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Eastman Tetrashield™ IC3021 protective resin system

Optimizing corrosion resistance in multi-substrate direct-to-metal applications with the addition of zinc-free corrosion inhibitors

Eastman Tetrashield™ IC3021 protective resin system is a highly durable polyester designed to provide excellent direct-to-metal (DTM) corrosion resistance in weatherable, 2K polyurethane industrial coatings. Tetrashield IC3021 can enable reduced labor costs, lower coatings consumption, lessen environmental impact, and increase productivity. The advantages of Tetrashield IC3021 are due to the tetramethyl structure of the key Tetrashield monomer 2,2,4,4-tetramethyl-1,3-cyclobutanediol (TMCD), which allows for increased solubility and low viscosity for higher-solids applications.

One of the challenges in industrial and protective applications is to have a resin system that can achieve corrosion resistance over multiple substrates. Tetrashield IC3020 and IC3021 intrinsically provide corrosion resistance properties in industrial applications for the DTM market due to shielded secondary hydroxyls providing a moisture barrier, which leads to reduced water permeation and improved adhesion. While Tetrashield IC3020 provides best-in-class weathering performance, Tetrashield IC3021 establishes multiple active binding sites to various metal surfaces, enabling superior corrosion resistance over a broad selection of substrates. For optimum balance of weathering and corrosion resistance, a 60:40 blend of IC3021:IC3020 is recommended. The addition of zinc-free corrosion inhibitors, in combination with Tetrashield IC3020 and IC3021 blends, further improves corrosion resistance over multi-substrate applications such as shot-blasted, cold-rolled, and iron-phosphate pretreated steel. Formulation options with zinc-free corrosion inhibitors in combination with IC3021 enable flexibility to tailor performance to target applications.

Formulations

The corrosion inhibitors provide the formulator two different mechanisms to improve corrosion performance. The inorganic additives, Halox[®] CW-2230 and Halox 430, provide a typical passivation mechanism in addition to ion exchange benefits, which will prevent corrosion at the metal-paint interface. The organic inhibitors can improve coating adhesion, resulting in reduced corrosion failures. Halox 650 is a diacid functional organic additive, whereas Halox 550 WF is a liquid additive based on silane chemistry that is further stabilized for ease of formulation. Two corrosion inhibitor combinations resulted in improved performance over the commercial acrylic control:

- **Option 1**—Halox 430 at 6 wt% of total formulation weight and Halox 550 WF at 3 wt% of total formulation weight
- **Option 2**—Halox CW-2230 at 6 wt% of total formulation weight and Halox 650 at 1.5 wt% of total formulation weight

Formulations (see Table 1) were prepared by grinding a mill base with a Dispermat high-speed mixer. The mill base is then let down by adding more resin, surface additives, and solvent. Cross-linker was added to the A component, starting the curing reaction. The formulations were sprayed in a humidity- and temperature-controlled environment (75°F, ~50% RH) at 35 seconds, Ford cup No. 4 viscosity using a conventional spray gun.

Table 1. IC3021 starting point formulas containing zinc-free corrosion inhibitors

Compound	Option 1 wt%	Option 2 wt%	Description	Supplier
Mill base – Part A				
Tetrashield IC3020	12.31	12.11	Polyester resin	Eastman
Tetrashield IC3021	0.00	6.73*	Polyester resin	Eastman
Zoldine® MS Plus	0.73	0.72	Moisture scavenger	Angus
DISPERBYK-164	0.57	0.56	Wetting and dispersing agent	BYK
BYK-A501	0.55	0.54	Air release additive	BYK
Crayvallac® Ultra	0.78	0.77	Rheology modifier	Arkema
Ti-Pure™ R960	14.24	14.01	Pigment	Chemours
Vulcan® XC72R GP 3921	0.18	0.18	Carbon black pigment	Cabot
Microalc IT Extra	3.68	3.62	Pigment extender	Elementis
Microdol™ Extra	10.27	9.76	Pigment extender	Omya
Halox® CW-2230	0.00	6.00	Inorganic anticorrosion pigment	ICL
Halox® 430	6.00	0.00	Inorganic anticorrosion pigment	ICL
Halox® 650	0.00	1.50	Organic corrosion inhibitor	ICL
Halox® 550 WF	3.00	0.00	Organic corrosion inhibitor	ICL
MAK	4.09	8.24	Solvent	Eastman
Letdown—Part A				
Tetrashield IC3021	17.10	10.09	Polyester resin	Eastman
BYK-306	0.05	0.05	Surface additive	BYK
BYK-392	0.74	0.73	Antipopping additive	BYK
Tinuvin® 292	0.39	0.38	UV absorber	BASF
Tinuvin® 400	0.46	0.46	UV absorber	BASF
1% DBTDL in A100	1.93	1.90	Catalyst solution	Various
MAK	4.95	5.45	Solvent	Eastman
Cross-linker—Part B				
Desmodur® N3390 BA/SN	14.60	14.36	Cross-linker	Covestro
Thinner—Part B				
MAK	3.38	1.84	Solvent	Eastman
Total	100.00	100.00		

*Halox 650 will increase viscosity of the grind; IC3021 is added into the mill base for option 2 to manage viscosity.

Note: Acrylic control formula used a commercial resin (148 OH #, 75% NV) and was formulated as above, maintaining NCO/OH ratio and P/B. For formulas made without anticorrosive additives, Microdol Extra and Microalc IT extra pigment extender were both increased in proportion to maintain P/B.

Table 2. IC3021 formula parameters

Parameter	Value (option 1) 6% Halox 430 3% Halox 550 WF	Value (option 2) 6% Halox CW-2230 1.5% Halox 650
NCO:OH	1.10	1.10
Wt% solids	73.00	73.00
Vol. % solids	60.63	60.16
PVC	0.26	0.25
P/B	0.89	0.85

Figure 1. 1,250-hour salt spray—option 1 Halox® 430/Halox® 550 WF (ASTM B117)

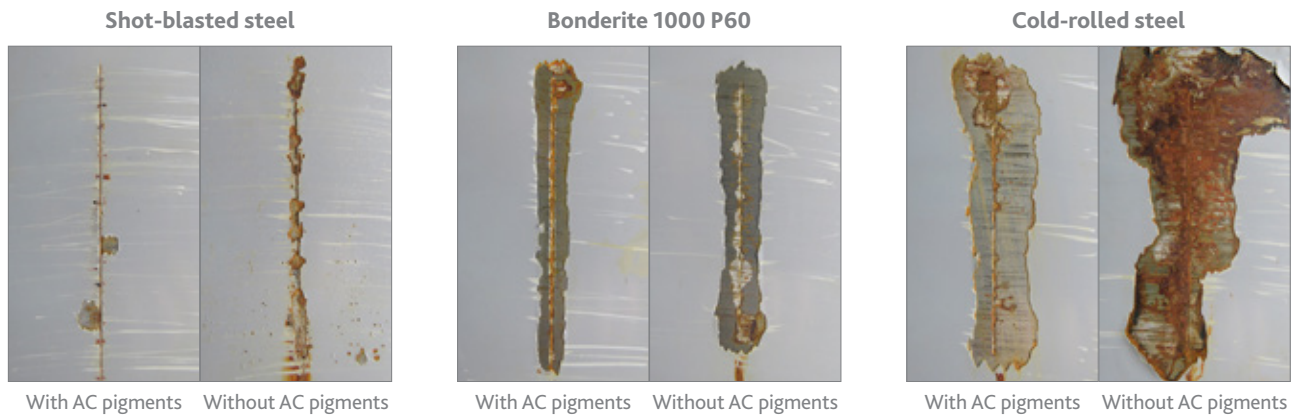


Table 3. Option 1 data

Substrate	Shot-blasted steel		Bonderite 1000 P60		Cold-rolled steel	
	With	Without	With	Without	With	Without
AC pigments	With	Without	With	Without	With	Without
DFT (mils)	4.65	2.94	5.15	5.30	4.65	4.92
Initial gloss (60°)	76.4	77.9	82.5	84.3	82.5	83.8
Face blistering	10	8M	4F	4F	10	10
Scribe creep (mm)—avg of 5	2.4	2.2	5.2	6.6	11.8	21.6

Figure 2. 1,250-hour salt spray—option 2 Halox® CW-2230/Halox® 650 (ASTM B117)

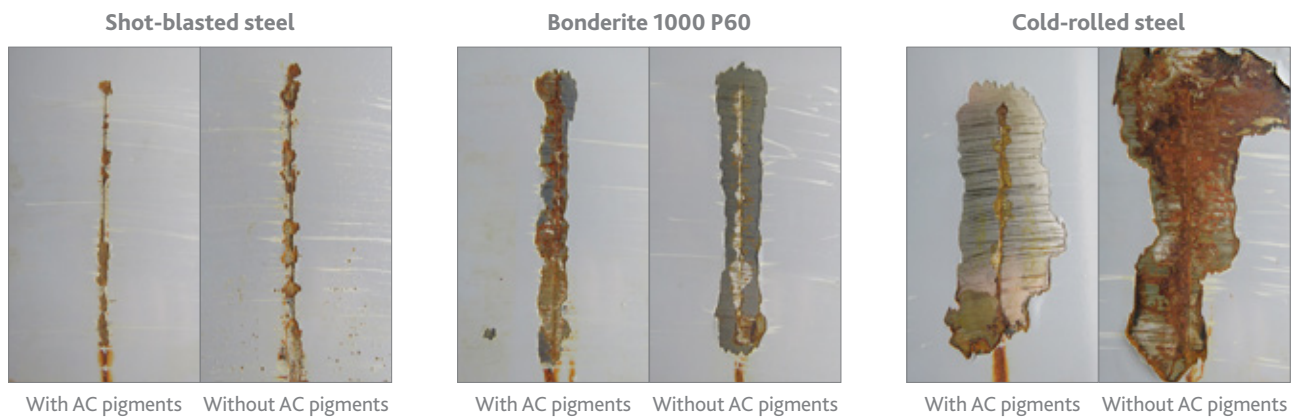


Table 4. Option 2 data

Substrate	Shot-blasted steel		Bonderite 1000 P60		Cold-rolled steel	
	With	Without	With	Without	With	Without
AC pigments	With	Without	With	Without	With	Without
DFT (mils)	3.77	2.94	5.23	5.30	4.96	4.92
Initial gloss (60°)	78.1	77.9	83.7	84.3	89.2	83.8
Face blistering	10	8M	6F	4F	10	10
Scribe creep (mm)—avg of 5	1.2	2.2	4.8	6.6	18.8	21.6

Summary

Tetrashield IC3021 is recommended for multi-substrate DTM applications over shot-blasted, cold-rolled, and iron-phosphate pretreated steel and meets most performance specifications required in the protective market. For improved performance, the addition of corrosion inhibitors is recommended. Corrosion improvement when using IC3020 and IC3021 blends is not limited to the substrates listed, and improvements may be noticeable on additional metal substrates. The use of Tetrashield IC3020 and IC3021 blends in combination with either Halox 430 and Halox 550 WF or Halox CW-2230 and Halox 650 zinc-free corrosion inhibitors has been found to be very effective. Specific levels of these corrosion inhibitors should be determined experimentally with the specific developmental formulation for the intended application to ensure properties meet performance specifications.



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