

Epoxy Curing Agents and Modifiers

EPODIL® LV5 Diluent

DESCRIPTION

Epodil LV5 diluent is a chemically inert, low viscosity liquid hydrocarbon resin. It is soluble in and compatible with a wide variety of epoxy resins as well as most curing agents. Epodil LV5 diluent is a specialized additive enhancing the performance properties of a formulated system and should be added at relatively low loadings, in the order of 5 to 15 phr. Epodil LV5 diluent acts as a surface tension reducer, as a pigment wetting aid, and as an adhesion promoter. In the formulation of trowel able epoxy mortars, the addition of Epodil LV5 diluent can help to improve trowel ability by reducing/eliminating the tendency for drag or sticking to occur, so that it is not necessary to keep wetting the trowel with solvent to obtain a smooth surface. In epoxy mastic coatings for application to poorly prepared surfaces it aids penetration of surface rust and oil leading to improved adhesion.

The optimum level of Epodil LV5 diluent addition for any particular application will depend upon a variety of factors including types of resin, curing agents, fillers, substrates, etc.

Contact your Evonik representative for formulating support.

BENEFITS

- Improved chemical resistance
- Improved adhesion
- Improved water resistance
- Low volatility
- Maintains high level of corrosion resistance

APPLICATIONS

- Solvent based marine and protective coatings
- Solvent-free coatings
- Solvent-free flooring and concrete primers
- Grouts

STORAGE AND HANDLING

Refer to the Safety Data Sheet for Epodil LV5 diluent.

SHELF LIFE

At least 24 months from the date of manufacture in the original sealed container at ambient temperature. Store away from excessive heat and humidity in tightly closed containers. Do not freeze.

TABLE 1: TYPICAL PROPERTIES

Appearance	Clear Amber Liquid
Color ¹ (Gardner)	2 max
Viscosity ² @ 25°C (77°F), (mPa.s)	50
Specific Gravity @ 21°C (70°F)	1.019
Recommended use Level, (phr)	5-15
Solids Content, (%)	100

TABLE 2: TYPICAL HANDLING PROPERTIES

Pot life ³ @ 21°C (70°F)	Increased by 15-60% ⁵
Thin Film Set Time ^{4,5} @ 21°C	Increased by 35-200% ⁵

Footnotes:

- (1) ASTM D 1544-80
- (2) Brookfield RVTD, Spindle 4
- (3) 150 g mixed mass
- (4) BK Drying Recorder Phase II
- (5) Depending upon the curing agent and addition level

SUPPLEMENTARY DATA

Epodil LV5 diluent is a chemically inert, low viscosity liquid hydrocarbon resin. It is compatible with a wide variety of epoxy resins as well as most curing agents. Epodil LV5 diluent is most often used at 5 to 15 phr. Epodil LV5 diluent acts as a surface tension reducer, as a pigment wetting aid, and as an adhesion promoter.

The optimum level of Epodil LV5 diluent addition for any particular application will depend upon a variety of factors including types of resin, curing agents, fillers, substrates, etc.

PERFORMANCE EVALUATION

Epodil LV5 diluent was evaluated for its compatibility with liquid epoxy resin, impact on liquid epoxy resin viscosity, influence on reactivity, adhesion over sandblasted steel, influence on chemical resistance and 5% salt spray, following a 10 day ambient cure of applied coatings.

To perform the tests, liquid epoxy resin with EEW=190 was modified with Epodil LV5 diluent at the addition level of 5 and 15 phr. Unmodified liquid epoxy resin was used as a control.

Many different curing agents were used to cure the modified and unmodified liquid epoxy resin and in all tests and the stoichiometry was 1 EEW to 1 AHEW.

COMPATIBILITY OF EPODIL® LV5 DILUENT WITH EPOXY RESIN AND CURING AGENTS:

Epodil LV5 diluent is compatible with most curing agents and with a variety of epoxy resins, making it a viable additive for most epoxy systems. Compatibility with epoxy resin and curing agents were evaluated by mixing Epodil LV5 diluent with the liquid epoxy resin or with the curing agent up to the proportion of 1 part by weight of Epodil LV5 diluent to 1 part by weight of liquid epoxy resin or curing agent. Blends were observed immediately and after 24 hours. Table 1 shows the compatibility results.

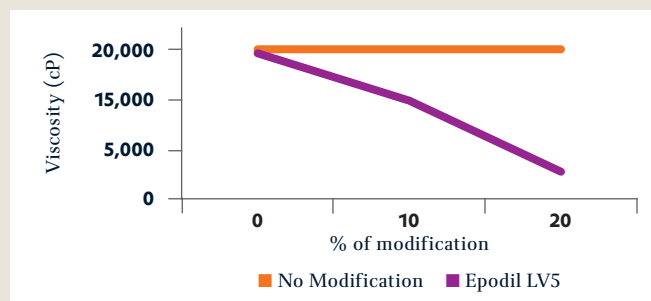
TABLE 1: COMPATIBILITY WITH LIQUID EPOXY RESIN AND CURING AGENTS

	Epodil LV5
Ancamide® 260A Curing Agent	Hazy
Ancamide® 350A	Hazy
Ancamide® 500	Compatible
Ancamine® K54	Compatible
Ancamine® 2089M Curing Agent	Compatible
Ancamine® 1618	Compatible
Ancamine® 2489	Compatible
Ancamine® 2280	Compatible
Ancamine® 2432	Compatible
Liquid Epoxy Resin (EEW=190)	Compatible
Solid epoxy resin supplied at 75% in xylene (EEW= 450 – 650)	Compatible

IMPACT OF EPODIL LV5 DILUENT ON LIQUID EPOXY RESIN VISCOSITY:

Epodil LV5 diluent reduces the viscosity of liquid epoxy resin, allowing the formulators to increase the fillers and or pigments concentration, or simply having a system with lower viscosity. Impact on liquid epoxy resin viscosity was evaluated by modifying the liquid epoxy resin with Epodil LV5 at 5 and 15 phr. The viscosity for each mixture was determined using a Brookfield viscosimeter after 24 hours. Figure 1 shows the impact of Epodil LV5 diluent on resin viscosity.

FIGURE 1: IMPACT ON LIQUID EPOXY RESIN VISCOSITY



INFLUENCE OF EPODIL LV5 DILUENT ON CURING AGENT REACTIVITY: Epodil LV5 diluent increases the pot life of ambient cured epoxy systems from 15 to 60%, depending on the curing agent and addition level of Epodil LV5 diluent. Influence on curing agent reactivity was determined by modifying the liquid epoxy resin with Epodil LV5 diluent at 5 and 15 phr.

The reactivity was measured by viscosity increase during the pot life; the viscosity was determined using a Brookfield viscosimeter.

The modified liquid epoxy resin and unmodified liquid epoxy resin were cured with Ancamine® 1618 and Ancamine® 2432 curing agents. Figure 2 and 3 shows the impact of Epodil LV5 diluent on curing agent reactivity.

FIGURE 2: IMPACT ON CURING AGENT REACTIVITY USING ANCAMINE® 1618 CURING AGENT

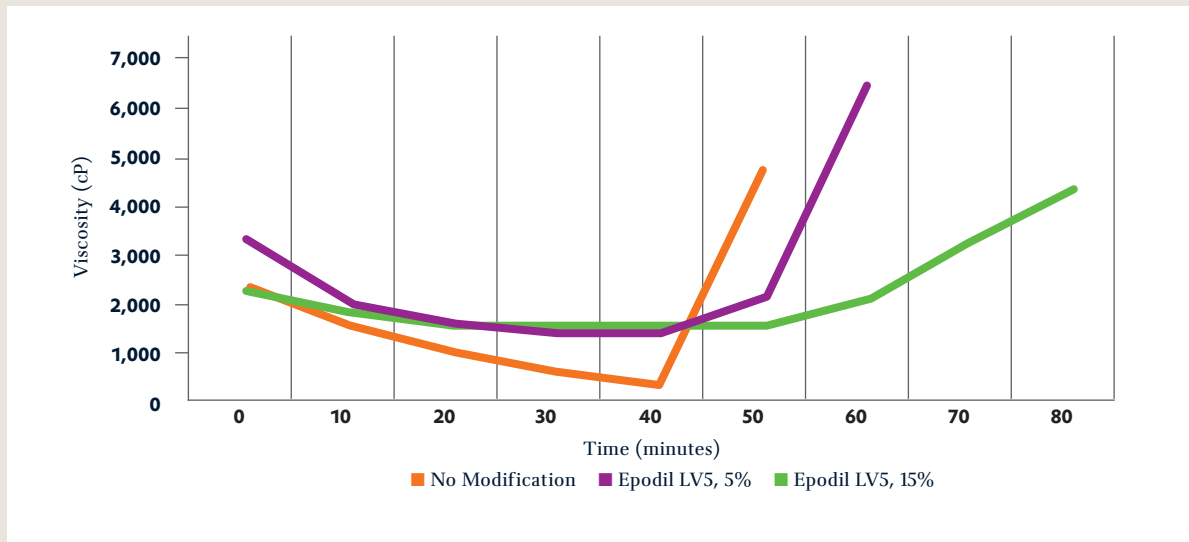
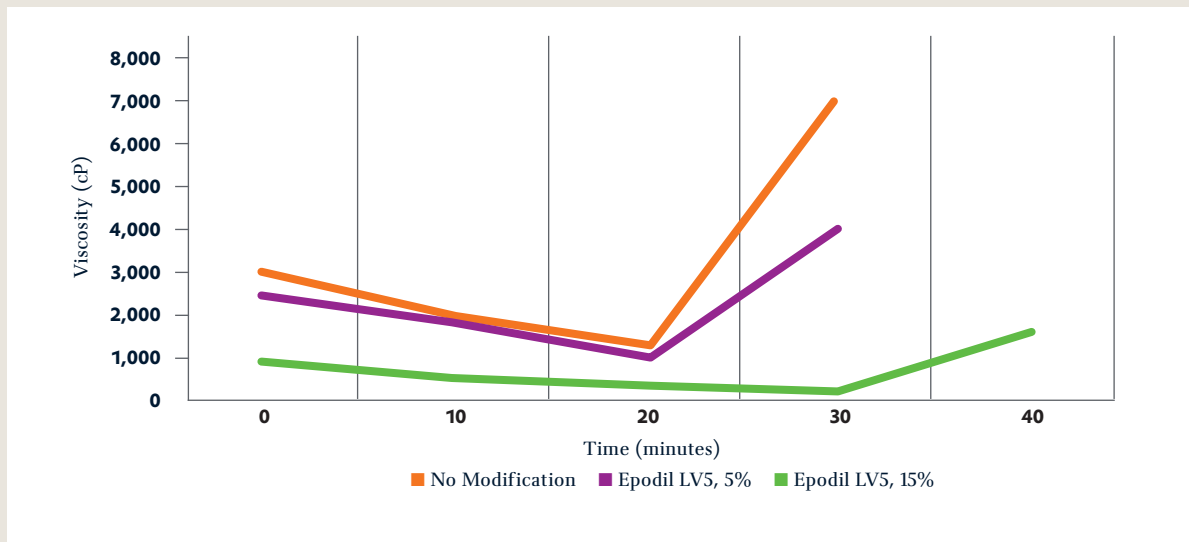


FIGURE 3: IMPACT ON CURING AGENT REACTIVITY USING ANCAMINE® 2432 CURING AGENT



INFLUENCE OF EPODIL LV5 DILUENT ON ADHESION: Epodil LV5 diluent reduces the surface tension of epoxy systems and as a consequence it helps to improve the adhesion of systems that do not have a good substrate wetting characteristic. Adhesion improvement is dependent of the curing agent being used as well as the addition level of Epodil LV5 diluent. For maximum performance tests varying the concentration of Epodil LV5 diluent are recommended.

To determine the influence of Epodil LV5 diluent on adhesion the liquid epoxy resin was modified with 5 and 15 phr of Epodil LV5 diluent. The curing agents selected for this evaluation were: Ancamine 1618, Ancamine 2280 and Ancamine 2432 curing agents. The clear coatings were brush-applied at a dry film thickness of 100 to 125µm (4-5 mils) over steel panels sandblasted to white metal (Sa3) and adhesion was measured following a 10 days of cure at room temperature. Adhesion was measured according to ASTM 3359 (tape adhesion) and ASTM 4541 (pull-off test). The same was made to evaluate an unmodified liquid epoxy resin was used as a control. Table 2 shows the adhesion of modified and unmodified systems.

TABLE 2: ADHESION OVER SANDBLASTED STEEL

		ASTM 3359	ASTM 4541 (KPa)
Ancamine® 1618	Unmodified liquid epoxy resin	5B	14
	Epodil® LV5	5 phr	25
		15 phr	17
Ancamine® 2280	Unmodified liquid epoxy resin	5B	20
	Epodil® LV5	5 phr	21
		15 phr	20
Ancamine® 2432	Unmodified liquid epoxy resin	5B	14
	Epodil® LV5	5 phr	23
		15 phr	27

NOTE: 5B=100% adhesion

INFLUENCE OF EPODIL LV5 DILUENT ON CHEMICAL RESISTANCE: Epodil LV5 diluent improves the resistance of epoxy systems to diluted chemicals and water. A special improvement was observed on 10% solution of acetic acid. The impact of Epodil LV5 diluent on chemical resistance is dependent on the curing agent as well the addition level of Epodil LV5 diluent.

The influence of Epodil LV5 diluent on the chemical resistance was determined by modifying the liquid epoxy resin (LER) with 5 and 15 phr. The modified epoxy resin was cured with Ancamide 350A, Ancamine 1618, Ancamine 2280 and Ancamine 2432 curing agents. To perform the chemical resistance test, the samples were cast and immersed in the various chemicals after a 10 day cure at room temperature. The chemical resistance was checked by weight gain or loss after 7 and 28 days. The results obtained are expressed on Table 3, 4, 5 and 6.

TABLE 3: CHEMICAL RESISTANCE OF LER CURED WITH ANCAMIDE 350A CURING AGENT

	Unmodified System		Epodil LV5			
			5 phr		15 phr	
	7 days	28 days	7 days	28 days	7 days	28 days
Water	0.21	0.92	0.22	0.63	0.24	0.80
NaCl 3.5%	0.24	0.71	0.23	0.78	0.22	0.87
NaOH 10%	0.24	0.68	0.26	0.69	0.24	0.78
H₂SO₄ 10%	1.43	2.98	0.74	1.73	0.60	1.10
MIBK	3.98	5.84	4.98	8.22	6.78	11.16
PM solvent	5.49	8.51	5.53	8.42	5.88	9.62
Xylene	9.61	15.28	10.80	18.44	11.60	21.52
Acetic acid 10%	7.83	17.17	3.44	7.62	2.63	5.58

Note: Results are expressed in %.

TABLE 4: CHEMICAL RESISTANCE OF LER CURED WITH ANCAMINE 1618 CURING AGENT

	Unmodified System		Epodil LV5			
	7 days	28 days	5 phr		15 phr	
			7 days	28 days	7 days	28 days
Water	0.21	0.48	0.21	0.46	0.18	0.40
NaCl 3.5%	0.20	0.44	0.19	0.43	0.18	0.41
NaOH 10%	0.18	0.41	0.19	0.40	0.15	0.33
H₂SO₄ 10%	0.39	0.81	0.30	0.68	0.20	0.48
MIBK	0.32	1.07	0.41	1.32	1.15	2.82
PM solvent	3.55	6.33	3.48	6.34	3.51	6.84
Xylene	-0.31	-0.20	-0.27	0.09	0.64	2.29
Acetic acid 10%	10.1	2.08	0.68	1.45	0.51	1.10

Note: Results are expressed in %.

TABLE 5: CHEMICAL RESISTANCE OF LER CURED WITH ANCAMINE 2280 CURING AGENT

	Unmodified System		Epodil LV5			
	7 days	28 days	5 phr		15 phr	
			7 days	28 days	7 days	28 days
Water	0.19	0.44	0.20	0.43	0.20	0.45
NaCl 3.5%	0.17	0.39	0.18	0.41	0.21	0.40
NaOH 10%	0.17	0.38	0.14	0.35	0.18	0.40
H₂SO₄ 10%	0.23	0.54	0.22	0.52	0.24	0.91
MIBK	0.04	0.44	0.10	0.64	1.15	2.09
PM solvent	2.14	4.58	2.33	4.45	3.06	6.34
Xylene	-0.16	-0.01	-0.10	0.29	1.00	2.09
Acetic acid 10%	0.87	1.98	0.73	1.65	0.54	1.34

Note: Results are expressed in %.

TABLE 6: CHEMICAL RESISTANCE OF LER CURED WITH ANCAMINE 2432 CURING AGENT

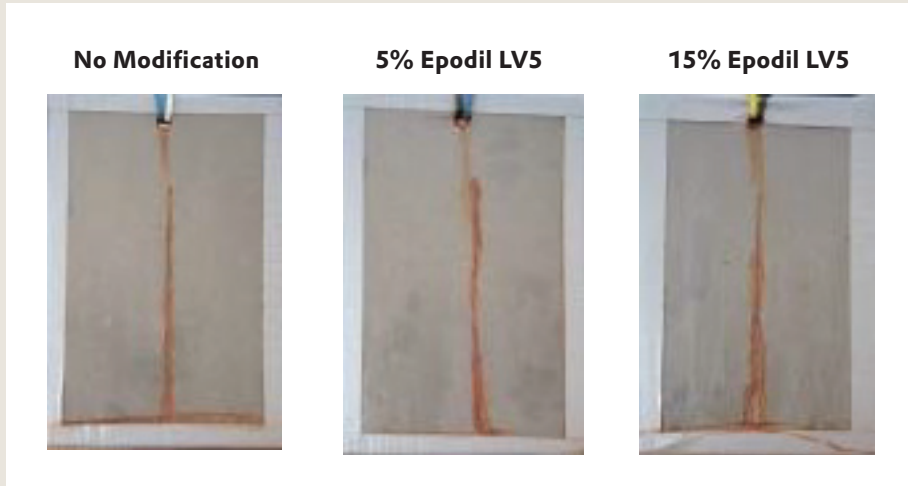
	Unmodified System		Epodil LV5			
	7 days	28 days	5 phr		15 phr	
			7 days	28 days	7 days	28 days
Water	0.17	0.43	0.17	0.40	0.16	0.38
NaCl 3.5%	0.14	0.36	0.20	0.38	0.13	0.33
NaOH 10%	0.15	0.36	0.17	0.38	0.18	0.37
H₂SO₄ 10%	0.27	0.62	0.27	0.59	0.24	0.51
MIBK	-0.26	-0.22	-0.22	-0.12	-0.26	0.02
PM solvent	0.55	1.35	0.82	1.73	1.21	2.42
Xylene	-0.21	-0.13	-0.13	-0.05	-0.19	0.08
Acetic acid 10%	0.62	1.32	0.54	1.10	0.42	0.88

Note: Results are expressed in %.

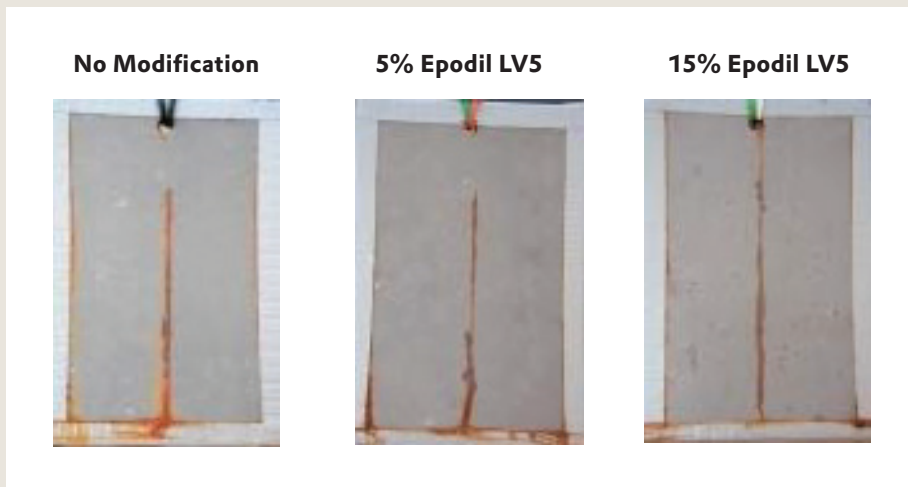
INFLUENCE OF EPODIL LV5 DILUENT ON CORROSION RESISTANCE: Epodil LV5 diluent when added to a coating formulation maintains the high levels of corrosion resistance observed with 2 component epoxy systems. This is demonstrated by the excellent data obtained following exposure to salt spray resistance weather testing.

To determine the influence of Epodil LV5 diluent on salt spray the liquid epoxy resin (LER) was modified with 5 and 15 phr of Epodil LV5 diluent. The curing agents selected for this evaluation were: Ancamide 350A, Ancamine 1618, Ancamine 2280 and Ancamine 2432 curing agent. The clear coatings were brush-applied at a dry film thickness of 100 to 125 μ m (4-5 mils) over steel panels sandblasted to white metal (Sa3). Salt spray test was performed according to ASTM B-117 after 10 days of cure at room temperature. Results obtained after 1,000 hours of exposure to salt spray cabinet are shown in pictures 1, 2, 3 and 4.

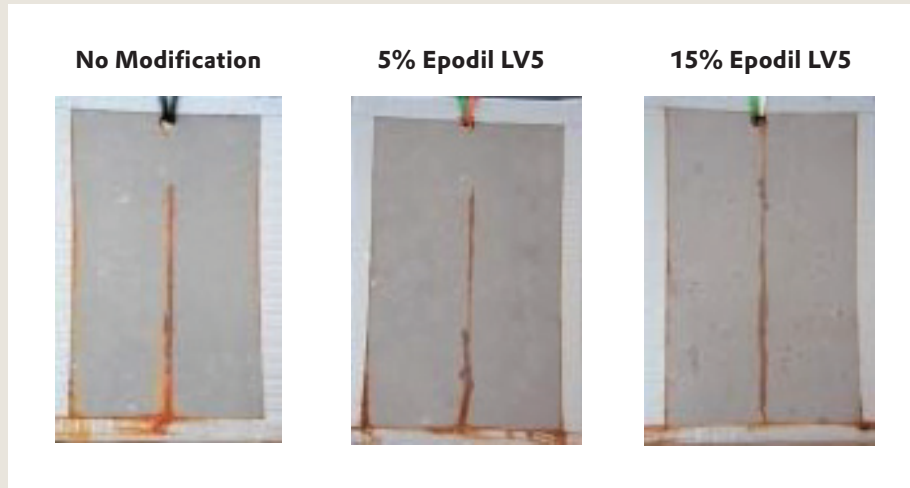
PICTURE 1: 1,000 HOURS SALT SPRAY OF LER CURED WITH ANCAMIDE 350A CURING AGENT



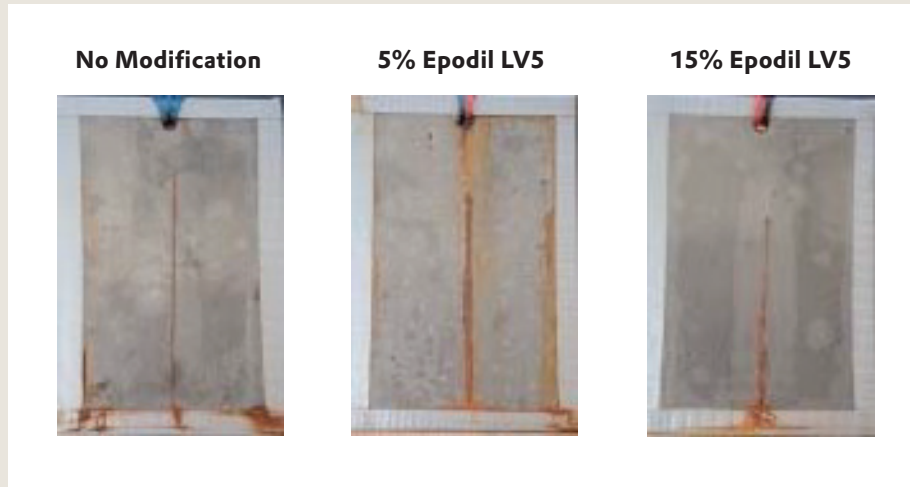
PICTURE 2: 1,000 HOURS SALT SPRAY OF LER CURED WITH ANCAMINE 1618 CURING AGENT



PICTURE 3: 1,000 HOURS SALT SPRAY OF LER CURED WITH ANCAMINE 2280 CURING AGENT



PICTURE 4: 1,000 HOURS SALT SPRAY OF LER CURED WITH ANCAMINE 2432 CURING AGENT



Epoxy Curing Agents and Modifiers

EPODIL® LV5 Diluent

EVONIK CORPORATION

7201 Hamilton Blvd.
Allentown, PA 18195
1 800 345-3148
Outside U.S. and Canada 1 610 481-6799

For Technical Information and Support:

Americas: picus@evonik.com
EMEA: apcse@evonik.com

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