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Dielectric Coatings Primer: Polyurethane (DuraShield 210-61) Vs. Epoxy (Protecto-401)

Dielectric Coatings:

Dielectric coatings have been gaining market share in the coating and lining industry. Dielectric coatings bond to pipe and fittings to isolate the electrolyte (soil and water) from the metal substrate. Examples include coal tar enamel, epoxy and polyurethane. This paper will focus on 2 types of dielectric coatings – Epoxy and Polyurethane. Specifically, the comparison will detail the advantages and disadvantages between LifeLast DuraShield 210-61 (polyurethane) and Protecto-401 (filled epoxy).

Epoxy Coatings – Protecto-401:

Epoxy is a two part system consisting of an epoxy resin and a curing agent. In the case of Protecto-401, it is classified as an amine cured novolac epoxy containing at least 20% by volume of ceramic quartz pigment. The novolac epoxy resin is synthesized by reacting phenolic novolac resin with epichlorohydrin in the presence of sodium hydroxide as a catalyst which creates multiple terminal epoxide groups and hydroxyl groups. The reactive hydroxyl groups create strong polar bonds that account for the great adhesion to most substrates. Epoxy resins must be crosslinked in order to develop the coating's required characteristics. This crosslinking process is achieved by chemically reacting the resin with a suitable curing agent or hardener. The multiple epoxide groups allow these resins to achieve high cross-link density resulting in excellent temperature, chemical and solvent resistance.

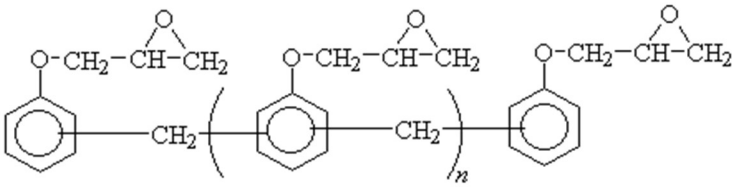

Figure 1: Chemical Structure of Novolac Epoxy Resin

Polyurethane Coatings – LifeLast DuraShield 210-61

Polyurethanes are produced by reacting a liquid isocyanate with a liquid blend of polyols, catalyst, and other additives. These two components are referred to as a polyurethane system. The isocyanate is commonly referred to as the 'A-side' or 'iso' and is characterized by a (NCO) group, which are highly reactive alcohols. The blend of polyols (a compound that contains multiple alcohol groups (OH)) and other additives is commonly referred to as the 'B-side' or as the 'poly'. Crosslinking occurs because of the high reactivity and affinity of the isocyanate group for the active hydrogen of the polyol. DuraShield 210-61 (DS210-61) is a 100% solids (solventless), two-component aromatic (containing a benzene ring) polyurethane coating that contains no volatile organic compounds (VOC) or extending fillers. By employing hydrophobic polyurethane resins, DS210-61 has a very low water absorption rate and superior cathodic disbondment protection.

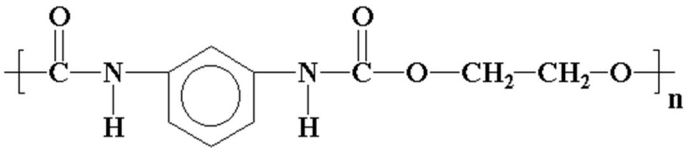

Figure 2: Chemical Structure of Typical Polyurethane

Physical Property Comparison

COMPARATIVE TEST	LIFELAST DURASHIELD 210	COMPARATIVE TEST	PROTECTO 401
ADHESION TO STEEL ASTM D4541	>3500 PSI	ADHESION TO STEEL	NO DATA
ADHESION TO DUCTILE	>2000 PSI	ADHESION TO DUCTILE	1000 PSI
PERMEANCE, ASTM E96, BW METHOD*	0.00849 - 0.049 PERMS	PERMEANCE ASTM E96, METHOD A	0.00 PERMS
CATHODIC DISBONDMENT ASTM G95	0 MM	CATHODIC DISBONDMENT ASTM G95	0.17 MM
IMPACT RESISTANCE ASTM G14	107 - 240.5 IN-LBS	IMPACT RESISTANCE ASTM G14	72 IN-LBS
EXTERIOR EXPOSURE, 2.5 YEARS	CHALKING, NEGLIGIBLE LOSS OF FILM; NO CORROSION	EXTERIOR EXPOSURE, 2.5 YEARS	CHALKING, NEGLIGIBLE LOSS OF FILM; NO CORROSION
ABRASION RESISTANCE ASTM D4060, CS17	17.5 MG	ABRASION RESISTANCE, ROCKING ABRASION 1,000,000 CYCLES	2 MILS LOSS
SHORE D HARDNESS ASTM D2240	77	SHORE D HARDNESS	71
WATER ABSORPTION ASTM D570	<1% WEIGHT GAIN	WATER ABSORPTION ASTM C413	NO WATER ABSORPTION
SALT FOG, ASTM B117	NO DATA	SALT FOG, ASTM B117	2 YEARS - PASSED
FLEXIBILITY ASTM D522, 1" MANDREL	NO CRACKING	DEFLECTION	5% DEFLECTION WITH 2: 1 SAFETY FACTOR
WET ADHESION ASTM D870, 38°C 270 DAYS	NO NOTICEABLE LOSS IN ADHESION	120°F HOT WATER IMMERSION	2 YEARS, NO EFFECT
EIS 180 DAYS AT 38°C 120 DAYS AT 60°C	 11.46 11.57	EIS	NO DATA
7-CYCLIC SALT FOG/QUV ASTM D5894, 120 DAYS	NO RUST OR BLISTERING	7-CYCLIC SALT FOG/QUV ASTM D5894, 120 DAYS	NO DATA

Figure 3: Material Property Comparison for DuraShield 210 and Protecto 401

Cathodic Disbondment

COMPARATIVE TEST	LIFELAST DURASHIELD 210	COMPARATIVE TEST	PROTECTO 401
CATHODIC DISBONDMENT ASTM G95	0 MM	CATHODIC DISBONDMENT ASTM G95	0.17 MM

The ASTM G95 method consists of placing a test specimen coated with the candidate material in series with a magnesium anode as part of a galvanic cell. The electrolyte is a mixture of various salts including NaCl, KCl, and sodium bicarbonate. Prior to placement in the electrolyte, the coating is intentionally damaged (holiday) in one or more locations to provide a site where edge corrosion may occur. The sample

is then allowed to remain in the electrolyte for 30 days after which time the edges of the holiday(s) are evaluated to determine the extent of disbondment.

The results relate directly to the long-term performance of barrier coatings used to protect metal pipe or fittings used in underground applications. Damage to the coating is real possibility, therefore it is important for the coating to remain bonded to the metal substrate. Dielectric coatings are only effective if they continue as a barrier to the electrolyte.

Impact Resistance

COMPARATIVE TEST	LIFELAST DURASHIELD 210	COMPARATIVE TEST	PROTECTO 401
IMPACT RESISTANCE ASTM G14	107 - 240.5 IN-LBS	IMPACT RESISTANCE ASTM G14	72 IN-LBS

ASTM G14 test method measures the energy required to rupture coatings applied to pipe after an impact from a falling weight. Impact resistance is an important measure of protection against mechanical damage during shipping, handling, and installation. A stronger impact resistance will provide a greater safety factor against in-field wear and tear.

Hardness

COMPARATIVE TEST	LIFELAST DURASHIELD 210	COMPARATIVE TEST	PROTECTO 401
SHORE D HARDNESS ASTM D2240	77	SHORE D HARDNESS	71

ASTM D2240 test method consists of measuring the penetration of a specific type of “indenter” when forced into the material. The hardness is inversely related to the penetration and is dependent on the elastic modulus and viscoelastic behavior of the material. For dielectric coatings, a greater hardness value allows for more protection against in-field installation and rough handling during shipping.

Application:

In addition to the properties mentioned above, the application of the coating plays an important role in the lifetime performance of the coating. Film thickness is a major factor in performance. Polyurethane is typically applied with a thicker film than most epoxies. The thicker film will insure a holiday free coating over a rough and irregular surface condition. Also a thinner film thickness does not offer the same abrasion allowance.

Conclusion:

LIFELAST DURASHIELD 210	PROPERTY/CHARACTERISTIC	PROTECTO 401
SAFE TO WORK WITH AND APPLY	SAFETY	CONTAINS COAL TAR PITCH
EXCELLENT; HYDROPHOBIC RESINS AND TIGHT MOLECULAR MATRIX RESISTS MOISTURE PENETRATION	MOISTURE RESISTANCE	EXCELLENT
VERY GOOD; CHEMICAL RESISTANT RESINS AND TIGHT MOLECULAR MATRIX RESISTS CHEMICAL ATTACK & PENETRATION	CHEMICAL RESISTANCE	VERY GOOD TO EXCELLENT
VERY GOOD; HYDROPHOBIC RESINS AND TIGHT MOLECULAR MATRIX RESISTS PENETRATION & ATTACK	ELEVATED TEMPERATURE RESISTANCE	VERY GOOD
VERY GOOD; CHEMICAL RESISTANT RESINS AND TIGHT MOLECULAR MATRIX RESISTS CHEMICAL ATTACK & PENETRATION	RESISTANCE TO ACIDS AND BASES	VERY GOOD
FAIR	RESISTANCE TO HYDROCARBONS	VERY GOOD
VERY GOOD; PASSES 1" MANDREL BEND	FLEXIBILITY/ELONGATION	FAIR; BRITTLE AND SUSCEPTIBLE TO SPIDER CRACKING
EXCELLENT; LITTLE DAMAGE FROM SHIPPING AND HANDLING OF PIPE	IMPACT RESISTANCE	FAIR; MORE BRITTLE FILM IS SUSCEPTIBLE TO DAMAGE FROM IMPACT
VERY GOOD	ABRASION RESISTANCE	GOOD
VERY GOOD; UNIQUE THIXOTROPIC PROPERTIES MINIMIZES EXOTHERMIC REACTION AND CREATES HIGH-APPLIED VISCOSITY TO MINIMIZE OUTGASSING	APPLICATION – PINHOLING & OUTGASSING RESISTANCE	UNKNOWN
EXCELLENT; UP TO 125 MILS IN SINGLE APPLICATION	APPLICATION – BUILD PROPERTIES	UNKNOWN

The material property comparisons have shown that both DuraShield 210 and Protecto 401 are superior dielectric coatings. Detailed side by side analysis showed that these coatings can be considered equal with the exception of a few instances. If the coating will be used in an area with heavy hydrocarbon pollution a detailed look will be needed to see if DuraShield 210 is suitable. DuraShield 210 should be considered superior when a lining is needed in applications with abrasion concerns such as raw water transmission and wastewater conveyance. DuraShield 210 should also be favored as a coating when an increased safety factor is desired for in-field installation because of its greater adhesion strength, impact resistance, hardness and flexibility.