

Dielectric oils



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REPSOL

*Centro de
Tecnología*

INDEX

INTRODUCTION

- REPSOL IN THE DIELECTRIC SECTOR..... 4
- MAIN CHARACTERISTICS 5
- STANDARDS..... 6

ELECTRA

- INTRODUCTION..... 7
- PRODUCTS..... 7
- CERTIFICATION AND PERFORMANCE..... 7

TENSIÓN CENTAURO

- INTRODUCTION..... 8
- PRODUCTS..... 8
- CERTIFICATION AND PERFORMANCE..... 8

ELECTRA vs TENSIÓN CENTAURO COMPARISON 9

BIO ELECTRA

- INTRODUCTION..... 10
- CHARACTERISTICS 10
- CERTIFICATION AND PERFORMANCE..... 10
- DIFFERENCES WITH MINERAL OIL 11

BIO ELECTRA SYNTH

- INTRODUCTION..... 12
- CHARACTERISTICS 12
- CERTIFICATION AND PERFORMANCE..... 12

TECHNICAL SPECIFICATIONS

- ELECTRA 3..... 13
- TENSIÓN CENTAURO 14
- ELECTRA 3X 15
- TENSIÓN CENTAURO X 16
- ELECTRA 3X PLUS 17
- ELECTRA 1X..... 18
- BIO ELECTRA..... 19
- BIO ELECTRA SYNTH 20

COMMERCIAL OFFICES 21

INTRODUCTION

REPSOL IN THE DIELECTRIC SECTOR

Repsol is an integrated global energy company which develops exploration, production, refining, distribution and marketing activities in more than 90 countries.

Repsol Lubricantes y Especialidades, part of the Repsol group, carries out the development, manufacture and marketing of lubricant oils. It develops a wide range of industrial lubricants using the best resources, research and technology.

The range of industrial oils includes dielectric oils, a sector in which Repsol has more than 60 years' proven experience. These oils are used as insulating and coolant fluids in transformers and switchgear.

Repsol has production centres where high-quality lubricant base oils are refined and its oils are mixed and packaged. The highest and most demanding quality standards are met throughout the oil production process, from design to manufacture.

At Repsol we not only market high-quality, reliable products, but our professional and specialised team also provides the best technical advice and assistance. Repsol's range of dielectric oils complies with the IEC 60296 and ASTM D3487 international standards, and includes different types of inhibited and uninhibited oils: paraffinic, naphthenic and esters. These oils are marketed under the following names:

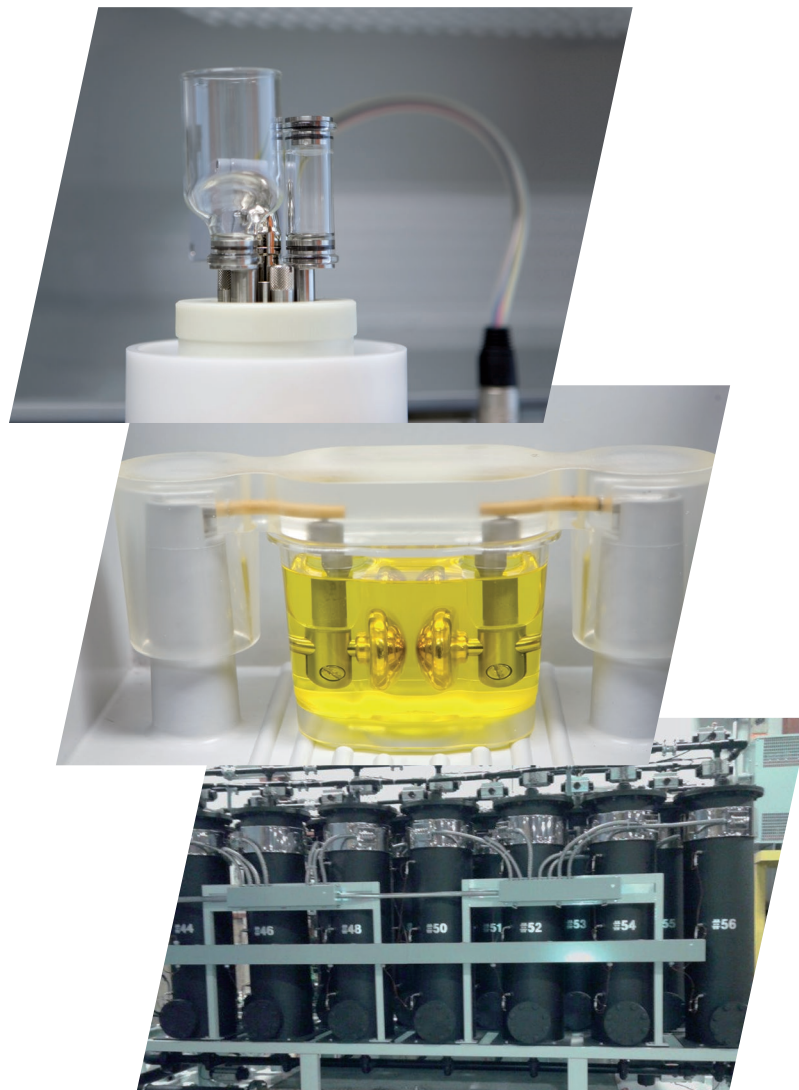
Dielectric oils		
Name	Type	Additives
Repsol Electra 3	Paraffinic	Uninhibited
Repsol Electra 3X	Paraffinic	Inhibited
Repsol Electra 3X Plus	Paraffinic	Inhibited
Repsol Electra 1X (for the Latin American market)	Paraffinic	Inhibited
Repsol Tensión Centauro	Naphthenic	Uninhibited
Repsol Tensión Centauro X	Naphthenic	Inhibited
Repsol Bio Electra	Vegetable ester	Uninhibited
Repsol Bio Electra Synth	Synthetic ester	Inhibited

We are also committed to technological innovation as a key element to provide our customers with a better service. This commitment is made clear at the Repsol Technology Centre: a leading centre in Europe, from where we promote R&D&i and continue to work on the development of new dielectric oils.



MAIN CHARACTERISTICS

- Cooling of components: dielectric oil is able to transfer the heat generated by the resistance of metal conductors and windings to the exterior.
- The oil also has the function of insulating the metal components of the transformer.
- Dielectric oil must have excellent antioxidant properties as it has to maintain its properties over long periods of time.
- To ensure that the transformer operates properly, it is therefore necessary to guarantee that the oil has excellent properties:
 - High dielectric strength: the capacity of an oil to resist the voltage between the windings of a transformer, preventing the formation of arcs and electrical discharges. It is very sensitive to the presence of free water.
 - Viscosity: low viscosity allows the circulation of the oil and consequently results in better heat transfer.
 - Loss factor: enables dielectric losses caused by the oil to be quantified. The presence of polar pollutants changes the direction of the electric field, using up more energy.
 - Interfacial tension: an indirect measurement of the amount of polar compounds present in the oil. It is an indicator of the presence of polar acids resulting from degradation of the oil.



STANDARDS

As the electricity generation/distribution systems are unique to each country, the fluids used in electro-technical applications have to meet different standards.

However, these particular requirements are based on two global standards: IEC 60296 and ASTM D3487:

- IEC 60296 is the standard applied in Europe and its catchment area (Africa, Russia and Western Asia).
 - For special applications, Section 7.1 (Higher oxidation stability and low sulphur content) may be required.
- ASTM D3487 is the standard applied in the USA, Latin America and Eastern Asia.

The properties required from the oil may be achieved using oils of different natures. The standards only make a distinction between oils with or without additives (inhibited or uninhibited).



INTRODUCTION

ELECTRA oils are light, paraffinic oils designed specifically for use as insulating fluid in electrical equipment such as power and distribution transformers, circuit breakers, rheostats, etc. In general, they can be used in any kind of electrical appliance requiring an oil bath which acts as a dielectric or coolant.

They are manufactured from highly-refined treated base oils which ensure the lack of any solid, polar or water compounds. The hydrogenation process guarantees that they do not contain any corrosive sulphur, which has been proven to be extremely damaging to transformers.

They are highly stable to oxidation and non-corrosive to copper. Their low pour point and viscosity means that they provide excellent heat transfer under any operating conditions.

PRODUCTS

Uninhibited oils:

- **ELECTRA 3:** complies with the IEC 60296 and ASTM D3487 Type I standards.

Inhibited oils formulated with antioxidant additives:

- **ELECTRA 3X:** complies with the IEC 60296 and ASTM D3487 Type II standards.
- **ELECTRA 3X PLUS:** oil formulated with isoparaffinic base stock which complies with the IEC 60296 and ASTM D3487 Type II standards. It also complies with Section 7.1 of the IEC 60296 standard (Higher oxidation stability and low sulphur content).

CERTIFICATION AND PERFORMANCE

ELECTRA oils are widely used by both transformer manufacturers and electricity companies. In order to make this possible, they have been submitted to various independent laboratories for validation, and are currently certified by the following companies:

- ELECTRICITY COMPANIES: **Endesa, Iberdrola, EDP (Energias de Portugal), EDF (Electricité de France).**
- TRANSFORMER and ELECTRICAL EQUIPMENT MANUFACTURERS: **SIEMENS, ABB.**

They are tested annually in inter-laboratory trials by **DOBLE ENGINEERING Co.**



TENSIÓN CENTAURO

INTRODUCTION

TENSIÓN CENTAURO oils are light, naphthenic oils, particularly recommended for use as insulating fluid in electrical equipment such as power and distribution transformers, circuit breakers, rheostats, etc. In general, they can be used in any kind of electrical appliance requiring an oil bath which acts as a dielectric or coolant.

Their production process ensures the lack of any solid, polar or water compounds, as well as the lack of any corrosive sulphur, which has been proven to be extremely damaging to transformers.

TENSIÓN CENTAURO is highly stable to oxidation and non-corrosive to copper. Its low pour point and viscosity means that it provides excellent heat transfer under any operating conditions.

PRODUCTS

Uninhibited oils:

- **TENSIÓN CENTAURO:** complies with the IEC 60296 and ASTM D3487 Type I standards.

Inhibited oils formulated with antioxidant additives:

- **TENSIÓN CENTAURO X:** complies with the IEC 60296 and ASTM D3487 Type II standards.



CERTIFICATION AND PERFORMANCE

TENSIÓN CENTAURO oils are widely used by both transformer manufacturers and electricity companies. In order to make this possible, they have been submitted to various independent laboratories for validation, and are currently certified by the following companies:

- ELECTRICITY COMPANIES: **Endesa, Iberdrola, EDP (Energias de Portugal), EDF (Electricité de France).**
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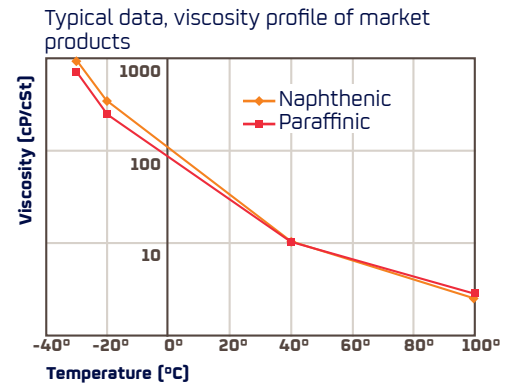
They are tested annually in inter-laboratory trials by **DOBLE ENGINEERING Co.**

ELECTRA vs TENSIÓN CENTAURO COMPARISON

Knowing that the products to be compared are dielectric oils, and therefore comply with the requirements of the IEC 60296 standard, the differences between them must be the result of their different chemical nature:

- The value of the freeze point for naphthenic oils is lower. However, viscosity at low temperature is greater for naphthenic oils than for paraffinic oils. At operating temperature [90 °C] the differences are minimal.
- The value of the flash point for paraffinic oils is around 30 °C higher than that for naphthenic oils, resulting in a bigger safety margin.

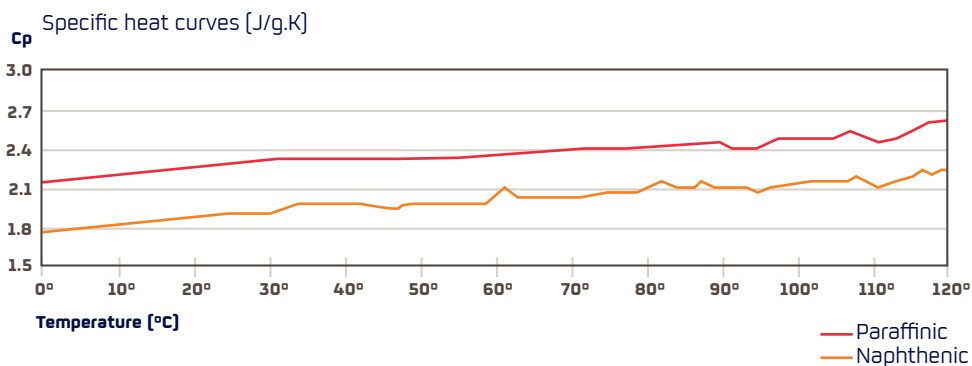
Characterisation	Unit	Naphthenic	Paraffinic
Viscosity at -30 °C	cP	930	740
Viscosity at -20 °C	cP	340	250
Viscosity at 40 °C	mm ² /s	10.2	10.5
Viscosity at 100 °C	mm ² /s	2.6	2.7
Viscosity Index		69	102



- In certain cases, naphthenic oils show a greater tendency than paraffinic oils to form and generate gasses. In certain specific tests [“stray gas” ASTM D7150], this leads to higher values.
- Paraffinic oils have a higher thermal capacity, which enables the transformer to be kept at a lower temperature.

Typical values

	RP Electra 3 %	RP Tensión Centauro %
Aromatic	5.1	9.5
Naphthenic	36.2	48.8
Paraffinic	58.7	41.7
	Paraffinic	Naphthenic



In summary:

- Naphthenic nature: good freeze point (PC<-50 °C) but flash points around 135-140 °C.
- Paraffinic nature: freeze point above that of naphthenic oils but more fluid at low temperature and higher flash points [170-180 °C].

INTRODUCTION

BIO ELECTRA dielectric oil is formulated with a percentage of over 99 % vegetable oils and without the presence of synthetic antioxidants. Its composition does not include silicones, halogens or any other component which could entail a risk to health or the environment. This high vegetable oil content means that it is a readily biodegradable oil which is non-toxic for aquatic and terrestrial ecosystems.

Its high fire point means that it is extremely safe. It is a fluid that reduces the risk of fire and the resulting consequences.

This product is suitable for new electrical equipment and for filling equipment previously operated with other types of dielectric fluids. It is recommended for equipment where there is no contact with the air.

BIO ELECTRA bioelectric oil has a fire point over 300 °C and is classified as a type-K fluid in accordance with the IEC 61100 standard.

CHARACTERISTICS

Main characteristics

Properties	Typical value
Viscosity at 40 °C	39.2 cSt
Pour point	-25 °C
Dielectric loss factor at 90 °C	0.03
Dielectric breakdown voltage	65 KV

CERTIFICATION AND PERFORMANCE

BIO ELECTRA complies with the IEC 62770:2013 standard.



DIFFERENCES WITH MINERAL OIL

BIO ELECTRA oil is based on natural polar triglycerides. There are significant differences with mineral oils as far as their chemical composition is concerned. The latter are made up of three main types of molecules: paraffinic, naphthenic and aromatic. These differences result in the different performances shown below:

- **Flammability.** The lack of compounds with low molecular weight and high volatility results in a fire point which is significantly higher in BIO ELECTRA oils when compared with that of mineral oils.
- **Pour point.** BIO ELECTRA oil bases its high resistance to oxidation on the presence of molecular structures which crystallise at higher temperatures than those found in mineral oils.
- **Gassing tendency.** BIO ELECTRA oil acts as a “gas absorber” when compared with mineral oils, which act as a “gas generator”.
- **Water saturation.** The high polarity of BIO ELECTRA oil means that its water saturation values are significantly higher than those found in mineral oil.
- **Compatibility with cellulose insulation.** BIO ELECTRA oil extends the life of the cellulose insulation mainly due to its greater capacity to capture water.
- **Influence of water presence on the dielectric properties.** The greater capacity of BIO ELECTRA oil to absorb water without reaching saturation means that the water content has a lower influence on the dielectric properties of the fluid.
- **Resistance to oxidation.** BIO ELECTRA oil has a low tendency to generate sludge and deposits. It is recommended for fully-filled sealed distribution transformers, without air chambers.



INTRODUCTION

Dielectric oil for transformers based on synthetic esters, manufactured from raw materials especially selected so as to obtain a high-performance fluid. It offers excellent oxidation stability whilst also having a very low pour point. It is therefore suitable for cold climates.

It provides increased safety for installations and the environment as a result of its excellent fire properties and is highly biodegradable. It is therefore suitable for cases where a fluid with a high flash point is required or when priority is given to sustainability and environmental factors.

It has the following properties:

- High oxidative stability.
- Highly biodegradable.
- Wide range of working temperatures.
- Outstanding performance at very low temperature.
- Excellent fire properties: fire point over 300 °C, classified as a K3 type fluid in accordance with the IEC 61100 standard.

CHARACTERISTICS

Main characteristics

Properties	Typical value
Viscosity at 40 °C	27.4 cSt
Pour point	-50 °C
Flash point	255
Biodegradability	72 %

CERTIFICATION AND PERFORMANCE

BIO ELECTRA SYNTH complies with the IEC 61099 standard.



TECHNICAL SPECIFICATIONS

ELECTRA 3

Values according to IEC 60296:2012 standard.

Main characteristics					
Properties	Units	Method	Guaranteed value		Typical value
			Min.	Max.	
Physical properties					
Appearance		Visual	Bright and clear		
Density at 20 °C	g/cm ³	ISO 12185		0.895	0.84
Viscosity at 40 °C	mm ² /s	ASTM D445		12	10.3
Viscosity at 100 °C	mm ² /s	ASTM D445		3	2.7
Viscosity at -30 °C	mm ² /s	ASTM D445		1800	807
Pour point	°C	ASTM D97		-40	-48
Interfacial tension	dynes/cm	ASTM D971	40		42
Chemical properties					
Acidity	mg KOH/g	ASTM D974		0.01	<0.01
Potentially corrosive sulphur	IEC 62535		Non-corrosive		
Corrosive sulphur	-	DIN 51353	Non-corrosive		
Corrosive sulphur	ASTM D1275B		Non-corrosive		
Antioxidant additive	% weight	IEC 60666	Exempt		
Water content	mg/kg	IEC 60814		30	15
Furfural content	mg/kg	IEC 61198		0.05	<0.05
Electrical properties					
Dielectric loss factor at 90 °C	-	IEC 60247		0.005	0.00074
Interfacial tension	mN/m	UNE 21320	40		42
Dielectric breakdown voltage		IEC 60156			
Untreated	kV		30		35
Treated	kV		70		>70
Oxidation stability IEC 61125C [164 h / 120 °C]					
Total acidity	mg KOH/g	IEC 61125C		1.2	0.39
Sludge	% weight	IEC 61125C		0.8	0.084
Dielectric loss factor at 90 °C	-	IEC 61125C		0.5	0.0707
Health, safety and the environment					
Flash point	°C	ASTM D93	160		170
PCA content	% weight	IP 346		3	0.8
PCB content	% weight	IEC 61619	Exempt		

TENSIÓN CENTAURO

Values according to IEC 60296:2012 standard.

Main characteristics					
Properties	Units	Method	Guaranteed value		Typical value
			Min.	Max.	
Physical properties					
Appearance		Visual	Bright and clear		
Density at 20 °C	g/cm ³	ISO 12185		0.895	0.87
Viscosity at 40 °C	mm ² /s	ASTM D445		12	9.6
Viscosity at 100 °C	mm ² /s	ASTM D445			2.4
Viscosity at -30 °C	mm ² /s	ASTM D445		1800	940
Pour point	°C	ASTM D5950		-45	-51
Interfacial tension	dynes/cm	ASTM D971	40		45
Chemical properties					
Acidity	mg KOH/g	ASTM D974		0.01	<0.01
Potentially corrosive sulphur	IEC 62535		Non-corrosive		
Corrosive sulphur	-	DIN 51353	Non-corrosive		
Corrosive sulphur	ASTM D1275B		Non-corrosive		
Antioxidant additive	% weight	IEC 60666	Exempt		
Water content	mg/kg	IEC 60814		30	15
Furfural content	mg/kg	IEC 61198		0.05	<0.05
Electrical properties					
Dielectric loss factor at 90 °C	-	IEC 60247		0.005	0.00075
Interfacial tension	mN/m	UNE 21320	40		46
Dielectric breakdown voltage		IEC 60156			
Untreated	kV		30		40
Treated	kV		70		>70
Oxidation stability IEC 61125C (164 h / 120 °C)					
Total acidity	mg KOH/g	IEC 61125C		1.2	0.31
Sludge	% weight	IEC 61125C		0.8	0.097
Dielectric loss factor at 90 °C	-	IEC 61125C		0.5	0.055
Health, safety and the environment					
Flash point	°C	ASTM D93	135		150
PCA content	% weight	IP 346		3	<3
PCB content	% weight	IEC 61619	Exempt		

ELECTRA 3X

Values according to ASTM D3487 standard.

Main characteristics					
Properties	Units	Method	Guaranteed value		Typical value
			Min.	Max.	
Physical properties					
Appearance	-	ASTM D1524	Bright and clear		
Colour	-	ASTM D1500		0.5	L0.5
Relative density at 15 °C	g/cm ³	ASTM D1298		0.91	0.873
Viscosity at 0 °C	cSt	ASTM D445		76.0	63.96
Viscosity at 40 °C	cSt	ASTM D445		12.0	10.85
Viscosity at 100 °C	cSt	ASTM D445		3.0	2.79
Pour point	°C	ASTM D97		-40	-42
Aniline point	°C	ASTM D611	63		96.4
Interfacial tension	dynes/cm	ASTM D971	40		43
Chemical properties					
Acidity	mg KOH/g	ASTM D974		0.03	<0.01
Corrosive sulphur	-	ASTM D1275B	Non-corrosive		
Water content	ppm	ASTM D1533		35	19
Inhibitor content	% weight	ASTM D2668		0.3	0.3
Electrical properties					
Dielectric dissipation factor (DDF)					
60 Hz, 25 °C	%	ASTM D924		0.05	0.009
60 Hz, 100 °C	%	ASTM D924		0.30	0.194
Breakdown voltage					
Breakdown voltage at 60 Hz - disk electrodes	kV	ASTM D877	30		61
Breakdown voltage at 60 Hz - VDE electrodes	kV	ASTM D1816			
0.04 in. [1.02 mm] gap			20		35
0.08 in. [2.03 mm] gap			35		
Breakdown voltage - impulse conditions, 25 °C 1-in. [25.4-mm] gap	kV	ASTM D3300	145		244
Gassing tendency	uL/min	ASTM D2300		30	15.4
Oxidation stability					
Acid-sludge test					
TAN	mg KOH/g	ASTM D2440		0.3 [72 h] 0.4 [164 h]	<0.01 <0.01
Sludge	% weight	ASTM D2440		0.1 [72 h] 0.2 [164 h]	<0.01 <0.01
Rotating bomb test	min	ASTM D2112	195		366
Health, safety and the environment					
Flash point	°C	ASTM D92	145		178
PCB content	ppm	ASTM D4059	Undetectable		

TENSIÓN CENTAURO X

Values according to ASTM D3487 standard.

Main characteristics					
Properties	Units	Method	Guaranteed value		Typical value
			Min.	Max.	
Physical properties					
Appearance	-	ASTM D1524	Bright and clear		
Colour	-	ASTM D1500		0.5	L0.5
Relative density at 15 °C	g/cm ³	ASTM D1298		0.91	0.873
Viscosity at 0 °C	cSt	ASTM D445		76.0	67.29
Viscosity at 40 °C	cSt	ASTM D445		12.0	9.99
Viscosity at 100 °C	cSt	ASTM D445		3.0	2.48
Pour point	°C	ASTM D97		-40	-48
Aniline point	°C	ASTM D611	63		82
Interfacial tension	dynes/cm	ASTM D971	40		45
Chemical properties					
Acidity	mg KOH/g	ASTM D974		0.03	<0.01
Corrosive sulphur	-	ASTM D1275B	Non-corrosive		
Water content	ppm	ASTM D1533		35	22
Inhibitor content	% weight	ASTM D2668		0.3	0.3
Electrical properties					
Dielectric dissipation factor (DDF)					
60 Hz, 25 °C	%	ASTM D924		0.05	0.004
60 Hz, 100 °C	%	ASTM D924		0.30	0.142
Breakdown voltage					
Breakdown voltage at 60 Hz - disk electrodes	kV	ASTM D877	30		56
Breakdown voltage at 60 Hz - VDE electrodes	kV	ASTM D1816			
0.04 in. (1.02 mm) gap			20		38
0.08 in. (2.03 mm) gap			35		
Breakdown voltage - impulse conditions, 25 °C 1-in. (25.4-mm) gap	kV	ASTM D3300	145		>300
Gassing tendency	uL/min	ASTM D2300		30	15.4
Oxidation stability					
Acid-sludge test					
TAN	mg KOH/g	ASTM D2440		0.3 (72 h) 0.4 (164 h)	<0.01 <0.01
Sludge	% weight	ASTM D2440		0.1 (72 h) 0.2 (164 h)	<0.01 <0.01
Rotating bomb test	min	ASTM D2112	195	0.5	295
Health, safety and the environment					
Flash point	°C	ASTM D92	145		154
PCB content	ppm	ASTM D4059	Undetectable		

ELECTRA 3X PLUS

Values according to IEC 60296:2012 standard.

Main characteristics					
Properties	Units	Method	Guaranteed value		Typical value
			Min.	Max.	
Physical properties					
Appearance		Visual	Bright and clear		
Density at 20 °C	g/cm ³	ISO 12185		0.895	0.82
Viscosity at 100 °C	mm ² /s	ASTM D445			3
Viscosity at 40 °C	mm ² /s	ASTM D445		12	11.1
Viscosity at -30 °C	mm ² /s	ASTM D445		1800	392
Pour point	°C	ISO 3016		-40	-65
Interfacial tension	mN/m	UNE 21320	40		52
Chemical properties					
Acidity	mg KOH/g	IEC 62021-2		0.01	<0.01
Corrosive sulphur	-	DIN 51353	Non-corrosive		
Corrosive sulphur	-	ASTM D1275B	Non-corrosive		
Potentially corrosive sulphur	-	IEC 62535	Non-corrosive		
Total sulphur content	%	ASTM D2622		0.050	0.0001
Water content	mg/kg	IEC 60814		30	11.5
Inhibitor content	% weight	IEC 60666		0.4	0.3
DBDS	mg/kg	IEC 62697-1	Undetectable		
Furfural content	mg/kg	IEC 61198	Undetectable for each component [<0.05]		
Electrical properties					
Dielectric loss factor at 90 °C	-	IEC 60247		0.005	0.0004
Breakdown voltage		IEC 60156			
Untreated	kV		30		63
Treated	kV		70		>70
Oxidation stability IEC 61125C (500 h / 120 °C)					
Total acidity	mg KOH/g	IEC 61125C		0.3	0.161
Sludge	% weight	IEC 61125C		0.05	Undetectable
Dielectric loss factor at 90 °C	-	IEC 61125C		0.05	0.0002
Health, safety and the environment					
Flash point	°C	ASTM D93	135		193
PCA content	% weight	IP 346		3	0.8
PCB content	% weight	IEC 61619	Exempt		

ELECTRA 1X

Values according to ASTM D3487 standard.

Main characteristics					
Properties	Units	Method	Guaranteed value		Typical value
			Min.	Max.	
Physical properties					
Appearance	-	ASTM D1524	Bright and clear		
Colour	-	ASTM D1500		0.5	0.5
Relative density at 15 °C	g/cm ³	ASTM D1298		0.91	0.855
Viscosity at 0 °C	cSt	ASTM D445		76.0	68.3
Viscosity at 40 °C	cSt	ASTM D445		12.0	11.3
Viscosity at 100 °C	cSt	ASTM D445		3.0	2.8
Pour point	°C	ASTM D97		-40	-26
Aniline point	°C	ASTM D611	63		91.8
Interfacial tension	dynes/cm	ASTM D971	40		41
Chemical properties					
Acidity	mg KOH/g	ASTM D974		0.03	<0.01
Corrosive sulphur	-	ASTM D1275B	Non-corrosive		
Water content	ppm	ASTM D1533		35	29
Inhibitor content	% weight	ASTM D2668		0.3	0.3
Electrical properties					
Dielectric dissipation factor (DDF)					
60 Hz, 25 °C	%	ASTM D924		0.05	0.002
60 Hz, 100 °C	%	ASTM D924		0.30	0.167
Breakdown voltage					
Breakdown voltage at 60 Hz - disk electrodes	kV	ASTM D877	30		47
Breakdown voltage at 60 Hz - VDE electrodes	kV	ASTM D1816			
0.04 in. (1.02 mm) gap			20		28
0.08 in. (2.03 mm) gap			35		
Breakdown voltage - impulse conditions, 25 °C 1-in. (25.4-mm) gap	kV	ASTM D3300	145		178
Gassing tendency	uL/min	ASTM D2300		30	
Oxidation stability					
Acid-sludge test					
TAN	mg KOH/g	ASTM D2440		0.3 [72 h] 0.4 [164 h]	0.01 <0.01
Sludge	% weight	ASTM D2440		0.10 [72 h] 0.30 [164 h]	0.01 <0.01
Rotating bomb test	min	ASTM D2112	195	0.5	255
Health, safety and the environment					
Flash point	°C	ASTM D92	145		186
PCB content	ppm	ASTM D4059	Undetectable		

BIO ELECTRA

Values according to IEC 62770:2013 standard.

Main characteristics					
Properties	Units	Method	Guaranteed value		Typical value
			Min.	Max.	
Physical properties					
Appearance	-	ASTM D1524	Bright and clear		
Density at 20 °C	g/cm ³	ASTM D4052		1.00	0.91
Viscosity at 0 °C	mm ² /s	ASTM D445		500	275.9
Viscosity at 40 °C	mm ² /s	ASTM D445		50	39.2
Viscosity at 100 °C	mm ² /s	ASTM D445		15	8.5
Pour point	°C	ASTM D97		-10	-25
Coefficient of thermal expansion 0-50 °C	°C ⁻¹	ASTM D1903			0.00072
Thermal conductivity at 25 °C	W/K m	ASTM D2717			0.1691
Specific heat at 25 °C	J/K g	ASTM D2766			1.97
Chemical properties					
Soluble acidity	mg KOH/g	IEC 62021-3		0.06	0.05
Water content	mg/kg	IEC 60814		200	150
DBDS	mg/kg	IEC 62697-1	Undetectable		
Electrical properties					
Dielectric dissipation factor at 90 °C, 50 Hz	-	IEC 60247		0.05	0.03
Breakdown voltage [on delivery]	kV	IEC 60156	35		65
Electrical conductivity at 25 °C	pS/m	ASTM D2624			3
Dielectric constant at 25 °C	-	IEC 60247			3.1
Gassing tendency	µl/min	IEC 60628A			-31.2
Oxidation stability		IEC 61125C			
Total acidity	mg KOH/g	IEC 61125C		0.6	0.38
Viscosity at 40 °C	% increase	ISO 3104		30	14.1
Dielectric dissipation factor at 90 °C and 50 Hz		IEC 60247		0.500	0.120
Health, safety and the environment					
Fire point	°C	ASTM D92	300		362
Flash point	°C	ASTM D92	250		330
Biodegradability after 28 days	%	OECD 301B	60		85
Aquatic ecotoxicity	mg/l	OECD 201 OECD 202 OECD 203	100 100 100		>1000 >1000 >1000
Terrestrial ecotoxicity	mg/kg	OECD 207 OECD 208	100 100		>1000 >1000

BIO ELECTRA SYNTH

Values according to ASTM D3487 standard.

Main characteristics					
Properties	Units	Method	Guaranteed value		Typical value
			Min.	Max.	
Physical properties					
Appearance	-	Visual	Bright and clear		
Colour	-	ISO 2211	200 Hazen		30
Density at 20 °C	g/cm ³	ISO 12185		1.000	0.969
Viscosity at -20 °C	mm ² /s	ASTM D445		3000	1196
Viscosity at 40 °C	mm ² /s	ASTM D445		35	27.4
Pour point	°C			-45	-50
Chemical properties					
Acidity	mg KOH/g	ISO 6618		0.03	0.01
Water content	mg/kg	IEC 60814		200	22
Electrical properties					
Dielectric breakdown voltage	kV	IEC 60156	45		77
Dielectric dissipation factor and loss tangent at 90 °C and 50 Hz	-	IEC 60247		0.03	0.005
Resistance at 90 °C on continuous current	G Ohm.m	IEC 60247	2		7.4
Oxidation stability			IEC 61125C (164 h)		
Soluble acidity	mg KOH/g	IEC 61125C			0.04
Volatile acidity	mg KOH/g	IEC 61125C			0.01
Total acidity	mg KOH/g	IEC 61125C		0.3	0.05
Sludge totals	% (m/m)	IEC 61125C		0.01	0.01
Health, safety and the environment					
Fire point	°C	ISO 2592	300		308
Flash point	°C	ISO 2719	250		255
Biodegradability after 28 days	%	OECD 301B	60		72
Aquatic ecotoxicity	mg/l	OECD 201	100		>1000
		OECD 202	100		>1000
		OECD 203	100		>1000

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