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POLYMERIC MESH BACKED COATING INTERACTION WITH CATHODIC PROTECTION

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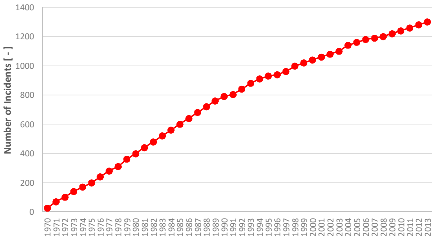
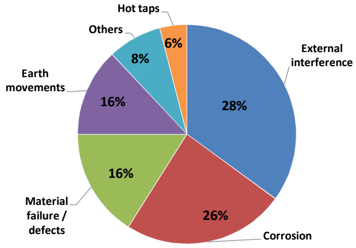
Pipeline incidents occurrence remains high
In Europe, 26% are caused by corrosion

Cumulative number of pipeline incidents



2009 – 2013: main causes of incidents



Corrosion risks have significantly increased in the last 5 years to become **among the leading causes of incidents** [1]

Note 1: CONCAWE

Source: Gas Pipeline Incidents – 9th Report of the European Gas Pipeline Incident Data Group

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EXTERNAL CORROSION PROTECTION

Interaction between:

COATING & CATHODIC PROTECTION

COATINGS:

ISO15589-1: Cathodic Protection of pipelines systems – On-land pipelines. Chapter 7.5 (Coating):

The coating provides the primary prevention against corrosion. It reduces protection current demand, improves current distribution, extends the protected area, and reduces interference to other foreign structures.

NACE SP0169: Control of External Corrosion on Underground or Submerged Metallic Piping Systems. Chapter 5.1.1

The function of external coatings is to control corrosion by isolating the external surface of the underground or submerged piping from the environment, to reduce CP current requirements, and to improve current distribution.

COATINGS:

Insulate Physically (mechanical damage) and electrically steel pipe from the environment (electrolyte).

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SHIELDING

ELECTRICALLY: *Specific Electrical Insulation Resistance*:

EN12068 (Tapes & HSS) : R_{S100} ≥ 10^8 Ω.m² & R_{S100}/R_{S70} ≥ 0,8
EN10290 (PU) & EN10289 (Epoxy):
R_{S100} ≥ 10^7 Ω.m² (≥ 1500µm) & R_{S100}/R_{S70} ≥ 0,8
R_{S30} ≥ 10^4 Ω.m² (≥ 1500µm) @ T_{max}

***ISO21809-3*:**
- Hot Applied bituminous tape: R_{S100} ≥ 10^6 Ω.m² & R_{S100}/R_{S70} ≥ 0,8
- Petrolatum tape: R_{S100} ≥ 10^6 Ω.m² & R_{S100}/R_{S70} ≥ 0,8
- Viscoelastic: R_{S100} ≥ 10^8 Ω.m² & R_{S100}/R_{S70} ≥ 0,8
- Elastomeric coating: Electrical volume resistivity (for information)
- Liquid coatings: R_{S100} ≥ 10^6 Ω.m² & R_{S100}/R_{S70} ≥ 0,8

MECHANICAL DAMAGE: *Impact, Indentation, Lap Shear, Abrasion & Soil stress – BUT:*

ISO13623: 2017: Petroleum and natural gas industries — Pipeline transportation systems (Chapter 10.6.3)
Any bedding material or mechanical protection shall not act as a shield to the passage of the cathodic-protection current to the pipe surface

NACE SP0169: Control of External Corrosion on Underground or Submerged Metallic Piping Systems. Chapter 5.1.3.1
Mechanical damage protection such as rock shield, abrasive resistance overcoatings, etc, maybe installed if required by owner specifications, and should be designed to eliminate or minimize damage to the pipe and its coating without inhibiting or interfering with CP requirements (see Electrical shielding in section 2)

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COMPROMISE & CONFUSION BETWEEN:

- **Mechanical Resistance**
- **Electrical Insulation**
- **The prevention or diversion of cathodic protection current from its intended path** (NACE SP0169)

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CP SHIELDING

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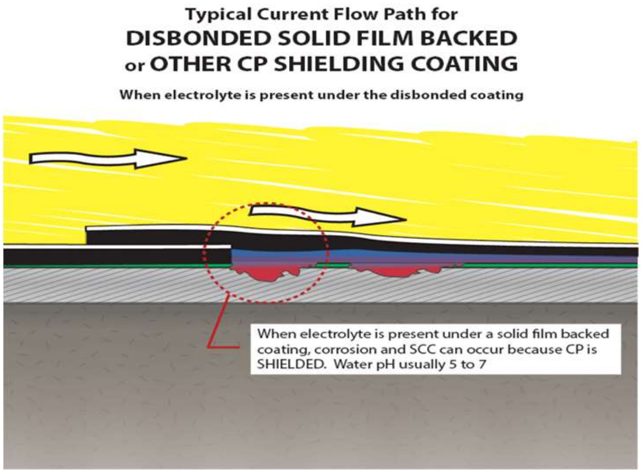

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External Corrosion mainly due to Cathodic Protection Current Shielding

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Case Study

USA 2006: 10-inch Pipeline
Shrink sleeve applied in 1997 and resulting corrosion found in 2006. Shrink sleeve shielded the CP. Pipe potentials met all NACE criteria

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Case Study

EUROCORR 2004: TOTAL 18-inch Rabi-Cap Lopez (Gabon)
The major part of corrosions are under field joint coatings at girth welds: massive disbonding of HSS with steel leading to corrosion caused by shielding effect

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Case Study

EDINBURG 2007: TOTAL 16-inch in Syria

Pipeline operated in Syria for about 12 years has revealed severe external corrosion at many girth welds areas coated with HSS (hot-melt adhesive type).

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Case Study

DISBONMENTS FACTORY COATING

France: pipeline with a 3LPP coating has suffered complete loss of adhesion without any corrosion.

***Gaz de France & Total: S*tudy of the "CP shielding effect" under disbonded coatings.**

no detrimental consequence on corrosion with 3-layer Polyolefin (3LPO) systems because the gap remains very low, in opposition to the case of other coatings such as coal tar or asphalt enamels, tapes or heat-shrinkable sleeves (HSS).

NACE RP0502-2002 *recommends a corrosion rate of 0.4mm/yr under disbonded coating in absence of any specific data*

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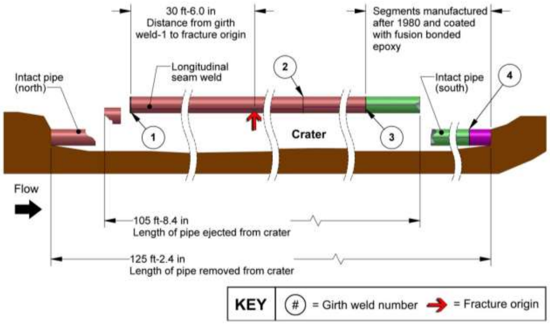
Case Study

MAY 2009: Rupture 18-inch Pipeline
Florida Gas Transmission Company



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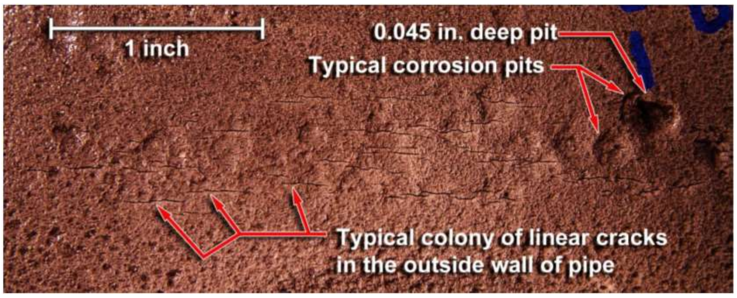

SCC (Stress Corrosion Cracking) occurs with mechanically failed coating in the absence of adequate cathodic protection (Shielding)

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NACE Task Group 523 (since 2015) clarifies the definition of cathodic shielding for CP specialists:

The main "shielding" issue is not whether the stand-alone coating is electrically insulating, it is whether the coating has a tendency to disbond (to fail) in such a way that polarization of the exposed steel surface is not possible

- 18 Coating Types (Ex: FBE, Liquids, Tapes, Wax, HSS, 2-3LPE,…etc)
- 21 Failure Modes (Ex: Wrinkling, Blisters, Penetration, Disbondment, CD…etc)
- Tendency to result in CP shielding:
  - Wrinkling = High
  - Disbondment = High
  - Blisters = Medium
  - Penetration = Low

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FAILURE MODE is the most important factor that influences shielding behavior

Surface preparation is critical for some coating systems
ISO21809-3: Soluble Salt: $\leq$ 20mg/m² (Chapter 9.1.2.2)

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FAILURE MODE is the most important factor that influences shielding behavior

ISO15589-1 Chapter 7.5.1: *Field joints and fittings coated on site are applied under more demanding conditions and can be a weak point in the general corrosion protection system if not selected and applied correctly.*

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FAILURE MODE is the most important factor that influences shielding behavior

Poor Soil stress resistance

ISO15589-1: Cathodic Protection of pipelines systems – On-land pipelines. Chapter 7.5.6:
Disbondment can cause cathodic protection current shielding by preventing access of the cathodic current to the steel surface … Non-bonded polyethylene wraps should be avoided as they cause shielding of the cathodic protection current and can be detrimental to the protection.

PHMSA (Pipeline and Hazardous Material Safety Administration) 2010:
Some examples of shielding coatings are polyethylene, tapes, shrink sleeves, coal tar mastics, asphalts, etc...

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POLYMERIC MESH BACKED COATING:

- Mechanical Resistance
- Electrical Insulation
- Interaction with Cathodic Protection: Secures cathodic protection current from its intended path if the coating fails.

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POLYMERIC MESH BACKED COATING:

Mechanical Resistance:

Impact & Indentation: meet Int. Standards

Soil Stress: PP Mesh applied with very high tension + Optional SP-6 (allows CP current flow)

Rock Shield if necessary (allows CP current flow)

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POLYMERIC MESH BACKED COATING:

Electrical Insulation:

Specific Electrical Insulation Resistance Test (ISO21809-3) – Charter Coating - June 2014:

$$R_{S100} = 4{,}7 \times 10^{8}\ \Omega.m^2$$

$$R_{S100}/R_{S70} = 1$$

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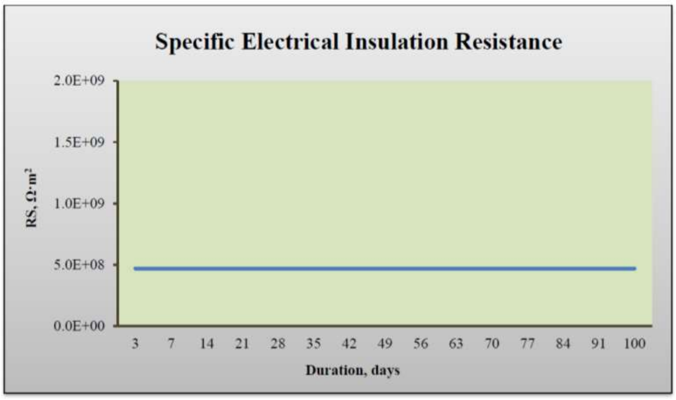

Figure 1. The Plot of the Specific Electrical Insulation Resistance of the RD-6 Polymeric Tape Coating verse Time for Immersion in 0.1 mol/L NaCl Solution at 23±2°C

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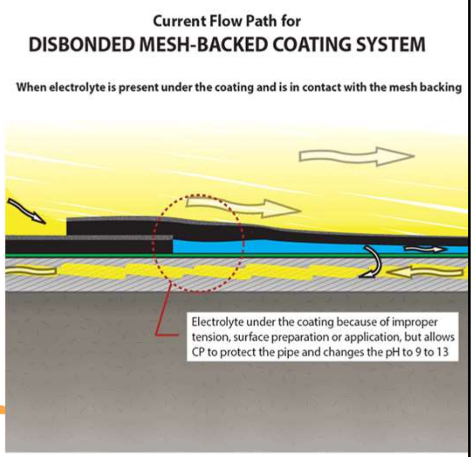
POLYMERIC MESH BACKED COATING:

Interaction with Cathodic Protection:
Failure mode compatible with CP



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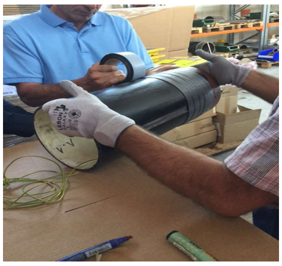

GRT gas: June 2017 … on going

CP current: 10 µAmps (sweet water) – 230 µAmps (salt water) - 0 µAmps (sand)

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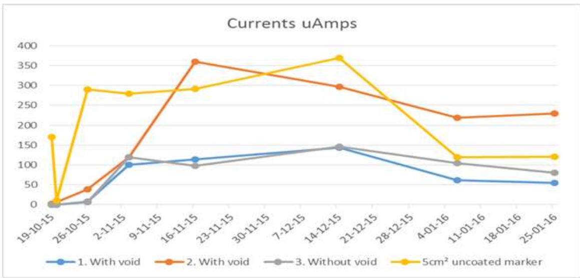

INGECA – France : Oct 2015 – Jan 2016

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POLYMERIC MESH BACKED COATING:

- **Developed in the 80's with superior performances to reduce coating failures**
- **Mechanical Resistance & Electrical Insulation (Shielding)**
- **Interaction with Cathodic Protection if the coating fails (Non-Shielding)**

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