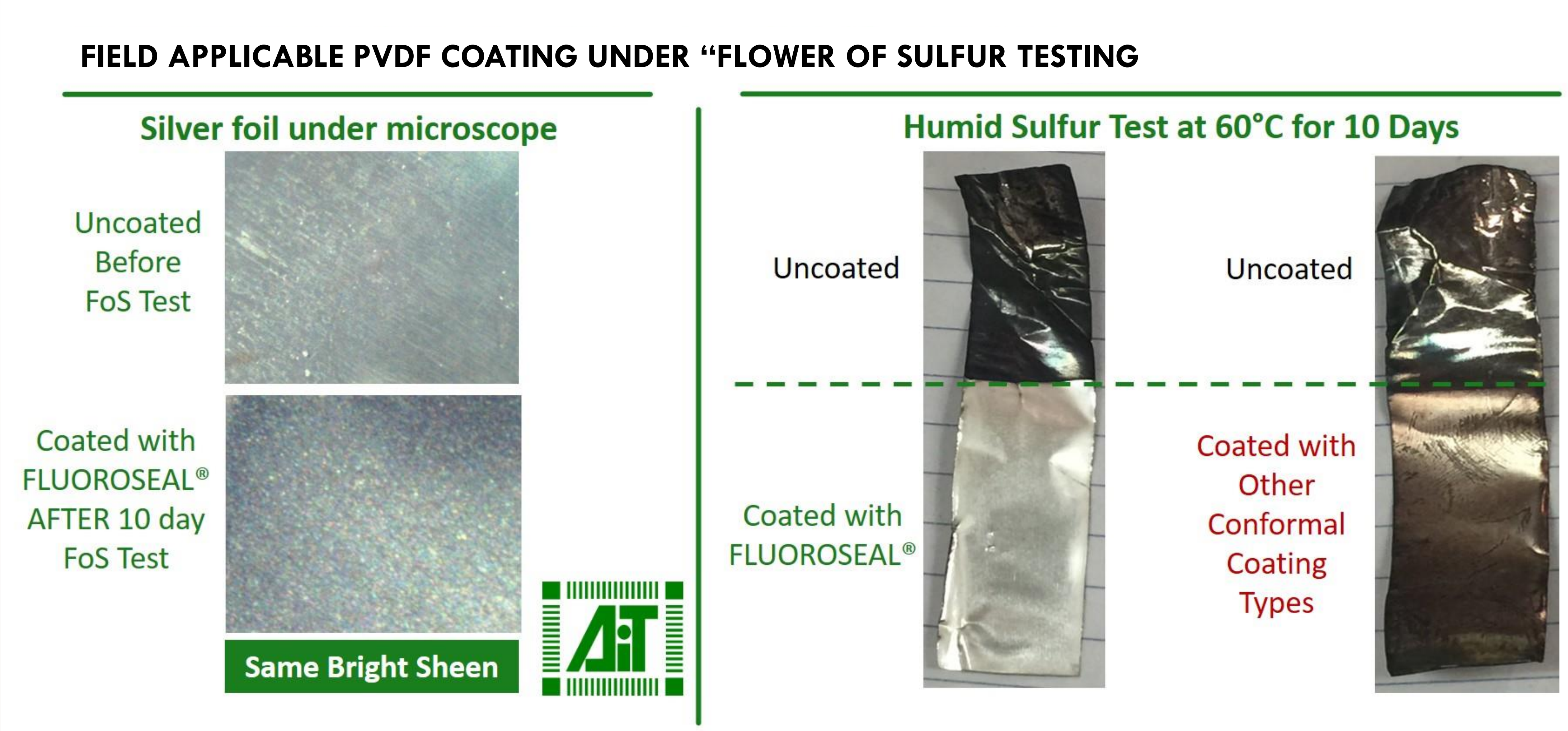


Bisphenol F Epoxy Resin (DGEBF)



CORROSION PROTECTION WITH AND WITHOUT FLUOROSEAL® 100% PVDF COATING

FIELD APPLICABLE FLUOROSEAL® PVDF COATING IS ORDERS OF MAGNITUDE BETTER IN BLOCKING MOISTURE AND CORROSIVE GASES FROM PENETRATING AND INGRESS



STEEL WITH FBE EPOXY COATING SUFFERED CORROSION FROM MOISTURE LADEN WITH CORROSIVE GASES QUICKLY WHEN ANY COATED SURFACES ARE SCRATCHED OR PEELED AWAY EXPOSING THE BARE STEEL SURFACES

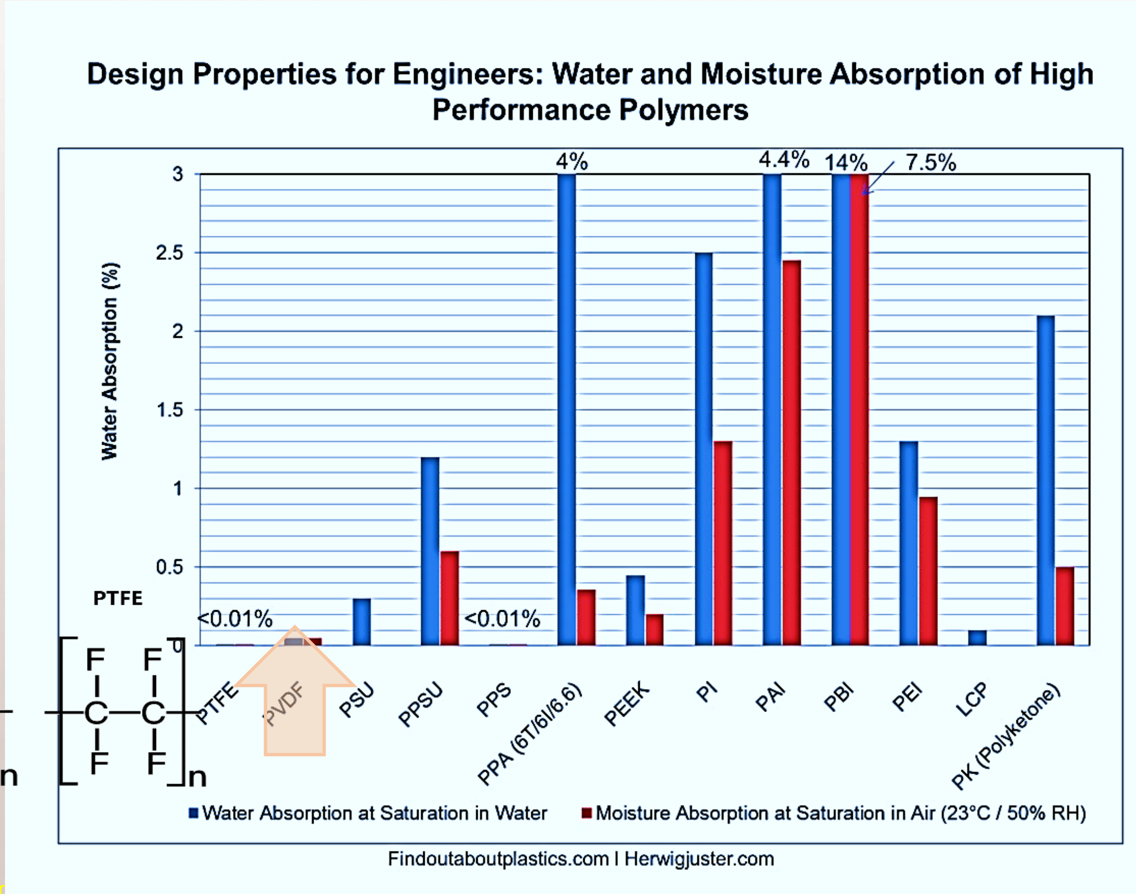
FBE coated steel bar cut edge exposed to sulfur-chlorine-moisture at 60°C for 10 weeks

Cut edge coated with FLUOROSEAL® CPC-EXT-7280 shows no sign of corrosion

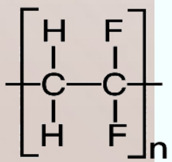
Cut edge directly exposed and shows obvious corrosion on steel edge and inside the FBE

Corrosion Protection Coating-Sealant must also be LOW in absorbing and retaining water and water laden with dissolved salts and corrosive acidic gases:

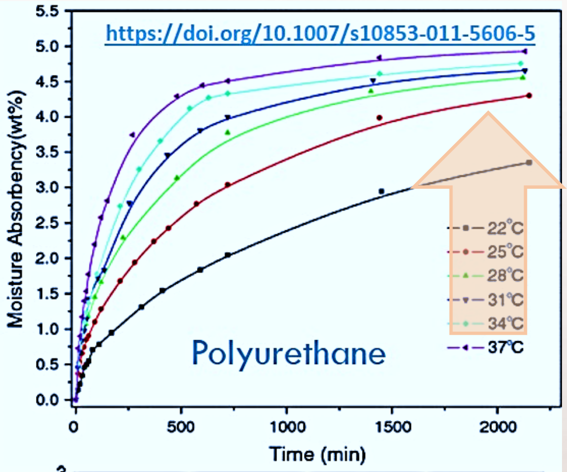
- **Acrylic, Epoxy, Polyurethane coatings absorb and retain good amount of water**
- **PVDF absorb and retain 100 times less than epoxy and polyurethane coating. That is, it 100 times more effective in preventing corrosion.**

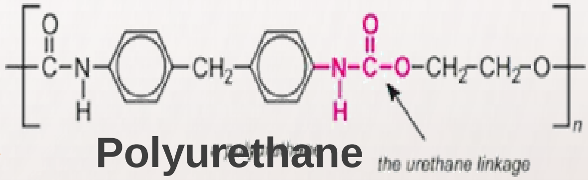


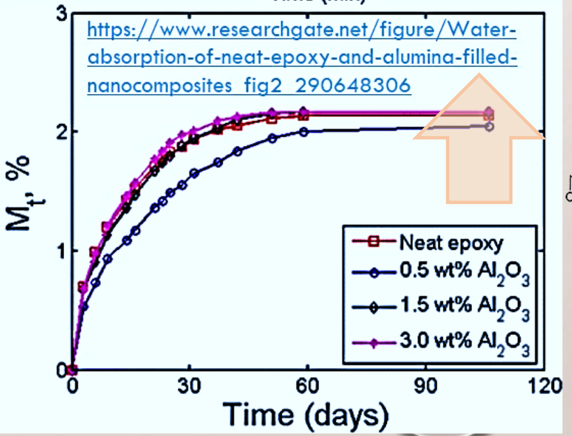
PVDF

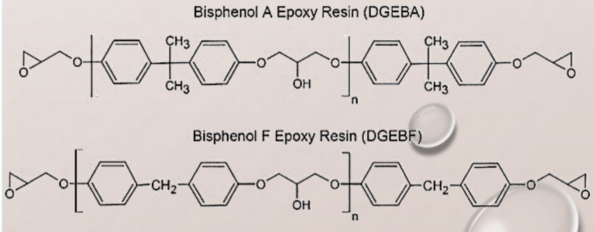


PTFE

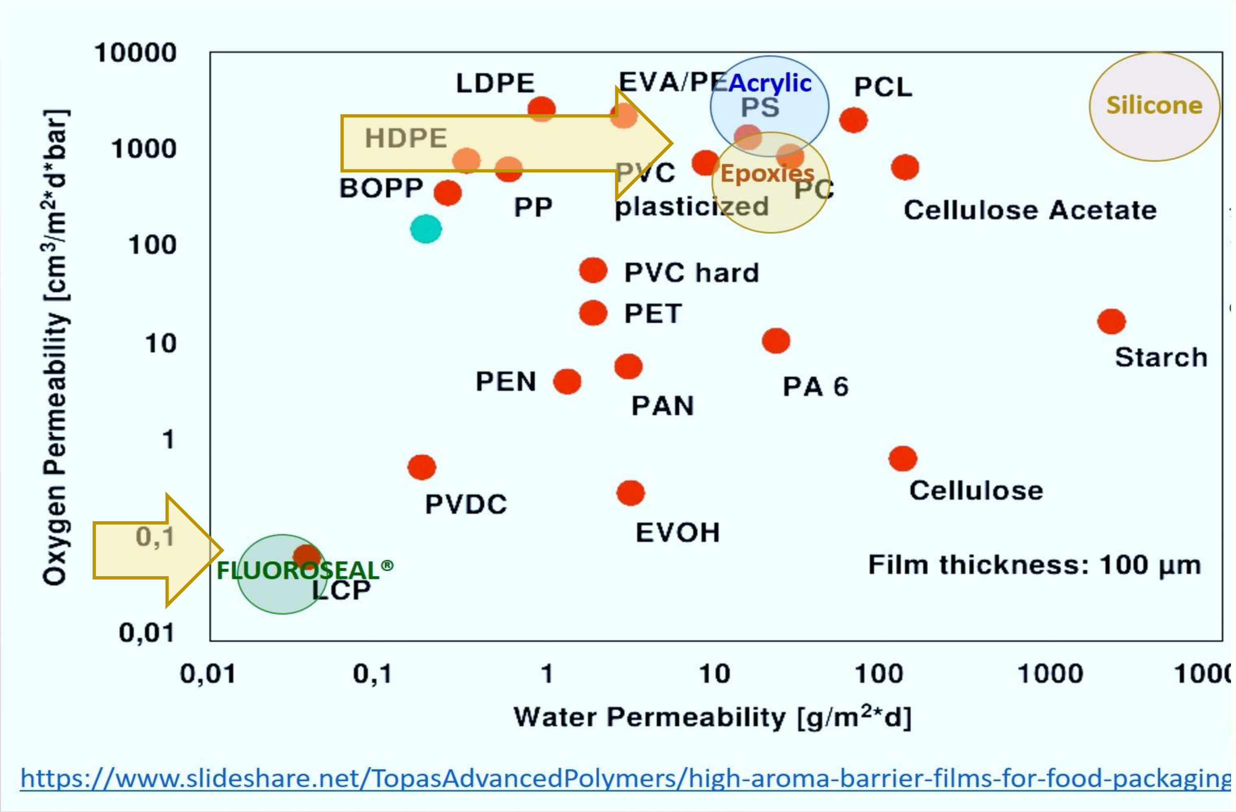


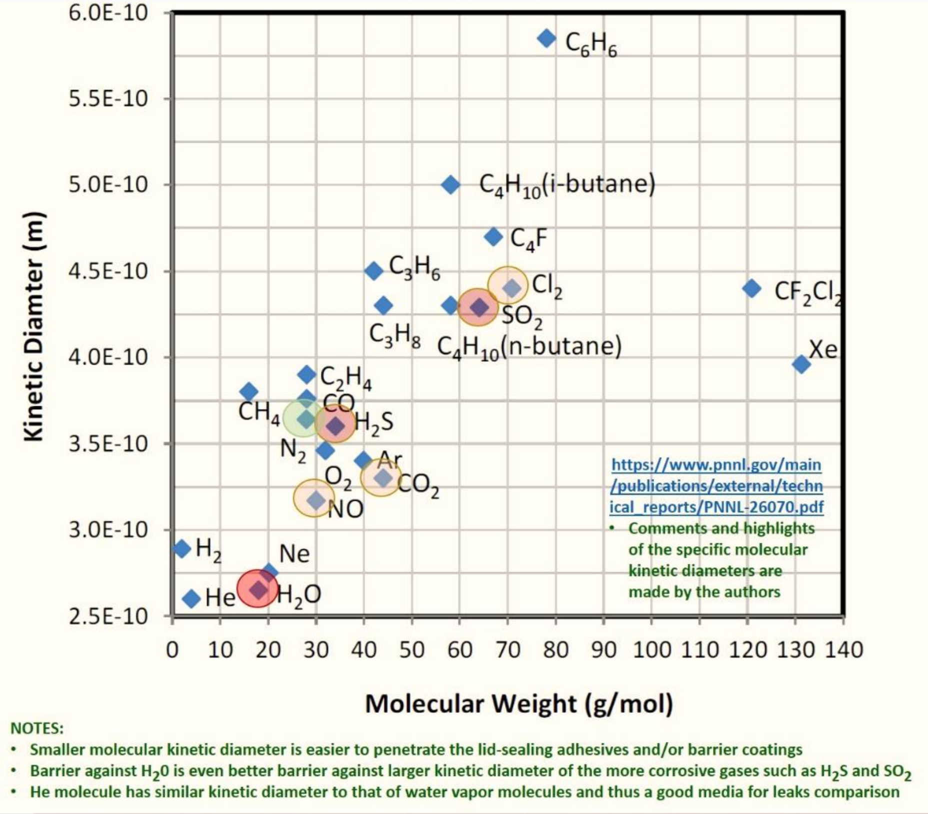






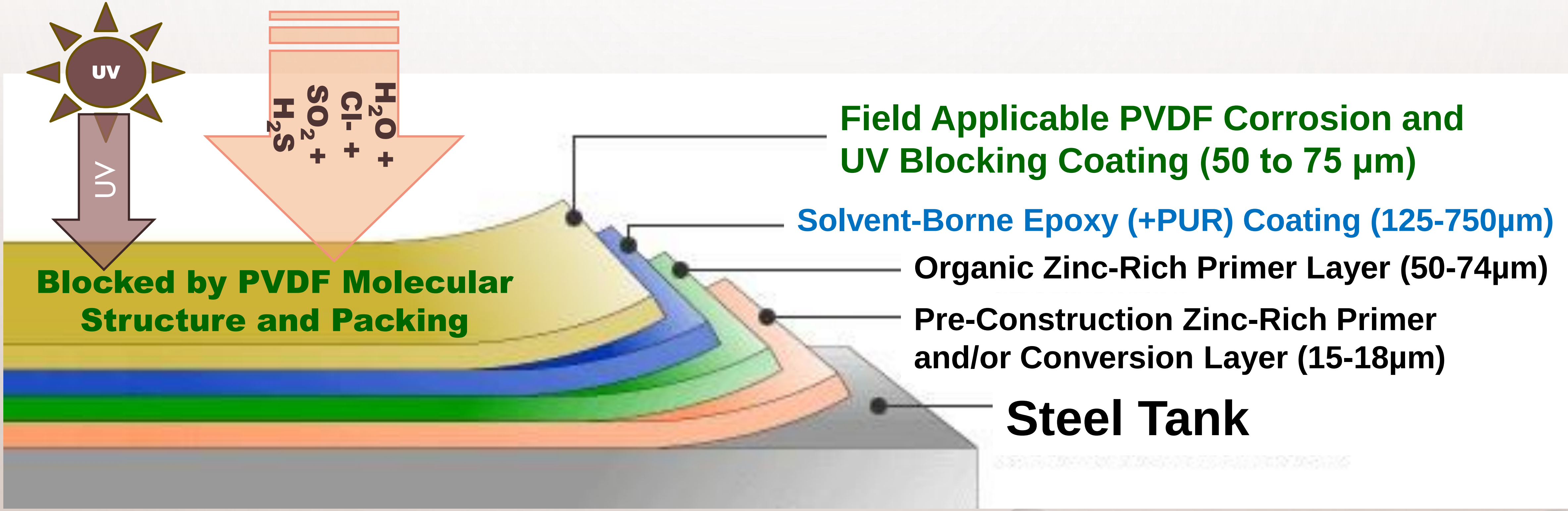
- The left chart summarizes the relative <u>moisture permeability</u> of polymer thin film. FLUOROSEAL® PVDF coating has intrinsic density in the range 1.6-1.8 is similar to LCP (>1.3) to afford one of the highest moisture barrier as coating.
- The left chart summarizes the relative <u>permeability of O_2</u>, having similar to or smaller kinetic diameter than corrosive gases such as NO, $C0_2$, H_2S, SO_2, Cl_2 (right chart). FLUOROSEAL® PVDF coating has intrinsic density (molecular packing density) of 1.6-1.8 is similar to PVDC (1.6) afford one of the highest barrier as thin coating in blocking these corrosive gases.





FLUOROSEAL® PVDF COATINGS ARE MOLECULARLY PACKED TO AFFORD ONE OF THE HIGHEST MOISTURE AND CORROSIVE GASES BARRIERS

FIELD APPLICABLE PVDF CORROSION-UV BLOCKING STORAGE TANK PROTECTIVE COATING STRUCTURE



FLUOROSEAL® Epoxy Coating Combination Provides <u>Life-Time External Protection</u>

HOW DOES FLUOROSEAL® PVDF COATINGS PREVENT CORROSION INSIDE THE WALL OF THE STORAGE TANKS?

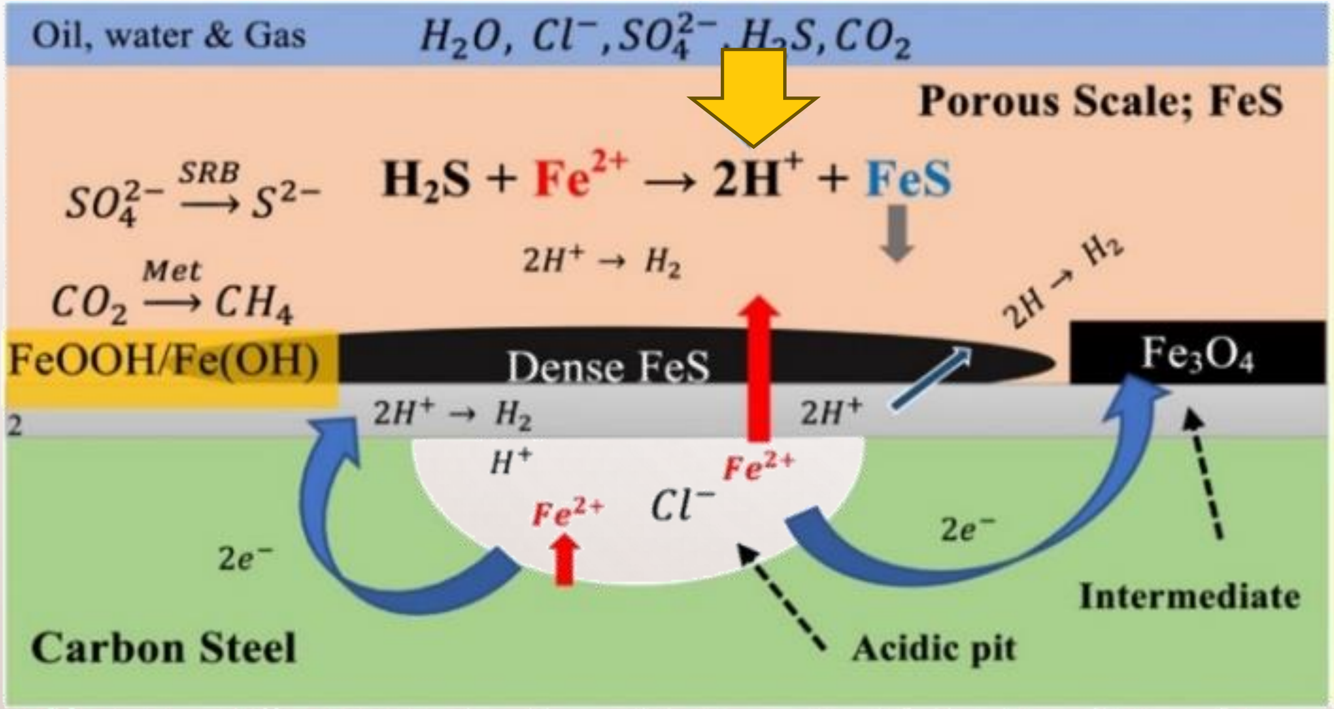

Elements that Causes Interior Corrosion of Storage Tank:

1. **Impurities of contents that include corrosive gases such as H_2S, NO, CO_2, SO_2, etc., salt ions that are dissolved in water that settles at the bottom of storage tank**
2. **Microbials that thrive in this environment that can cause pitting by "eating" away the steel at the bottom and bottom edge of the storage tank**

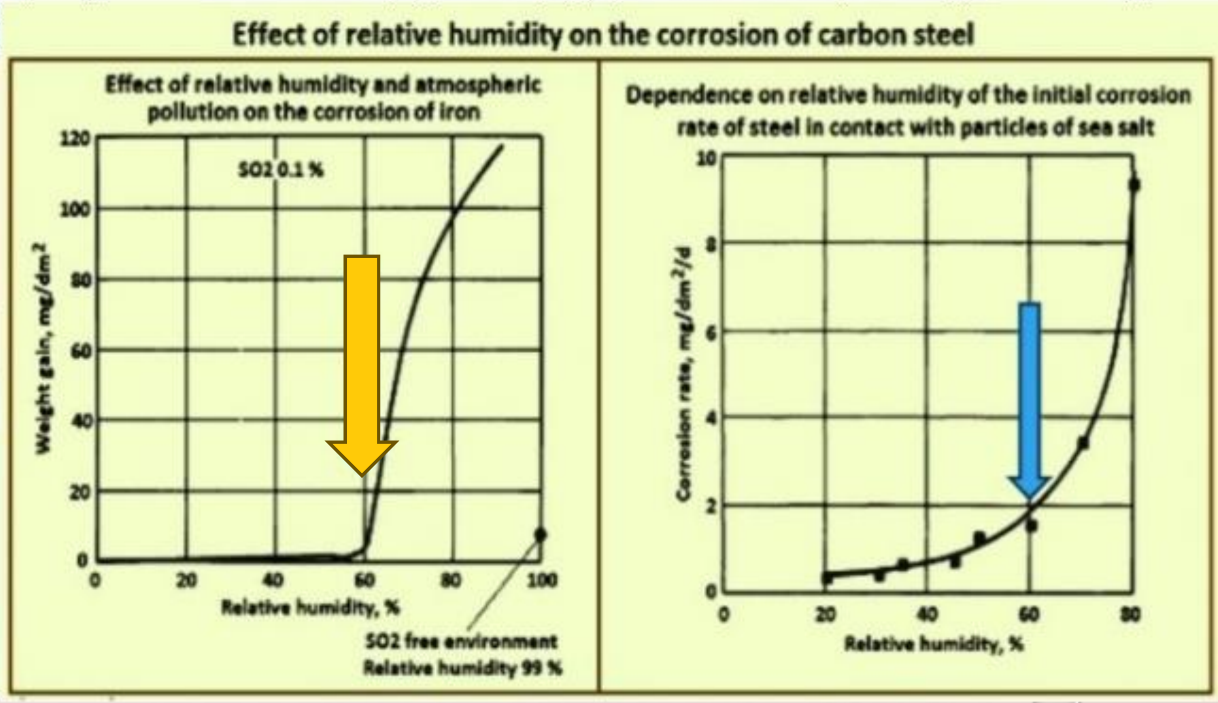
Protecting inside and particularly the bottom of steel storage tank:

1. Corrosive gases such as H_2S, NO, CO_2, SO_2, etc.
2. Moisture
3. Moisture laden with dissolved salt ions &corrosive gases

STEEL CORROSION DEGRADATION REQUIREMENTS: MOISTURE-WATER + DISSOLVED SALT IONS, ACIDIC CORROSIVE GASES

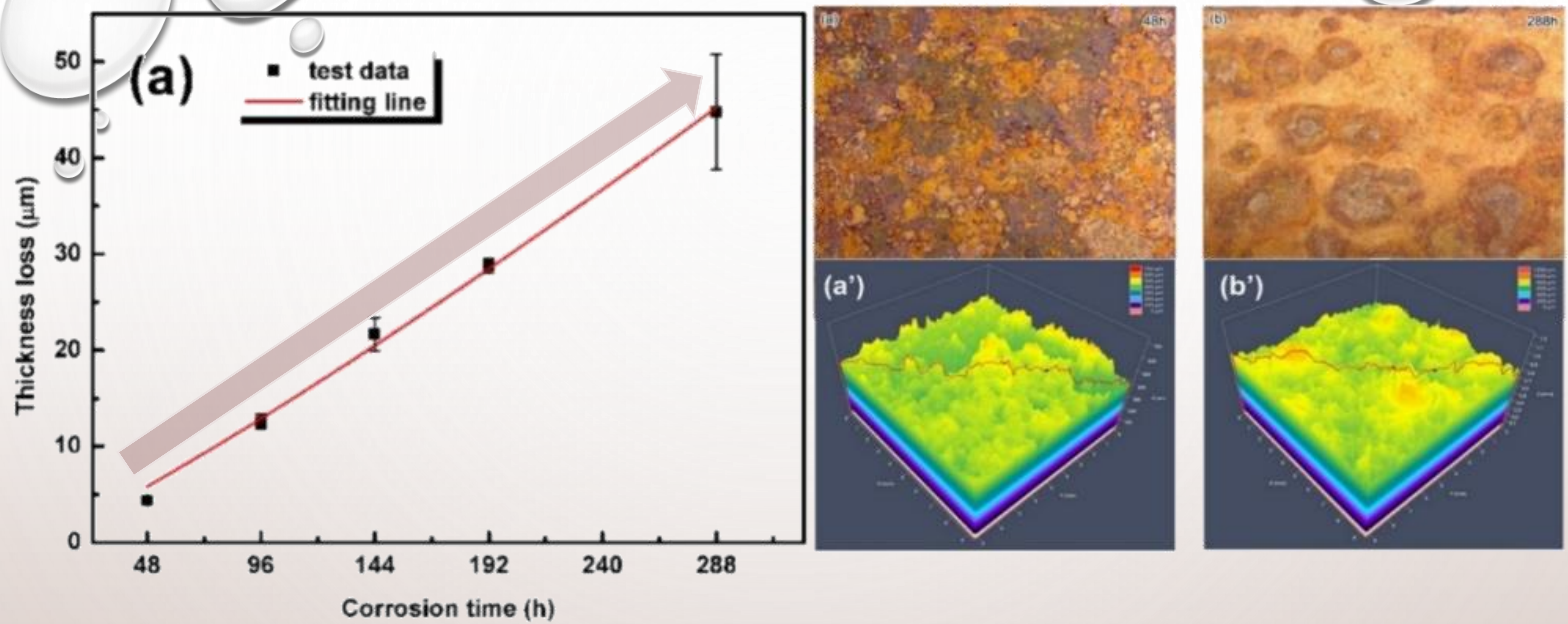


Shokri, A., Sanavi Fard, M.; Under deposit corrosion failure: mitigation strategies and future roadmap. *Chem. Pap.* 77, 1773–1790 (2023). https://doi.org/10.1007/s11696-022-02601-6



https://www.ispatguru.com/corrosion-in-carbon-steels/

Mechanism of corrosion with acidic gases and dissolved ions carried by moisture and water[5]. Higher concentration of water and moisture is one of the key criteria for the increasing rate of corrosion.



Thickness loss of carbon steel samples as a function of corrosion time

Influence of Seawater on the Carbon Steel Initial Corrosion Behavior; Yuwei Liu, Zhenyao Wang, Yinghua Wei;

http://www.electrochemsci.org/papers/vol14/140201147.pdf


EPOXY COATED STEEL BAR WITH
FLUOROSEAL PVDF TOP COATING
EPOXY COATED STEEL BAR WITHOUT
FLUOROSEAL PVDF TOP COATING

FLUOROSEAL® PVDF COATING IS A CORROSION PROTECTION COATING FOR INSIDE AND OUTSIDE OF ABOVE GROUND STORAGE TANKS

1. Blocks UV light from damaging the molecules in epoxy and/or polyurethane paint causing the coating to peel off or delaminate from the ships steel structure. The exposed steel surfaces and steel interfaces under the damaged coating are then directly exposed to salt-spray and other corrosive elements inducing rapid corrosion.

2. Blocking moisture laden with corrosive ionic salts and corrosive acidic gases, from passing through the more permeable epoxy-polyurethane coating layers and creating aqueous solutions at the coating-steel interfaces, resulting in corrosion weakening.

3. Blocking corrosive gases (e.g., H_2S, SO_2, CO_2, NO, CL_2) from passing through the more permeable epoxy-polyurethane coating, reaching the steel structure and causing corrosion.

4. Not supporting microbial growth and block off corrosive gases generated by the microbial growth from causing corrosions.