BASF Pipeline Materials Overview with Cathodic Study

Outline

BASF
We create chemistry

- BASF materials for pipeline applications
- Rigid pipeline foam technical information
- Cathodic Shielding
  - Comments from the Pipeline Research Council
  - BASF study results

BASF Materials Pipeline Applications

BASF
We create chemistry

- Thermal insulation
- Pipeline stabilization
- Joint Infill
- Anode Protection
- Corrosion Protection
- Light stabilization
- Pigging
- Composites

Rigid Foam

- Material of choice for pipeline insulation, support, and protection
- Rigidity results in excellent compressive strength
- 100% quality – no buckles or pipe anomalies

BASF Pipeline Ditch Foam

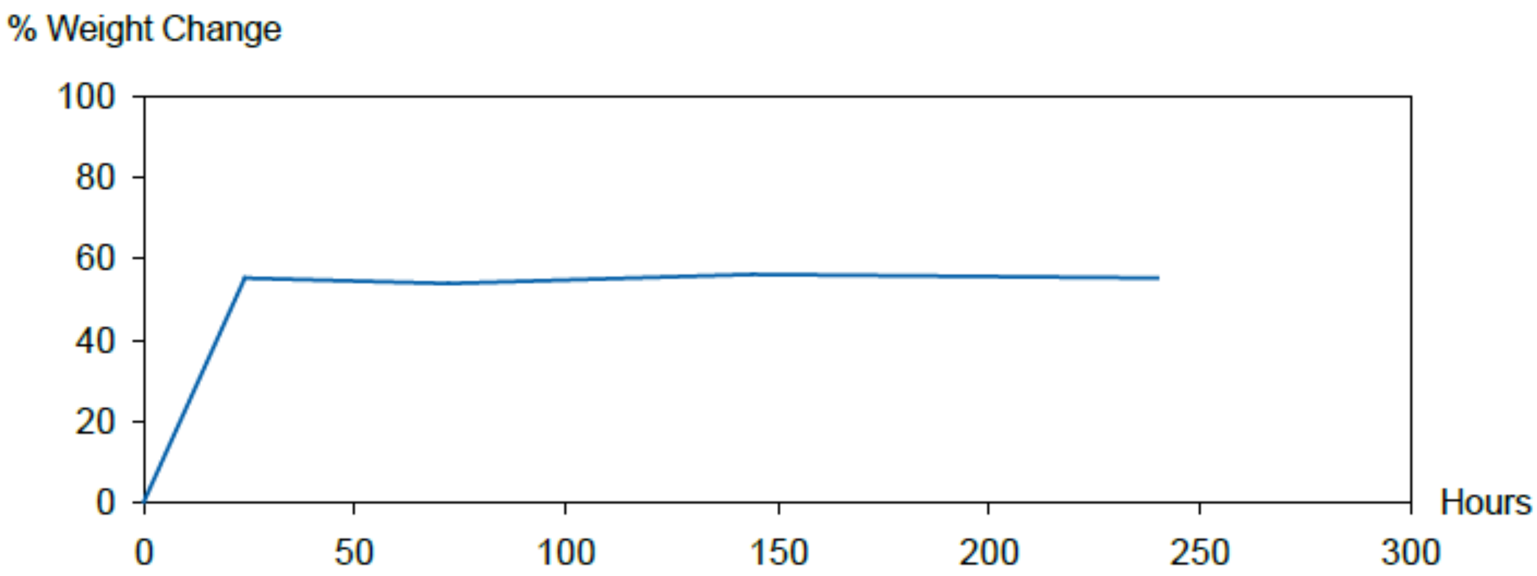
BASF
We create chemistry

BASF Pipeline Foam is a two-component, rigid, polyurethane spray foam system specifically developed for use in pipeline support and ditch-filling applications. When processed using Standard foam dispensing machines, this product will produce a high quality foam having superior mechanical properties.

Property	Value	Comments
Core Density	2.3 pcf 850 kg/m3	
Parallel Compressive Strength (10%)	127.0 kPa 18.4 psi	ASTM D1621
Parallel Compressive Modulus	3.7 Mpa 534 psi	ASTM D 1621
Thermal Conductivity	0.0235 W/m•K	ASTM C 518
Thermal Resistance	42.5 m•K/W	ASTM C 518

Water Absorption

The designed cellular structure of BASF Foam allows for the absorption of water while in service. Using ASTM C272, a 6”x6”x1” block of foam was fully submerged in water. Absorption as a function of weight change was measured to equilibrium.



Pipeline Research Council Study

Cathodic Shielding of polyurethane foam was addressed by the Pipeline Research Council (PRCI) in 1992. The objective of the study was to determine whether concrete and urethane foam-barrier coatings shield the pipe from cathodic-protection current.

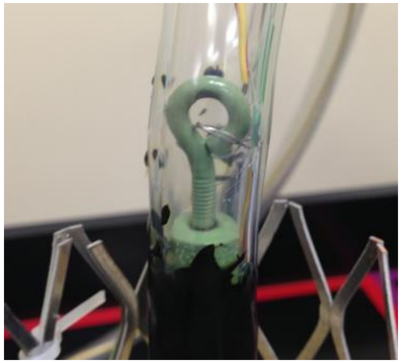
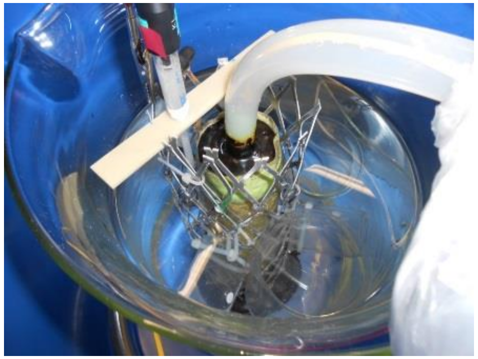
Conclusions:

Although there are trade offs in their physical and electrochemical properties, none of the concrete, urethane foam, or sand barrier coatings studied shielded the steel from cathodic-protection currents under the conditions tested.

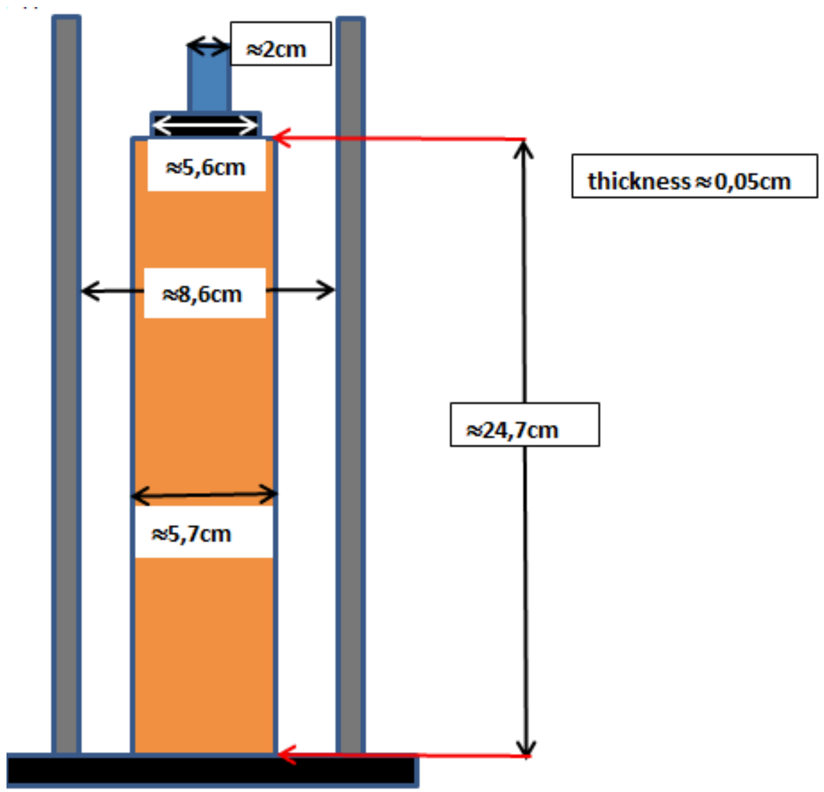
Bario, T.J., Werner, D.P. – "Shielding Effects of Concrete and Foam External Pipeline Coatings." PR-2080631

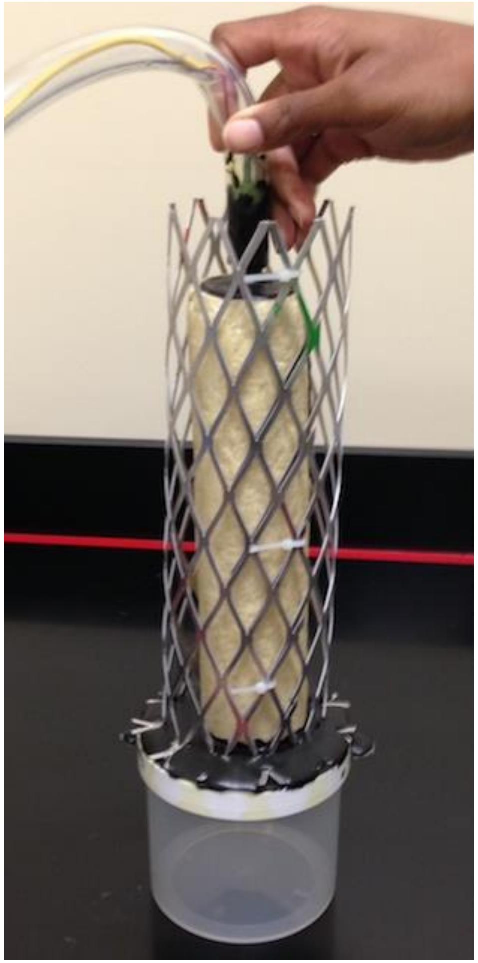
BASF Study

- In 2014, BASF completed a year long study to determine if urethane foam-barrier coatings shield pipe from cathodic-protection current
- General conclusion – The coating should not significantly shield the underlying metal from cathodic protection.

Experiment Setup





Measurement methodology

BASF
We create chemistry

- The foam coated sample was stored in the electrolyte under controlled conditions over a period of several months:

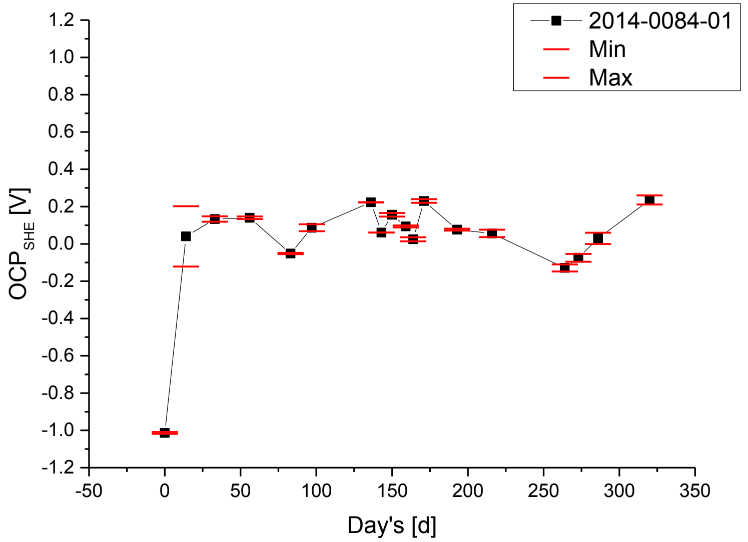
  T=23± 2°C, RH=50 ± 5%

- The following measurement protocol was performed in regular intervals:
  - Measurement of the open circuit potential (OCP, corrosion potential) for a duration of 5 min.
  - Linear Polarization Resistance (LPR:from -20mV to +20mV VS $OCP_{rel.}$; scanrate=166,666uV/s)
  - Electrochemical Impedance Spectroscopy (EIS, f=$1*10^{6}$-$1*10^{-2}$Hz; Amplitude: 20mV)

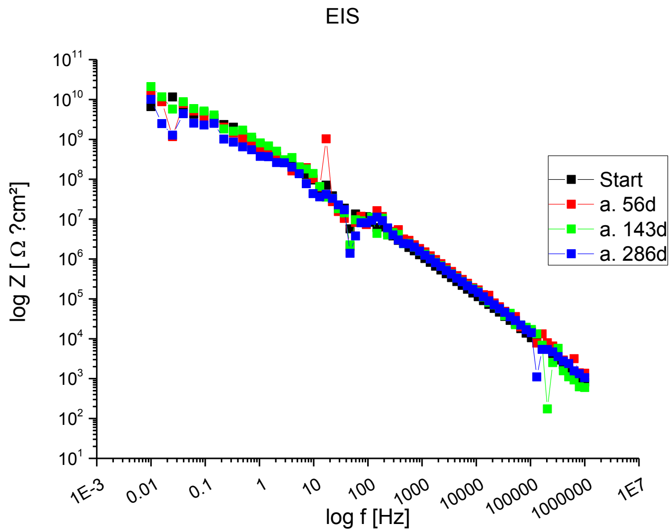
Open Circuit Potential - Results

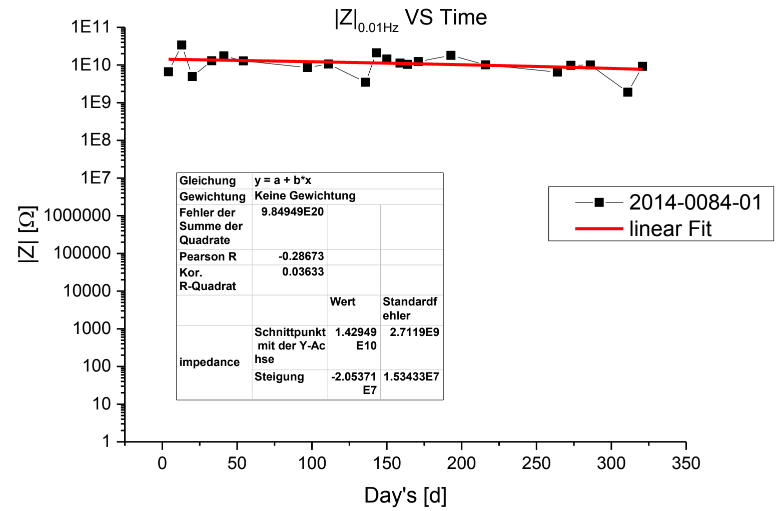
BASF
We create chemistry

- The FBE has to take up moisture to ensure steady state conditions during the electrochemical measurements.
- 30 days till 50 days were required before the OCP reaches steady state conditions.
- **The OCP after 50 days of immersion correspond to typical values of low carbon steel protected by organic coatings.**
- After approx. 250 days severe corrosion of the counter electrode materials is visible



Electrochemical Impedance Spectroscopy - Results





$Z_{0.1Hz}$ ≈ 1/icorr
= $1.43 \cdot 10^{10}$ Wcm^2 - $2.06 \cdot 10^{7}$ Wcm^{2}days^{-1} • t[days]

Capacitance of the water saturated coating: C = 1.927 10^{-10} F
Capacitance of the dry coating: C = 1.54 10^{-10} F

Estimation of the water uptake (Brasher-Kingsbury): 5% volume

No breakdown of protection properties observable within 330 days of exposure.

Conclusion

BASF
We create chemistry

- Experiment ended after 330 days. Difficulties due to corroding counter electrode after approx. 250 days of exposure.

- No under paint corrosion (coating disbondment) or other coating degradation detectable after 330 days of exposure

- Water uptake around 5 vol%
  - ▶ Material absorbs sufficient moisture in order to become electrically conductive and to allow cathodic protection (principally)

- Following the argumentation of the report PR- 208-631. The coating resistivity should not significantly shield the underlying metal from cathodic protection. The foam coating should not interfere with cathodic protection.

BASF

We create chemistry

www.performance-materials.basf.us