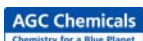




“Developments in Fluoropolymer Resins For Marine & Offshore Coatings”

Bob Parker
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Exton, PA

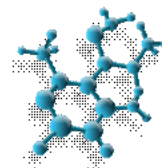


Fluoropolymer Resins for Marine & Offshore Coatings



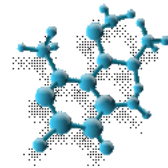
Fluoropolymer resins (Definition):

Organic polymers that contain fluorine atoms attached to the carbon backbone (e.g. Teflon®, Fluon®, Halar®, and Kynar®)



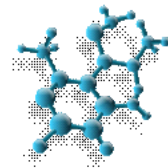
Performance Characteristics:

- Chemical Resistance
- Heat resistance (up to 500° F.)
- Resistance to UV Degradation
 - Low Surface Tension
- Low Coefficient of Friction



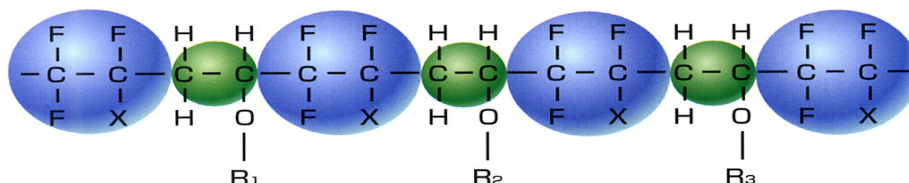
Limitations of Fluoropolymers:

- Poor solvent solubility
- Require High Temperature for Cure
- PVDF: limited gloss range and color selection



Fluoroethylene Vinyl Ether (FEVE) Resins

- Fluoro Ethylene
- Vinyl Ether



FLUORINATED SEGMENTS: Weatherability, chemical resistance

VINYL ETHER SEGMENTS: Gloss, solubility, crosslinking

Advantages of FEVE Fluoropolymer Resins:

- Ambient Cure
 - Field application
- OH Functional
 - Crosslinkable with isocyanates, blocked isocyanates, melamines
- Solvent Soluble
 - Conventional application techniques (airless spray)
 - Wide range of gloss (90 @ 60°)
- Fluoropolymer Segments
 - UV Resistance
 - Corrosion resistance

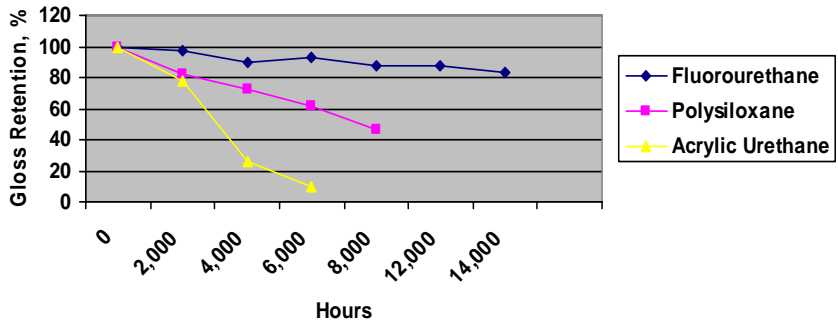
Markets for FEVE resin-containing coatings:

- 1) Architectural Coatings for commercial buildings
- 2) Industrial Maintenance Coatings for water towers, bridges, and assorted metal and concrete structures
- 3) Aerospace coatings
- 4) Applications in Marine environments

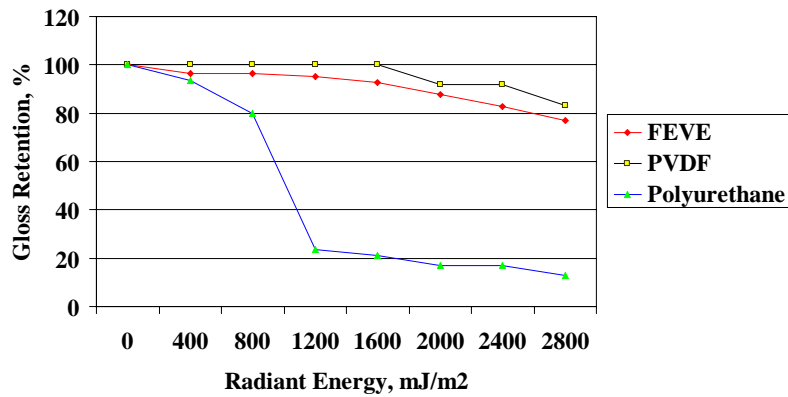
FEVE Resins can be formulated into 3 Types of Coatings:

- 1) Solvent-based Coatings (soluble in wide range of solvents for 2K systems)
- 2) Water-based Coatings (emulsions available for 1K and 2K systems)
- 3) Powder coatings

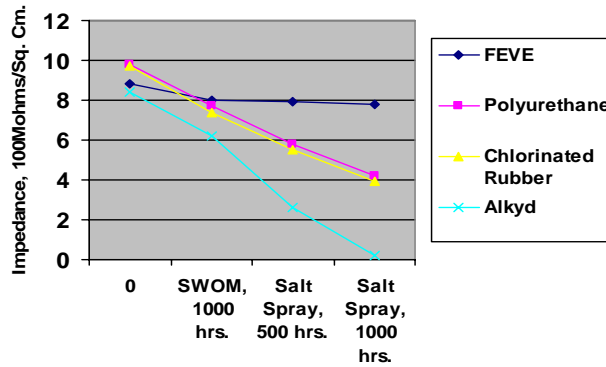
Weathering of FEVE Coatings QUV-A Test (ASTM D4587)



Weathering of FEVE Coatings EMMAQUA Testing



Corrosion Prevention with FEVE Based Coatings
Topcoat Properties



Electrochemical Impedance Spectroscopy Test Results

Corrosion Resistance Test of FEVE Coatings:

LOCATION: Suruga Bay Marine Test Station (offshore)

LENGTH OF TEST: 16 years

COATINGS SYSTEMS ON TEST:

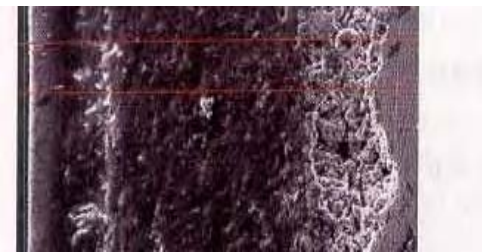
- 1) Zinc-rich primer / Epoxy Midcoat / Acrylic Urethane Topcoat
- 2) Zinc-rich primer / Epoxy Midcoat / Fluorourethane Topcoat

THICKNESS OF COATING:

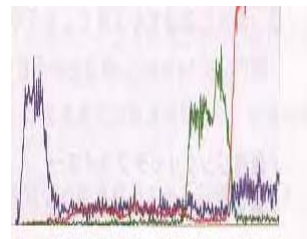
PRIMER = 3 mils / MIDCOAT = 6 mils / TOPCOAT = 1 mil(25 microns)

Measurement of Total Erosion of the Topcoat

	ACRYLIC URETHANE TOPCOAT	FLUOROURETHANE TOPCOAT
INITIAL MEASUREMENT (microns)	25	25
FINAL MEASUREMENT (microns)	0 (after 13 years)	21

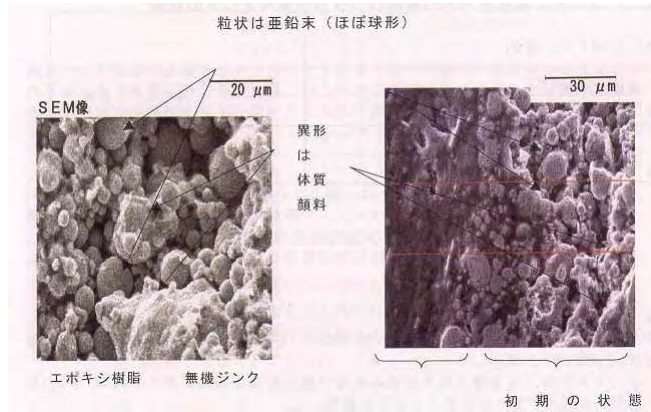


SEM Scan of cross section
Of Coating System
(after 16 year exposure)



EDX (Energy Dispersive X-Ray
Microanalysis)

BLUE: Chloride
GREEN: Coating System
RED: Metal



INITIAL

AFTER 15 YEARS

SEM Scan of Zinc-rich Primer

Offshore Projects Using FEVE Coatings



Location: Gullfaks B Platform, North Sea

Operator: Norwegian oil companies

FEVE-type Coatings Application Areas:
deck components

Comments: FEVE-type coatings utilized until 2000, when these companies stopped the use of isocyanates as crosslinkers.

Koshinmaru Cruiser for 15year

Specification: □ recoated Lumiflon white and clear
on aged Acrylic/polyurethane film



High Gloss Retention



Water Repellency Retention



Coastal Storage Tank Application



Topcoat:
FEVE-based Fluorourethane
Coating

Date of Application: 2002

Date of Photo: 2005

Life Cycle Cost Advantages

Initial Cost of FEVE-based Topcoat:

5 -10% higher than standard polyurethane topcoat

FEVE-based Topcoat Life Expectation:

30 - 60 years

Expected Repaints of Std. Polyurethane Topcoat
in this Time Frame:

2 to 3 (based on topcoat erosion data from offshore test)

Additional Costs of Repaints:

facility downtime

lodging of paint crew on offshore platform

Developmental Products

- 1) Silanol-functional solvent-borne FEVE resin
- 2) Water-borne FEVE dispersion resin for 2K
fluorourethane systems

Conclusion:

For over 25 years, FEVE resins have been included in exterior coatings for multiple end uses.

Their excellent weatherability and corrosion resistance make them attractive for several types of Marine applications.

Acknowledgements:

Takasi Takayanagi

Sho Masuda

Isao Kimura