

BLUESIL FLD 604V50

Description	<p>The following dielectric liquids are used to provide insulation and cooling in submerged transformers:</p> <ul style="list-style-type: none"> • Mineral oils, which have the disadvantage of being inflammable, • Silicone oils, esters, etc <p>BLUESIL FLD 604V50 is a dielectric liquid consisting of polydimethylsiloxane, whose purity has been checked especially for electrotechnical applications.</p> <p>BLUESIL FLD 604V50 is mainly used as an insulation and cooling medium for transformers and, more generally, for all medium tension equipment (switch boxes, chokes, capacitors, resistors, etc.) when environmental or fire safety problems arise, such as in public places, built-up areas, basements, proximity to water streams, etc.</p> <p>BLUESIL FLD 604V50 offers the following advantages:</p> <ul style="list-style-type: none"> • Excellent dielectric properties • Excellent thermal stability • Remarkable chemical inertia and strength • Good heat transfer properties • Non-propagation of fire • Not dangerous for man or the environment
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Examples of applications	Please consult your local ELKEM SILICONES sales office.
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Key benefits	Please consult your local ELKEM SILICONES sales office.
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Typical properties	BLUESIL FLD 604V50
Viscosity NF T 76102	50 mm ² /s

The general characteristics enabling the product to be identified are contained in table 1. Other characteristics, more closely linked to the use as a dielectric fluid, are given in the following tables :

- Tables 2 to 5: Dielectric properties
- Table 6: Heat transfer
- Tables 7 and 8: Fire risk
- Table 9: Compatibility of materials

Appearance.....	clear liquid
Coloration (Hazen).....	30 max
Odour.....	no
pH, approx.....	6.7
Density at 25°C approx.....	0.960
Viscosity at 25°C, mm ² /s, approx.....	50
Flash point, °C (AFNOR NF T 60 118 standard).....	280 °C
Melting point, °C approx.....	- 50
Refractive index at 25°C approx.....	1.402
Surface tension at 25°C mN/m, approx.....	20.7
Volatile matter (24 hrs. at 150°C), %.....	0.5 max
<u>Dielectric properties</u>	

Four criteria play a part in the choice of a dielectric fluid for transformers:

- Low dielectric coefficient,
- Low tangent of loss angle,
- High voluminal resistivity
- Above all, high dielectric strength.

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These four factors are combined in BLUESIL FLD 604V50 as is shown in table 2.

1. Dielectric loss

The dielectric constant is the tangent of the angle of loss giving an indication of the energy dissipated in a dielectric fluid in the form of heat.

It should be noted that, in the case of the BLUESIL FLD 604V50, an increase in temperature results in a decrease of the dielectric coefficient - this is beneficial - while the tangent delta remains practically unchanged.

2. Dielectric strength

2 - 1 Measurement methods

Two methods are currently used to measure this value:

- Method CEI 5¹ with spherical electrodes or in an open cup
- ASTM² method with flat electrodes.

	BLUESIL FLD 604 V 50	MINERAL OIL
Dielectric coefficient at 50/60 Hz, • at 25 °C • at 75 °C • at 100°C (CEI 247 - AFNOR NF C 27 210 standards)	2.7 2.6 2.5	2.2 -- --
Tangent of loss angle at 50/60 Hz, • at 23 °C • at 75 °C • at 100 °C (CEI 247 - AFNOR NF C 27 210 standards)	3.10 ⁻⁵ max. 5.10 ⁻⁵ 3.10 ⁻⁵	1.10-4 -- --
Voluminal resistivity, in Ω.cm, (ASTM D 1169, CEI 247 and AFNOR NF C 27 210 standards) • at 23 °C • at 75 °C • at 100 °C	1.10 ¹⁵ min. 8.10 ¹⁴ 1.10 ¹⁴	2.5.10 ¹³ -- --
Dielectric strength, in kV at 23 °C (3) • According to ASTM D 877 standard (flat electrodes, spacing 2.54 mm)	40 min. 50 min.	40 to 55 50 to 70

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| <ul style="list-style-type: none"> • According to CEI publication n° 156 (AFNOR NF C 27 221 standard) (spherical electrode, spacing 2.5 mm) | | |
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¹ CEI publication No. 156 or AFNOR NF C 27 221

² ASTM D 87 standard.

³ According to the literature, the dielectric strength remains unchanged up to 150°C.

N.B. The values indicated in the tables for silicon and mineral oils are either measurement results or literature data. Hence they should be considered as approximate figures, as they are likely to change according to the quality or source of the product.

With CEI type spherical electrodes, the indicated distance is obtained only between the two extreme points of the cups. As soon as we move away from these points, the length of the track to be followed by the arc increases. Hence it is only the very narrow stream of liquid joining these extreme points which is subject to the maximum field.

On the other hand, with ASTM type flat electrodes, all points on the electrode are at an equal distance from the opposite electrode. Hence, it is the whole cylinder of liquid between the electrodes which is subject to the field. The volume of the exposed liquid is much greater than previously, and consequently the probability of discovering a fault is greater and the result is automatically more reliable. Roughly speaking, we can achieve a factor of 1.2 to 1.5 between the results of these two methods.

Hence, it is always important to specify the method used.

2 - 2 The influence of humidity

During its manufacture, BLUESIL FLD 604V50 is degassed under vacuum at elevated temperatures and contains only a few mg/kg (or ppm) of water. It is, however, important to keep in mind, that silicone oils, exposed to damp air, quickly absorb humidity until equilibrium thanks to the great facility of distribution of gas and vapors in silicones in general. The quantity of water in the oil is always proportional to the relative humidity of the air (HENRY'S law).

Hence, it is essential to take care during preparation of a silicone oil sample for analysis, so as to avoid humidity take up.

It is preferable not to leave the containers or drums of BLUESIL FLD 604V50 open unnecessarily, so as to avoid water take up. The solubility of water in BLUESIL FLD 604V50 is higher than in other dielectrics.

At saturation, the following values of mg water /kg of dielectric (or ppm) can be observed.

Solubility of water in dielectrics ¹

Temperature	Water content mg/kg	
°C	BLUESIL FLD 604V50	MINERAL OIL

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0	--	20
25	200	70
55	600	330

¹ Water metering by the standard Karl Fischer method is not applicable in the case of silicone oils because of a secondary reaction. Bluestar Silicones has developed a modified method which is available on request.

Consequently, the water content, by which the dielectric strength of the oil is affected, is at the equilibrium higher for BLUESIL FLD 604V50 than for other dielectrics. It has been observed that the decisive factor causing the decrease in dielectric strength is not the absolute value of water in the dielectric, but its percentage in relation to saturation.

We demonstrate this behaviour by adopting a graphical visualisation :

- X axis : water content (%) in relation to saturation
- Y axis: Dielectric strength (%) in relation to the maximum dielectric strength of a perfectly dry dielectric liquid.

BLUESIL FLD 604V50 behaved identically, or even slightly better than a mineral oil. In both cases, there is practically no observable decrease in dielectric strength up to saturation of 25%.

This means that BLUESIL FLD 604V50 containing 50 ppm of water (50 mg of water/kg of oil) still retains a dielectric strength which is very little different from that of dry oil. Beyond this point, desiccant treatment has to be carried out as for other dielectrics. The same installations as for mineral oils can be used. The treatment consists of heating the oil under vacuum so as to eliminate water and gases. The dielectric should also be filtered on a dry filter paper. However, it should be borne in mind that:

- BLUESIL FLD 604V50 has a vapor tension of less than 10^{-2} mm Hg at 200°C So it can be treated at up to 200°C under a vacuum of 1mmHg.
- We do not recommend to use the same installation for the treatment of both, mineral oils and BLUESIL FLD 604V50, because a pollution by a small quantity of mineral oil rapidly reduces the fire resistance of silicone liquids, although it does not greatly affect the dielectric properties, as can be seen from the following figures in table 4.

The presence of traces of silicone in mineral oil is not detrimental to its general properties, but may cause frothing during drying and degassing operations.

Properties of mixtures of mineral transformer oil with BLUESIL FLD 604V50

Characteristics measured	Measurement standard	FLD 604V50	FLD 604V50		MINERAL OIL
			+ 2 % of mineral oil	+ 5 % of mineral oil	
Dielectric coefficient	AFNOR NF C 27 210	2.70	2.70	2.68	2.20
Tangent of loss angle		$5 \cdot 10^{-5}$	$6 \cdot 10^{-5}$	$7.5 \cdot 10^{-5}$	$9.7 \cdot 10^{-5}$

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Voluminal resistivity $\Omega \cdot \text{cm}$	AFNOR NF C 27 210	1.10 ¹⁵	1.5.10 ¹⁴	9.10 ¹²	2.5.10 ¹³
Dielectric strength kV	AFNOR NF C 27 210				
Flash point, °C, (open cup)	AFNOR NF C 27 221	70	67	65	40
	AFNOR NF T 60 118	315	247	216	145

2.3. Solubility of gases in BLUESIL FLD 604V50

As for water, we also observe higher gas solubilities in silicone liquids than in other dielectrics.

Temperature °C	Solubility (volume %)		
	Oxygen	Nitrogen	Air
25	27	17	19
120	21	15	16

In addition, BLUESIL FLD 604V50 very quickly reaches the equilibrium with the ambient atmosphere, and consequently dielectric measurements are always taken on an oil which is saturated in air.

It has also been shown that the dielectric strength is little affected by the dissolved gas content. We can see in graph 1, that a silicone oil saturated with air retains 90% of the dielectric strength which it would have had without the gas.

Please note: The typical properties are not intended for use in preparing specifications. Please contact our local Sales Department for assistance in writing specifications.

Instruction of use	Please consult your local ELKEM SILICONES sales office.
Regulation	Please consult your local ELKEM SILICONES sales office.
Limitations	Please consult your local ELKEM SILICONES sales office.
Packaging	<ul style="list-style-type: none"> • BLUESIL FLD 604V50 is available in <ul style="list-style-type: none"> ○ Pallet of 1000 KG (2205 LB) ○ Drum of 200 KG (441 LB)
Storage and shelf life	When stored in its original packaging: BLUESIL FLD 604V50 may be stored at temperatures between -20°C / -4°F and 50°C / 122°F for up to 36 months from its date of manufacturing. Comply with the storage instructions and expiration date marked on the packaging. Beyond this date, Elkem Silicones no longer guarantees that the product meets the sales specifications.
Safety	Please consult the Safety Data Sheet of: BLUESIL FLD 604V50

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Visit our website www.elkem.com/silicones/

Warning to the users

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