



Natural Ester-based Fluid for Transformers

*Ecological & sustainable alternative
for electrical transformers*

Technical information



Powering reliable solutions for you

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Technical Data Sheet

Description

VG-100® is a dielectric fluid derived from natural esters of edible seeds, formulated using a proprietary process for use in electrical transformers – both new and retrofill. It was developed by **Prolec GE** in 2009 as an environmentally-friendly alternative to existing dielectric fluids. It is 100% natural and biodegradable, and does not contain any synthetic antioxidant, petroleum, or toxic compounds.

Properties

VG-100® fluid fulfills with international standards and requirements such as ASTM & IEEE. It is also certified by Factory Mutual (FM) and Underwriters Laboratories (UL).

Table 1. Electrical, physical and chemical properties of **VG-100®** fluid

Properties	Test Method		Requirement		VG-100 fluid ³
	ASTM	ISO/IEC	ASTM D6871 ¹	IEC 62770 ²	
ELECTRICAL					
Dielectric breakdown, kV 2mm	D1816		≥ 35		>60
2.5mm		IEC 60156		≥ 35	80-98
Dissipation factor, % 25°C	D924		≤ 0.2		0.08
90°C		IEC 60247		≤ 0.05	0.011
100°C	D924		≤ 4.0		0.29
PHYSICAL					
Color	D1500	ISO 2211	L1.0		L0.5
Appearance	visual	visual	bright & clear	bright & clear	bright & clear
Relative density, g/cm ³ 15°C	D1298		≤ 0.96		0.916
Density, g/cm ³ 20°C		ISO 3675		1.00	0.919
Viscosity, cSt 0°C	D445	ISO 3104	≤ 500		178
40°C	D445	ISO 3104	≤ 50	≤ 50	31
100°C	D445	ISO 3104	≤ 15	≤ 15	6
Pour Point, °C	D97	ISO 3016	ISO 3016		-12 to -15
Flash Point, °C	D92	ISO 2592	≥ 275		330
Fire Point, °C	D92	ISO 2592	≥ 300		352
CHEMICAL AND ENVIRONMENTAL					
Water content, mg/kg	D1533		≤ 200		50
		IEC 60814		≤ 200	34
Acidity number, mg KOH/g	D974		≤ 0.06		0.05
		IEC 62021.3		≤ 0.06	0.03
PCB content, mg/kg	D4059		not detectable	free from PCB	not detectable
Oxidation stability (48hrs, 120°C)		IEC 61125-C			
Total acidity, mg KOH/g		IEC 62021.3		≤ 0.6	0.43
Viscosity at 40°C, cSt		ISO 3104		≤ 30% increase	<20% increase
Dissipation factor at 90°C, tanδ		IEC 60247		≤ 0.5	0.17
Biodegradability		OECD 301	Readily biodegradable	Readily biodegradable	Readily biodegradable

¹ ASTM D6871. Standard Specification for Natural (Vegetable Oil) Ester Fluids Used in Electrical Apparatus

² IEC 62770. Fluids for electrotechnical applications – Unused natural esters liquids for transformers and similar electrical equipment.

³ Typical data for new fluid. These values may vary depending on the handling. For more information, please contact Prolec GE at 1-800-437-7653



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Storage & Handling

To maintain the optimal properties of **VG-100®** fluid, it is important to take some precautions related to its storage and handling. **VG-100®** is classified as a less-flammable dielectric fluid by UL-340 and FM-6933 approval agencies, so its fire point overpass of 300°C allows either indoor or outdoor storage. **VG-100®** fluid can be delivered in sealed totes (drums) or tankers. As with mineral oil, an inspection should be done when the material is received. Verify the fluid properties using IEEE C57.147 Guide for Acceptance and Maintenance of Natural Ester Fluids in Transformers (table below). If the fluid does not meet the required specifications, please contact **Prolec GE** for further guidance.

Storage considerations

Drums/totes are shipped with a positive pressure dry nitrogen blanket to prevent fluid contamination by humidity or oxygen inside the container, or other solid or volatile materials.

New fluid should be stored in a dry location, protected from rain, direct sunlight, or high temperatures. When the fluid is received in bulk tankers, the fluid must be degassed, filtered and dried (moisture extraction) to ensure optimal characteristics and benefits.

If **VG-100®** fluid has been stored or received during cold weather, heating the containers may be necessary to decrease the fluid's viscosity. Storage in a heated warehouse could reduce the amount of heating needed, thus making it easier to pump the fluid into storage containers or to the transformer filling line. It is recommended that the containers be opened before heating to avoid unintended pressure build-up in the containers during this process.

Table 1. IEEE C57.147 Acceptance values for receipt of shipments of natural esters

Parameter	Min	Max
Breakdown Voltage (kV), ASTM D1816, at 2mm		
Sampled from bulk tanker	35	–
Sampled from drums/totes	60	–
Dissipation Factor (%), ASTM D924		
at 25°C	–	0.2
at 100°C	–	4.0
Density (g/cm ³), ASTM D1298 at 25°C		≤ 0.96
Water content (mg/kg), ASTM D1533		
Sampled from bulk tanker	–	200
Sampled from drums/totes	–	100
Neutralization number (mgKOH/g), ASTM D974	–	0.06
Color, ASTM D1500	–	L1.0
Flash Point (°C), ASTM D92	275	
Fire Point (°C), ASTM D92	300	
Pour Point (°C), ASTM D97		-10
Viscosity (cSt), ASTM D445		
at 0°C	–	500
at 40°C	–	50
at 100°C	–	15

Once opened, a container can be closed and resealed by first filling the headspace of the container with a blanket of dry nitrogen to prevent any contaminant and moisture entrance.

If **VG-100[®]** fluid has been stored or received during cold weather, heating the containers may be necessary to decrease the fluid’s viscosity. Storage in a heated warehouse could reduce the amount of heating needed, thus making it easier to pump the fluid into storage containers or to the transformer filling line. It is recommended that the containers be opened before heating to avoid unintended pressure build-up in the containers during this process.

Once opened, a container can be closed and resealed by first filling the headspace of the container with a blanket of dry nitrogen to prevent any contaminant and moisture entrance.

Storage containers/ tanks should be made preferably of stainless steel or steel coated with a compatible paint. The use of new and clean containers is highly recommended, making sure the containers are in good condition.

As indicated previously, it is recommended that the exposure time of the fluid to air and high temperatures be limited, since polymerization reactions can occur in vegetable oils due to air exposure. However, **Prolec GE** has determined that exposure of bulk quantities during normal transformer manufacturing processes has no effect on the electrical and physical properties of the fluid.

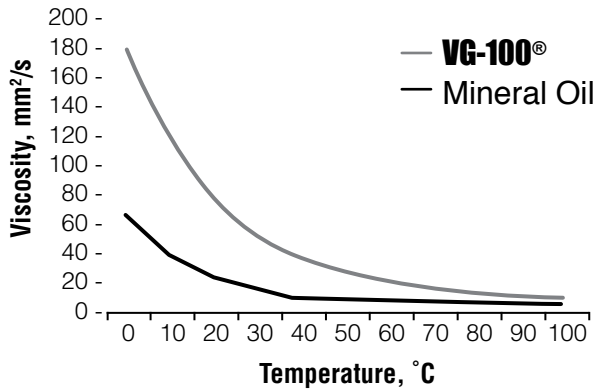


Figure 1. Viscosity behavior of **VG-100[®]** at different temperatures

IMPORTANT. Store fluid in dry location, protected from rain, direct sunlight, and high temperature to assure the optimal properties of the VG-100[®] fluid

IMPORTANT. Exposure to oxygen (O₂) for long periods should be avoided

Handling

Any equipment that is suitable for transformer oil can be used with **VG-100[®]**, although the capacity of the pump should be reviewed because **VG-100[®]** fluid has a higher viscosity than mineral oil. The required filling rate, the fluid temperature, and filling pressure will affect the proper pump size. It is recommended that the lowest operating temperature expected during handling operations be used for this analysis to derive the resulting viscosity of the fluid. Before using, pumping equipment should be cleaned and rinsed with **VG-100[®]** fluid to remove dirt, dust or traces of other oils, and then thoroughly flushed with new **VG-100[®]** fluid.

Handling for transformer maintenance, repairs, or retrofills

In cold weather, **VG-100**® fluid should be heated to reduce its viscosity and to avoid damage to pump equipment. If pipes, hoses and fittings are thermally insulated, a continuous flow can be maintained. A temperature above 10°C is suggested for easy handling of the fluid.

It is also recommended that the main tank be insulated with thermal sheets in order to minimize the heat released to the ambient and also to reduce the process time. If thermal sheets are not available, polystyrene sheets of 1" thickness can also be used. If heat blowers are available, either electrical or gas, those could be used to heat the ambient around the transformer to keep it heated to help the impregnation of cellulose insulation of the transformer.

Prior to filling the transformer, the liquid should be processed (degassed, filtered and dehydrated) to meet the acceptance levels of applicable standards (ASTM D6871, IEEE C57.147 or IEC 62770). The treated fluid should be placed in a tank under vacuum or directly to the transformer with a previous vacuum step. A target temperature of approximately 80 degrees C will improve the impregnation process of the insulation system. As is the case with any dielectric fluid, there is a possibility of static charge accumulation when **VG-100**® fluid flows through the pumping equipment. Therefore it is important that all pumps, lines and vessels be grounded during pumping operations to prevent this electrical phenomena.

For drying impregnated insulation with **VG-100**® fluid, kerosene vapors or hot nitrogen should be used. A drying process with air is not acceptable as it could lead to fluid polymerization on impregnated materials.

IMPORTANT. Higher temperatures will decrease the viscosity and improve the insulation system impregnation process

For any work inside a transformer that requires draining of **VG-100**® fluid, it will be necessary to transfer the fluid to suitable new clean sealed containers to minimize contamination. A positive pressure with a dry nitrogen blanket will help to prevent the admission of humidity or oxygen into the container, keeping the **VG-100**® fluid in good condition. All equipment used to manipulate the oil (pumps, pipes, hoses, fittings) should be cleaned after use to avoid gelification; thin films of **VG-100**® fluid or any natural ester oil over time will polymerize and that could be difficult to remove. This phenomena depends mainly on temperature, time of exposure to the ambient, and sunlight.

Oxidation performance

There are some differences in oxidation properties for natural ester based fluids versus mineral oils. Vegetable fluids are subject to a polymerization process in the continuous presence of oxygen and elevated temperatures.

However, when used in sealed environments, such as in sealed transformers, vegetable fluids are stable. **VG-100**® meets all IEC requirements for oxidation stability using the IEC 61125 method C modified test (see Table 1 below):

Table 1. Oxidation stability of **VG-100**® fluid based on IEC 61125 method C

Properties	Units	Standard	Acceptance criteria	VG-100® fluid
Total acidity	[mg KOH/g]	IEC 62021-3	≤ 0.6	0.4
Dissipation factor (90°C)	[tan δ]	IEC 60247	≤ 0.5	0.2
Viscosity at 40°C	cSt	ISO 3104	≤ 30% increase	<20% increase

In addition, **Prolec GE** has conducted testing of **VG-100**® fluid exposed to oxygen at room temperature which shows that **VG-100**® fluid does not change its characteristics and does not form oxidation by-products after two weeks of exposure. These results assure that **VG-100**® fluid can be used in transformer manufacturing – both during production processes and maintenance practices.

Since polymerization reactions are accelerated on the exposed surface of vegetable oils, it is recommended that the time where impregnated components are exposed to air and high temperatures be limited to what would be normal for production processes.

For additional information, please contact **Prolec GE** at 1-800-437-7653.

Retrofilling

There are many environmental benefits derived from the use of natural ester fluid in transformers, both for new units and for retrofill applications.

All retrofilling processes should be reviewed by qualified personnel. It is important to verify the good condition of the transformers as well as the reliability of their components.

When conducting a retrofill operation using natural ester fluid, the most relevant parameters to take into account are humidity and oxygen content. Humidity decreases the dielectric strength of the insulation and oxygen content affects the physical and chemical properties such as viscosity, which directly impact the transformer thermal performance.

If during retrofilling, the **VG-100[®]** fluid has been exposed or has been in contact with water or dust, it is recommended to process the oil as the same as in factory: degassed, filtered and dehydrate.

VG-100[®] fluid is fully miscible with conventional mineral oil, natural and synthetic esters, and it does not compatible with silicone oils.

IMPORTANT. Mineral oil and dielectric esters fluids are completely miscible with VG-100[®]

Once the transformer is drained, the remaining mineral oil needs to be controlled in order to minimize its volume, since high concentrations of it can reduce the original characteristics of the **VG-100[®]** fluid, such as fire resistance, biodegradability, among other. It is highly recommended to have less than 7% of mineral oil in order to maintain the optimal performance of **VG-100[®]** fluid.

The maintenance will be the same for **VG-100[®]** fluid and for mineral oil, highlighting that the equipment to be refilled should be non-free breathing, sealed transformer. Some parameters will need to be considered differently compared to those of mineral oil, such as exposure time, oil filtering before filling up the transformer, and others.

IMPORTANT. Avoid a concentration higher than 7% of residual mineral oil in a VG-100[®] retrofilled transformer.

Retrofilling process

Step 1	<ul style="list-style-type: none"> • De-energize the equipment • Perform power factor and insulating resistance tests • Take oil sample for analysis
Step 2	<ul style="list-style-type: none"> • Drain the oil • Allow the residual oil to drip out of windings and tank
Step 3	<ul style="list-style-type: none"> • Change all gaskets for new ones • Replace any damaged components
Step 4	<ul style="list-style-type: none"> • Flush core and coil with VG-100® fluid • Allow the residual fluid to drip out of windings and tank • Remove fluid residues
Step 5	<ul style="list-style-type: none"> • Apply vacuum process • Begin filling the unit with VG-100® fluid • Nitrogen blanket is required
Step 6	<ul style="list-style-type: none"> • Allow time for VG-100® fluid to saturate the windings • Perform power factor and insulating resistance tests
Step 7	<ul style="list-style-type: none"> • Reclassify the transformer as “Unit Retrofilled with VG-100® fluid” • Take a VG-100® oil sample for analysis
Step 8	<ul style="list-style-type: none"> • Connect transformer to the network • Check operational conditions of the transformer (temperature, pressure) • Verify no leaks are present
Step 9	<ul style="list-style-type: none"> • Verify no leaks are present • Continue with any other maintenance required and reenergize when ready

NOTE. These are general recommendations for a retrofilling process. It may vary depends on each installation. Further information are available, please contact Prolec GE at 1-800-437-7653.

Certifications

In order to assure optimal **VG-100®** performance, this ester fluid has been subjected to several tests, to meet usage, performance and testing criteria based on standards set by the industry.

FM Approvals

Is a company that certifies industrial and commercial products and services for companies worldwide. When a product or service meets the standards of FM Approvals, it is issued the FM APPROVED mark to signify it will perform as expected and support property loss prevention. FM Approvals backs its evaluations with scientific research and testing and lists more than 45,000 certified products and services.



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UL

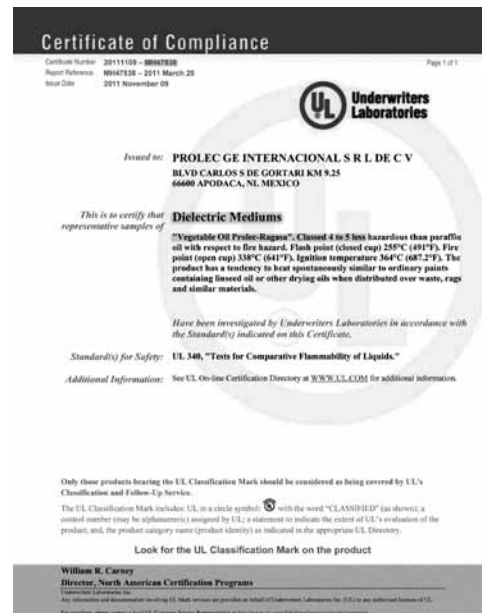
UL certifies, validates, tests, inspects, audits, and advises and trains, provides the knowledge and expertise to help customers navigate growing complexities across the supply chain from compliance and regulatory issues to trade challenges and market access.

OECD

The OECD has a collection of Test Guidelines of internationally agreed test methods used by government, industry and independent laboratories. They are used to determine the safety of chemicals and chemical preparations, including pesticides and industrial chemicals.

Table 1. List of certifications of **VG-100®**

Certifications	Organization	Code
Less Flammable Transformer Fluid	FM Approvals	Class number 6933
Less or non-flammable Liquid-Insulated Transformers	FM Approvals	Class number 3990
Tests for comparative Flammability of Liquids	UL	UL-340
Dielectric Medium	UL	EOUV
Acute Toxicity Test of Natural Dielectric Oil VG100 using rainbow trout ONCORHYNCHUS MYKISS (OECD Guideline203)	Maxxam	OECD 203
Ready Biodegradability of VG100® Using the Manometric Respirometry Test	Maxxam	OECD 301F



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Material Safety Data Sheet

SECTION I – IDENTIFICATION OF THE SUBSTANCE AND OF THE COMPANY

Product identifier: Natural ester **VG-100**[®]

Other forms of identification: High purity dielectric vegetable oil, food-grade dielectric vegetable oil, natural ester dielectric fluid.

Recommended use: To be used in electrical equipment such as transformers as an insulating element and cooling medium.

Produced by:

PROLEC GE INTERNACIONAL SRL DE CV
BLVD Carlos Salinas de Gortari km 9.25
66600 Apodaca NL México
Emergency phone in México: 1-800-437-7653

SECTION II - HAZARD IDENTIFICATION

VG-100[®] dielectric fluid is not classified as hazardous. It is a preparation classed 4 to 5 less hazardous than paraffin oil in respect to fire hazard.

NFPA Hazard Classification

Health (Blue)	0
Flammability (Red)	1
Reactivity (Yellow)	0

SECTION III – COMPOSITION

Chemical name: Mixed Triglycerides

CAS N°: 008001-22-7

Common name and synonyms: Natural ester fluid

Components: Vegetable oil: 100% wt
Synthetic additives: 0% wt

SECTION IV – FIRST AID MEASURES

Symptoms and effects

Ingestion: Abdominal pain and possible diarrhea.

Inhalation: No adverse effect.

Eye contact: May produce temporary blurred vision.

Skin contact: Sensitive people may experience dermatitis after a long time in contact with the oil.

First aid description

Ingestion: No special requirements, contact your doctor if necessary.

Eye contact: Flush with water, be sure to remove all product from affected area.

Skin contact: Remove clothing and wash skin with soap and water.

Inhalation: Unlikely to cause adverse effects.

SECTION V – FIRE FIGHTING MEASURES

Extinguishing medium: Dry chemical foam, carbon dioxide (CO₂), sand or earth.

Specific danger of the chemical substance, or mixes: The pressure in sealed containers can increase under the influence of heat as with most fluids.

Fire residues and contaminated firefighting water: It must be disposed according to local regulations.

Special precautions to be followed by fire fighting groups: In case of insufficient ventilation, wear breathing equipment. Application of water to flaming oil can cause spreading. Avoid contact with oxidant agents.

SECTION VI – ACCIDENTAL RELEASE MEASURES

Methods and materials for containment and cleaning up spills or leaks: Contain the liquid with sand, earth or control material and transfer it into a properly identified container for disposal.

Environmental precautions: Prevent leakage or spillage, prevent entry into drains, ditches or rivers by using sand, earth or barriers. Consult and follow all applicable Federal, State, and Local regulations.

SECTION VII – HANDLING AND STORAGE

Avoid dispersion of the material into air to minimize risks of ignition and health hazards. Store material in tightly-closed container, avoiding direct sunlight, heat, and oxidizing agents. Store at room temperature.

SECTION VIII – EXPOSURE CONTROLS/ PERSONAL PROTECTION

Signs and symptoms of exposure: There are no significant health hazards under normal conditions of use.

Respiratory protection: Not required under normal use conditions and proper ventilation; in the presence of any vegetable oil mists, proper respiratory protection should be used.

Eye Protection: Wear safety glasses to prevent eye contact.

Protective gloves: Usually not needed.

SECTION IX – PHYSICAL AND CHEMICAL PROPERTIES

Appearance and odor: Pale yellow transparent liquid, vegetable oil odor.

Flash point: >330°C

Vapor pressure 20°C: <1 mbar

Boiling temperature: >360°C

Specific gravity: 0.919-0.925

Solubility in water (20°C): Negligible

SECTION X – REACTIVITY AND STABILITY

Stability: The product is stable when is stored at normal room temperature.

Possibility of hazardous reactions: None.

Conditions that should be avoided: Avoid direct sunlight, heat sources.

Incompatible materials: Avoid oxidizing agents.

Hazardous decomposition products: None.

SECTION XI – TOXICOLOGICAL INFORMATION

VG-100® fluid base oil is generally recognized as safe (GRAS) by the U.S Food and Drug Administration (FDA).

Carcinogenicity (NTP) (IARC) (OSHA): Not listed as a carcinogen.

SECTION XII – ECOLOGICAL INFORMATION

Toxicity:

OECD 203: > 100mg/L

Persistence and biodegradability:

Readily biodegradable

OECD 301F, > 99% after 13 days

Potential for bioaccumulation:

No potential for bioaccumulation

Other adverse effects:

No other adverse effects detected

SECTION XIII – DISPOSAL CONSIDERATIONS

Product waste must be handled and disposed in accordance with applicable local, state, and federal regulations. In that case, **VG-100**® fluid is

not a hazardous waste and could be recycled when required following applicable regulations.

Empty containers should be completely drained and then discarded or recycled, if possible.

SECTION XIV – TRANSPORT INFORMATION

DOT (49 CFR 172.101)

UN Proper shipping name: Not regulated

UN/Identification No: Not applicable

Transport Hazard Class(es): Not applicable

Packing group: Not applicable

SECTION XV – REGULATORY INFORMATION

VG-100[®] fluid does not contain any hazardous component(s) according to EPA's hazardous substances list. When disposed, is not considered as hazardous waste.

SECTION XVI – OTHER INFORMATION

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