Institute of Corrosion - Aberdeen Branch
Corrosion Awareness Course 2014

Corrosion Mitigation by Protective Coatings

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Palm Court Hotel

Aberdeen

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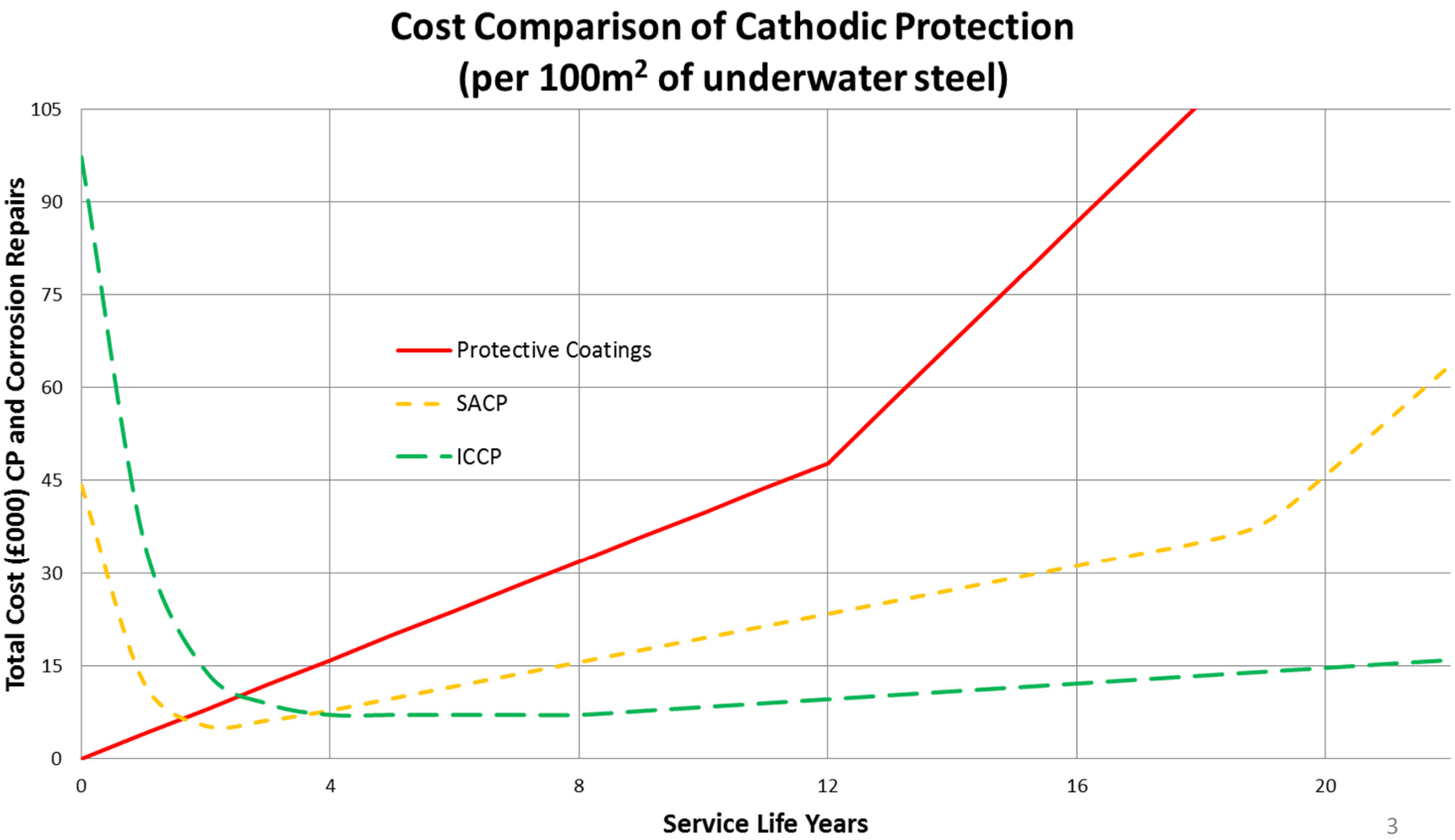
- **Economics**
- **Forces of Adhesion**
- **Impermeability – what does it mean to protective coating design life**
- **Damage Mechanisms (Stray Current, CP Shielding, CP Disbondment Electroendosmosis)**
- **Distribution of errors and defects throughout industry**
- **CP User friendly coatings**
- **The CP/Coating Engineer's wheel of fortune**
- **Discussion slides**

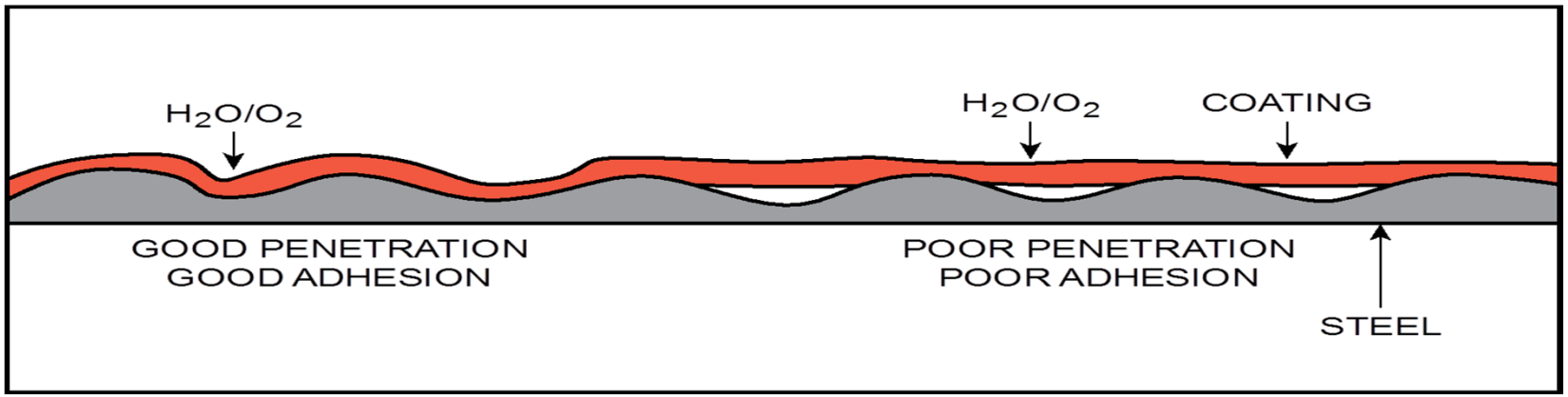
Economics


Cost Comparison of Cathodic Protection
(per 100m² of underwater steel)
Total Cost (£000) CP and Corrosion Repairs
105
90
75
60
45
30
15
0
0
4
8
12
16
20
Service Life Years
Protective Coatings
SACP
ICCP

Forces of Adhesion

Historical coatings/tape protection theory was the assumption that 'Paint' simply acted as a barrier to oxygen and water. Subsequent research has proven that oxygen and water, at a level sufficient to initiate the corrosion reaction, can indeed permeate through intact coatings.

Current theories propose that water permeating through a coating to the steel surface can cause displacement of the coating from the steel allowing corrosion to occur. Low permeability and good 'wet adhesion' i.e. adhesion under immersion, are widely believed to be the single most important aspects of corrosion control by coatings.

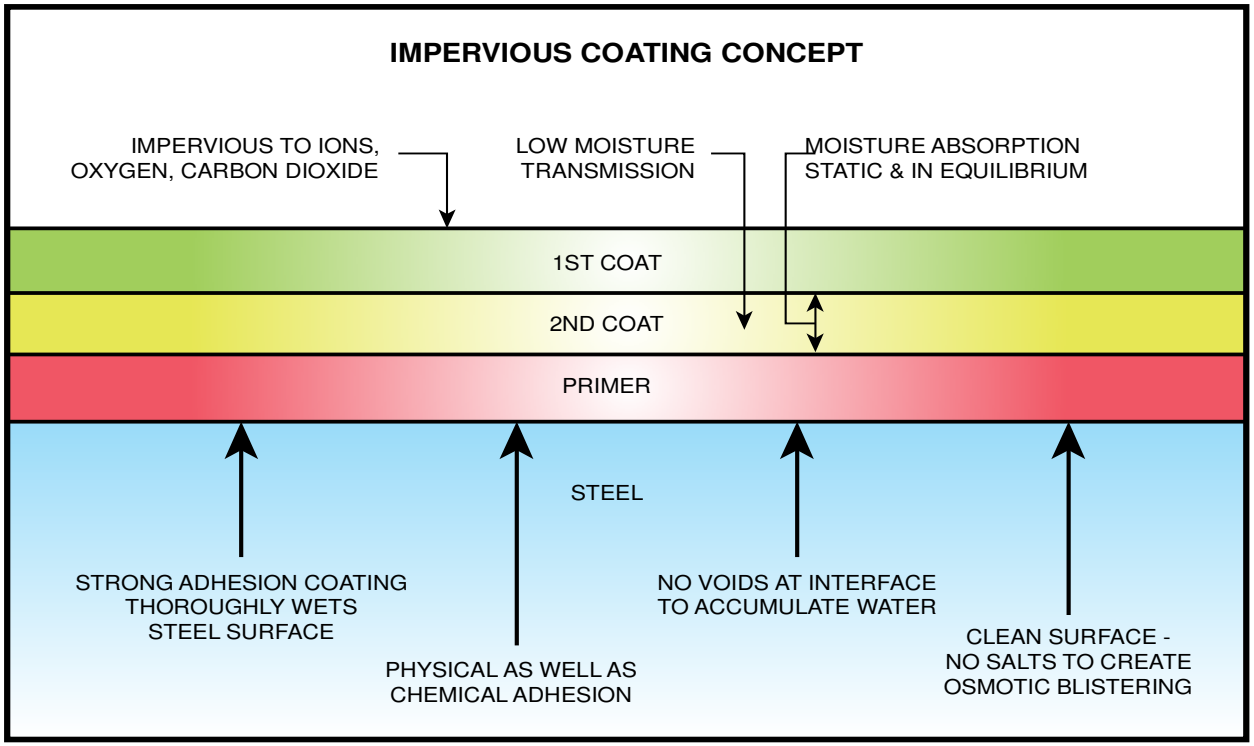


The force of adhesion is defined as the force of attraction between different substances

Impermeability – what does it mean to protective coating design life

Adhesion is critical in a protective coating/tape system

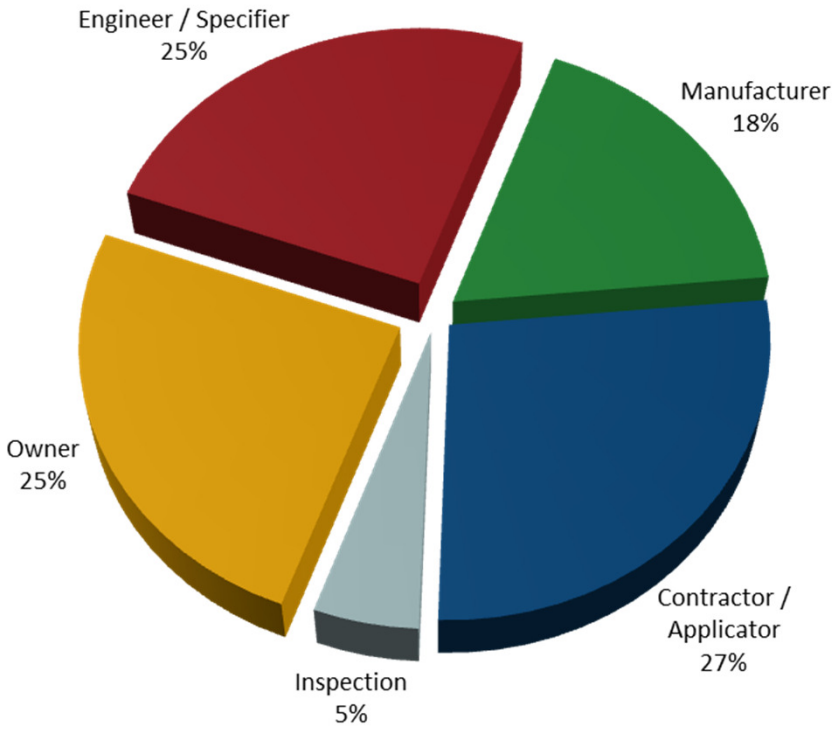
For maximum coatings adhesion steel surfaces must be clean, dry and free of oil, rust, salts and other contaminants. Whilst increasing surface roughness results in a greater surface area and potentially increases coatings adhesion, this is not always the case. If the coating does not 'wet out' and penetrate into all of the pores/crevices on the steel surface there will be areas of coating not in direct contact with the steel. In such cases more rapid oxygen and water passage through to steel will occur, resulting in corrosion and subsequent coating detachment.

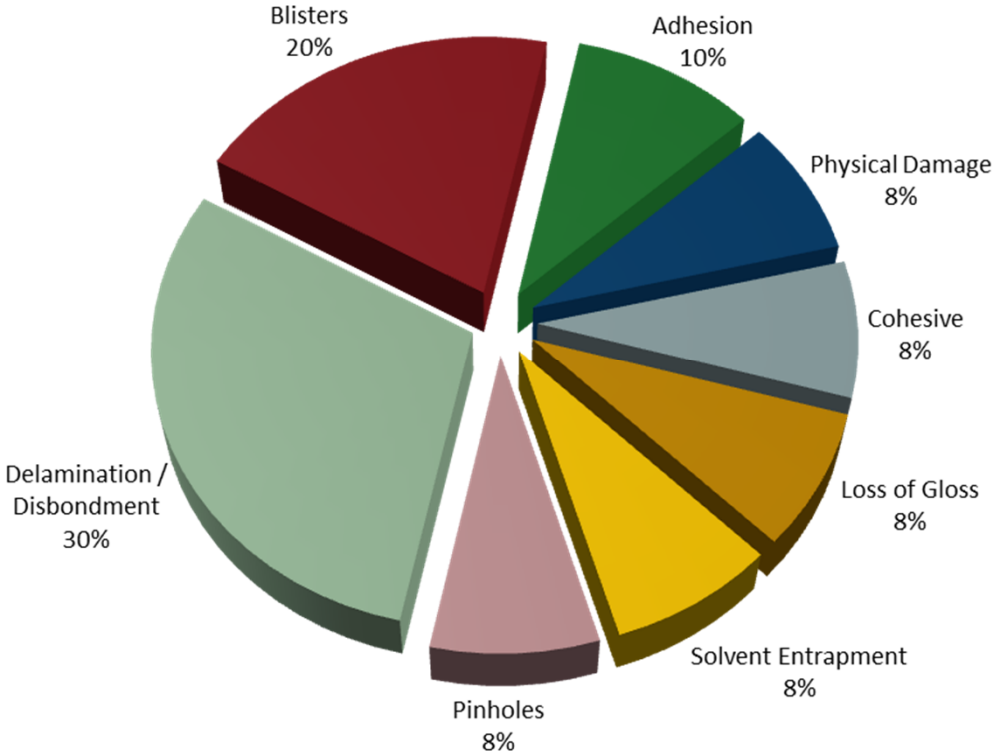


Damage Mechanisms (Stray Current, CP Shielding, CP Disbondment Electroendosmosis)

Damage Mechanism Type	Identification	Verification	Criticality (L/M/H/S)
Cathodic Disbondment	Disbondment/Blister formation/pH >11	Coating blisters semi-spherical ASTM D-714	Medium failure/full refurbishment
Cathodic Shielding	Coating/Tape	Fish mouth, wrinkles	Significant failure/rupture
Electroendosmosis	Concentric hemispherical blister formation	Moisture filled blisters indicating osmosis	Medium failure/full refurbishment
Stray Current	Usually severe pitting formation, probably through wall	Monitor the pipeline for stray currents from other pipelines and DC sources.	Significant failure/rupture
Hydrogen Embrittlement/ Hydrogen blistering	Hydrogen induced cracks (HIC) in the parent material, loss of coating adhesion/white calcaerous deposits.	Extremely alkaline blisters and lamelar separation in the parent material grain boundaries as the hydrogen atoms accumulate.	Significant failure/rupture

Distribution of errors and defects throughout industry





CP User friendly coatings/tapes

BURIED/IMMERSED PIPELINES	MARINE VESSELS/OFFSHORE STRUCTURES	ONSHORE STRUCTURES/TANKS
FBE	TSA	Epoxy Bis A
CTE	Epoxy Novalac	100% solids Urethane
Polychloroprene (Neoprene)	Epoxy Phenolic	TSA
Three Layer Polyolefin (3LPO)	Vinyl Ester Glassflake	Ceramic Polymers
Heat Shrink Sleeves	Polyester Glassflake	Petrolatum wax tapes
Zinc CNT	Polyurea	Bitumen/Butyl tapes
Polymer modified bitumen tape	Epoxy Mastics (Polyamine cured)	
High Density Polyethylene		
3 Layer Polypropylene		

The CP/Coating Engineer's wheel of fortune

INSTITUTE OF CORROSION

STRATEGIES

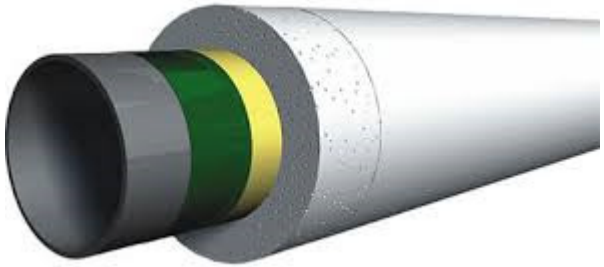
Greenfield
Ageing assets
Environments

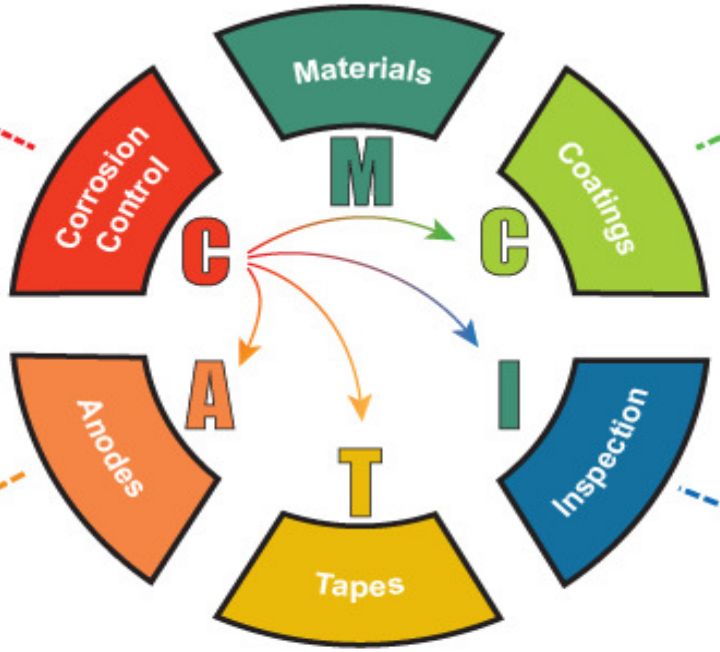
S/S CARBON STEEL

Material selection and specifications

PURPOSE INSULATE FLUID CONTROL

FBE
HDPE
3 LPP





SACP
ICCP

MPY
Half cell electrodes (Ag/AgCl), (Cu/CuSo4)

MASTICS
PE

Anti-Corrosion tapes and Design life

DMAIC

TR readings
Pearsons survey
ER probes
Corrosion coupons

Cathodic disbondment.
A suburban water provider northwest of Chicago was faced a few years ago with replacing more than half a mile of twin 16-inch diameter ductile iron water lines due to external corrosion and coating failure.
http://www.corrosionspecialists.com/protecting-against-water-line-failure.html

The pipeline was designed to ASME B31.4 and the investigation found that corrosion resulted from the break-down of the external coating. The exposed area of pipe was too large for the cathodic protection system.
http://www.twi-global.com/technical-knowledge/published-papers/pressure-vessel-corrosion-damage-assessment-november-2005/

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	Stray current pit http://www.chemmet.com/corrosion.html http://searchfiletype.com/Steel-Bridge-Corrosion-Issues-fs170438.html
	Shrink sleeve-CP shielding http://www.polyguardproducts.com/products/pipeline/nonshieldingcoating.htm

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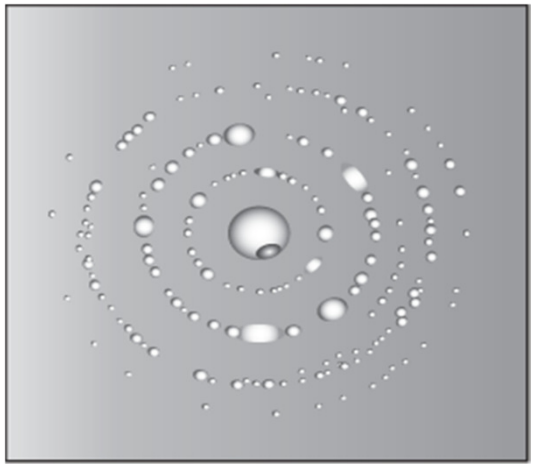
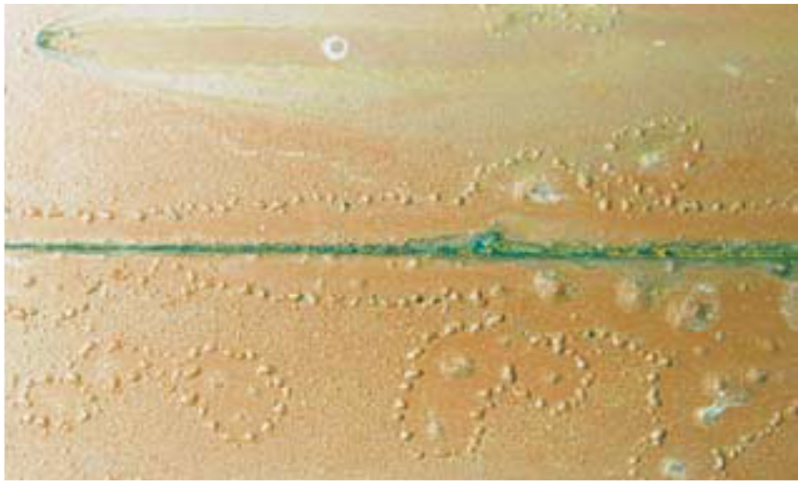
	**Electroendosmosis** Reference: MUNGER, C. G., & VINCENT, L. D. (1999). Corrosion protection by protective coatings. Houston, Tex, National Association of Corrosion Engineers. Crude Oil Storage Tank bottoms are prone to this defect.
	Electroendosmosis http://www.arcorepoxy.com/PDF.DATA.MSDS/news/non_osmotically_induced_blistering.pdf

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Access it :
http://crowleysyachtyard.blogspot.co.uk/2013/05/marine-corrosion-part-2.html

- For further information, visit the ICorr website

www.icorr.org