VARTECTOR

By MPC (Membrane Patch Colorimetry)

Lubrication Plus

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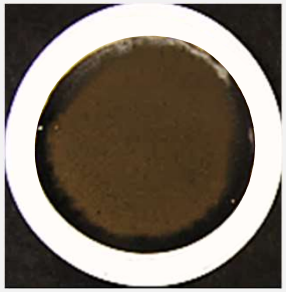
VARTECTOR

VARTECTOR detects the risk of turbine oil varnish ASTM D7843 (Standard Test Method for Measurement of Lubricant Generated Insoluble Color Bodies in In-Service Turbine Oils using Membrane Patch Colorimetry). The CIE delta E value, the optical colorimetric notation, is used to diagnose the risk of varnish formation. Potential hazards of turbine oil varnish warns that problems such as turbine bearing vibration and temperature rise, filter clogging, poor temperature control, turbine oil degradation may occur.

VARTECTOR diagnoses the potential hazards of varnish and soot in the control oil (phosphate ester Inflammable hydraulic oil) of the EHC system through CIE delta L value and a and b values as optical colorimetric notation, It is possible to diagnose whether the composition of the thermal load is created soot or varnish or whether both carbon and varnish are present and its seriousness. When CIE delta L value is high, it means generation of soot. It means that there is a bubble problem in the system and pump cavitation problem. When a and b values are high, it means a risk of varnish formation. Warning of danger.

Key Features:

•Fully Automation: Differently from the existing MPC tester, the process of loading, validating, and testing the samples is done automatically within 10 seconds after patching.
•Display: Patch image, MPC delta E, delta L, a, b value, Trending per machine to be managed.
•MPC tester for laboratory analyzer that meets ASTM D7843 for the first time in the world
•Automatic Diagnostic Reporting: Automatic diagnosis of the measured result (normal a, normal b, caution, warning)
•Automatic Validation: Differently from the existing portable type MPC testers, it is built in the device and automatically performs device validation after power on.
•Automatic Self Diagnostic: Perform self-diagnosis of major components such as spectrophotometer and board after power on
•Trend management: It is possible to manage the tendency when testing after registering facility information for each machine to be managed in the connector.
•Advanced Software: Perform manual validation, set management target value, trending, save more than 10,000 tables, perform instrument calibration

	Mineral oil – Turbine oil	Phosphate ester oil – EHC oil
Formulation	Base Oils (mineral based AP1 group II or III) + additives (antioxidants, rust inhibitors, anti-emulsifiers, anti-foam agents)	Base Oils (phosphate ester synthetic oil) + no or little additives
Main cause of degradation	Oxidation	Hydrolysis + oxidation + micro dieseling
Degradation factors	Temperature, deterioration, air, metal particles, water, etc.	Water, oxygen, air bubbles
contamination by oil degradation (sludge)	Soluble organic acids (i.e., oxides)	Inorganic acid (phosphoric acid), soot (carbide), GEL (gel, generated from acid control filter)
Degraded Oil Patch		

Mineral Turbine Oils Application

As the varnish value increases, bearing vibration and temperature hunting occurs, and varnish layer is formed on the surface of the bearing. It interrupts the flow of turbine oil, reduces cooling , brings early clogging of the filter. Varnish attached to the cooler brings ineffective cooling to the turbine oil and temperature rise, accordingly can cause shut down of the equipment.

"Oxidation of turbine oil changes fluid properties, and reduces machine life."

Normal A	Normal B	Caution	Warning
<15	15 - 29	30 - 40	>40

Progression of oil degradation = Increase of MPC value

Vibration and temperature hunting of bearings

Early clogging of line filter

Temperature rise due to varnish attached to the cooler

PE(Phosphate ester) Oil Application – EHC Oil

EHC oil can easily be hydrolyzed by water and degradation progresses by oxidation, thermal deterioration,.. etc.. As a result of the degradation, varnish and soot are generated, and the degree of varnish formation and soot can be managed as MPC (ΔL or Δa + b) values.
It is possible to quantify by measuring ΔL and Δa + b of varnish and soot respectively, which can not be distinguished by conventional MPC gravimetric method.
For instance, if ΔL and Δa + b are high, the risk of varnish and soot is high. If Δa + b is low and ΔL is high, it is contamination of soot.
When Δa + b is low and ΔL is also low, the patch has a light yellow color, and it means very good oil condition. Control oil oxidation is the main cause of oil deterioration and causes valve sticking. Carbide mainly causes valve wear which brings leaking and valve sticking.

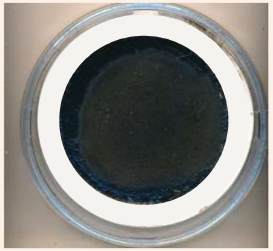
Controlling heat

Oxidation

Hydrolysis

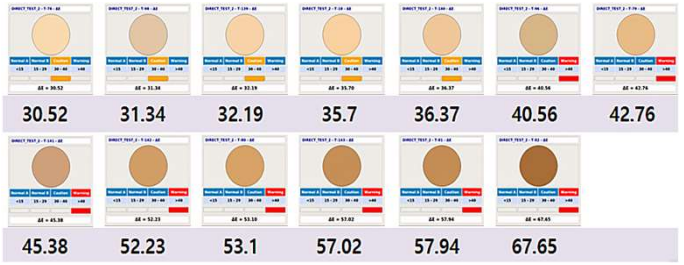
: Varnish (oxidation)
= A + b increase

Thermal degradation



: Soot = ΔL increase

▪ Oxidation (Δa + b ↑): Oil with high ΔE and high Δa + b



- **Bad valve control**
- **Valve Sticking**
- **Oil degradation**

▪ Carbonization (ΔL ↑): Oil with high ΔE and high ΔL

- **Pressure issue for leakage**
- **Valve Sticking**

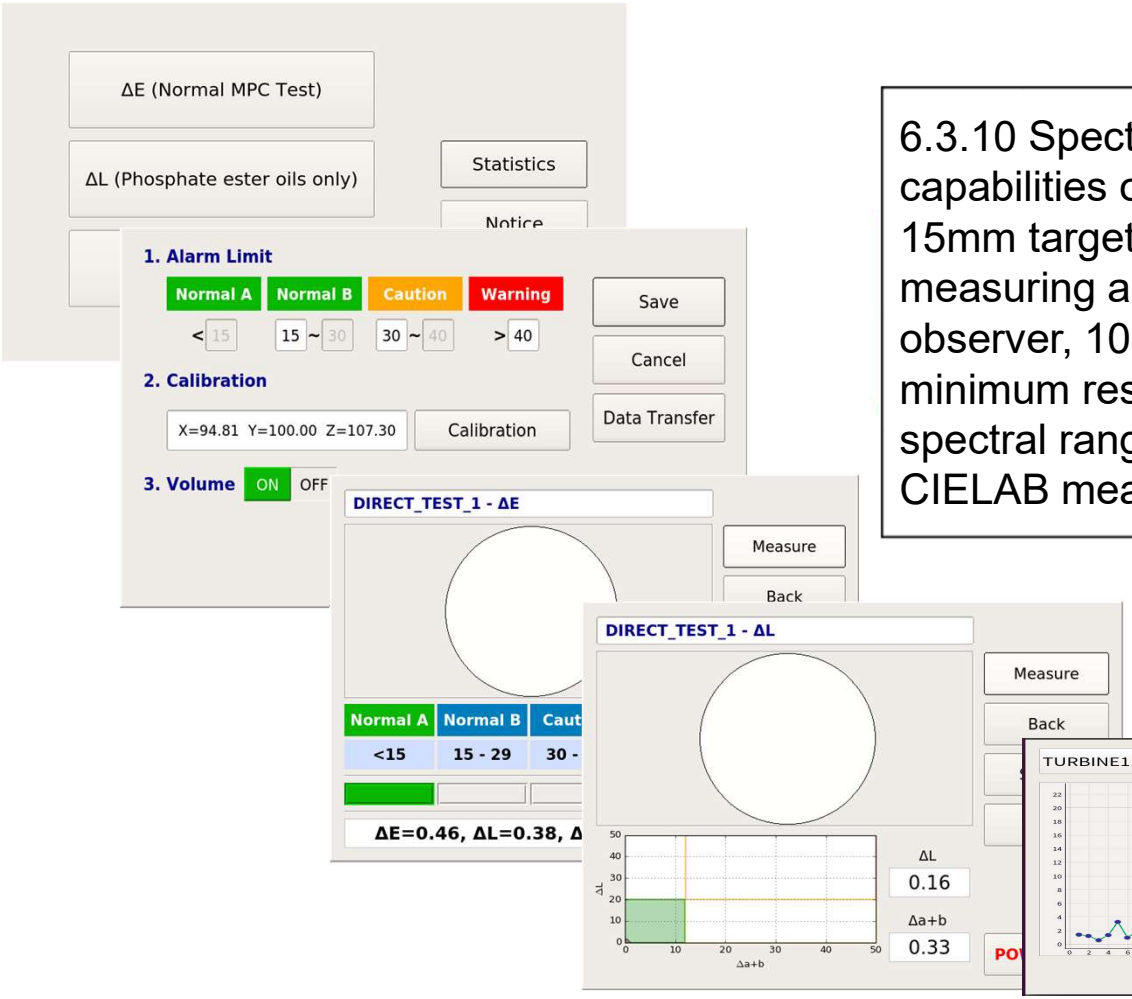
Vartector

Lubrication Plus® QUMENSUS

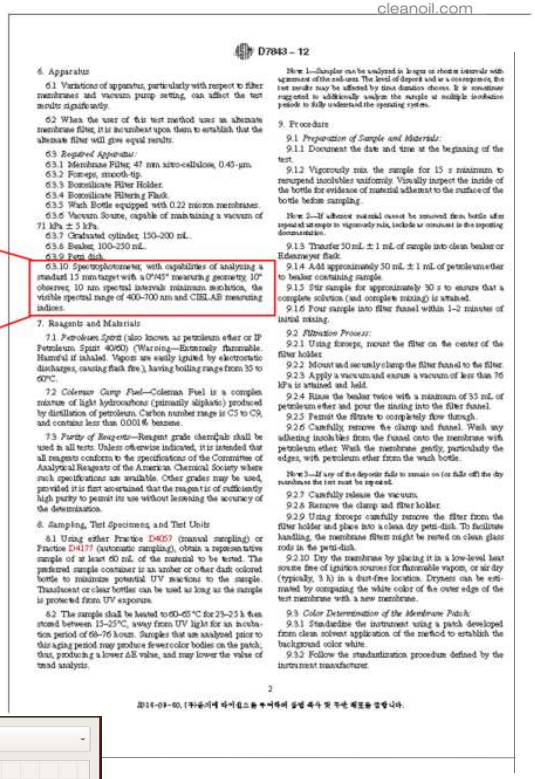
Fully Complied with ASTM D7843-12

EHC Fluid improvement test method is sourced from EPT. Cleanoil.com

EPT cleanoil.com



6.3.10 Spectrophotometer, with capabilities of analyzing a standard 15mm target with a 0'/45' measuring a geometry, 10' observer, 10 um spectral intervals minimum resolution, the visible spectral range of 400-700 um and CIELAB measuring indices.



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6. Apparatus

6.1 Variations of apparatus, particularly with respect to filter membranes and vacuum pump setting, can affect the test results significantly.

6.2 When the user of this test method uses an alternate membrane filter, it is incumbent upon them to establish that the alternate filter will give equal results.

6.3 *Required Apparatus:*

6.3.1 Membrane Filter, 47 mm nitro-cellulose, 0.45-µm.

6.3.2 Forceps, smooth-tip.

6.3.3 Borosilicate Filter Holder.

6.3.4 Borosilicate Filtering Flask.

6.3.5 Wash Bottle equipped with 0.22 micron membranes.

6.3.6 Vacuum Source, capable of maintaining a vacuum of 71 kPa ± 5 kPa.

6.3.7 Graduated cylinder, 150–200 mL.

6.3.8 Beaker, 100–250 mL.

6.3.9 Petri dish.

6.3.10 Spectrophotometer, with capabilities of analyzing a standard 15 mm target with a 0°/45° measuring geometry, 10° observer, 10 nm spectral intervals minimum resolution, the visible spectral range of 400–700 nm and CIELAB measuring indices.

7. Reagents and Materials

7.1 *Petroleum Spirit* (also known as petroleum ether or IP Petroleum Spirit 40/60) (Warning—Extremely flammable. Harmful if inhaled. Vapors are easily ignited by electrostatic discharges, causing flash fire.), having boiling range from 35 to 60°C.

7.2 *Coleman Camp Fuel*—Coleman Fuel is a complex mixture of light hydrocarbons (primarily aliphatic) produced by distillation of petroleum. Carbon number range is C5 to C9, and contains less than 0.001 % benzene.

7.3 *Purity of Reagents*—Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents conform to the specifications of the Committee of Analytical Reagents of the American Chemical Society where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

8. Sampling, Test Specimens, and Test Units

8.1 Using either Practice D4057 (manual sampling) or Practice D4177 (automatic sampling), obtain a representative sample of at least 60 mL of the material to be tested. The preferred sample container is an amber or other dark colored bottle to minimize potential UV reactions to the sample. Translucent or clear bottles can be used as long as the sample is protected from UV exposure.

8.2 The sample shall be heated to 60–65 °C for 23–25 h then stored between 15–25°C, away from UV light for an incubation period of 68–76 hours. Samples that are analyzed prior to this aging period may produce fewer color bodies on the patch, thus, producing a lower ΔE value, and may lower the value of trend analysis.

Note 1—Samples can be analyzed in longer or shorter intervals with agreement of the end-user. The level of deposit and as a consequence, the test results may be affected by time duration chosen. It is sometimes suggested to additionally analyze the sample at multiple incubation periods to fully understand the operating system.

9. Procedure

9.1 *Preparation of Sample and Materials:*

9.1.1 Document the date and time at the beginning of the test.

9.1.2 Vigorously mix the sample for 15 ± minimum to resuspend insolubles uniformly. Visually inspect the inside of the bottle for evidence of material adherent to the surface of the bottle before sampling.

Note 2—If adherent material cannot be removed from bottle after repeated attempts to vigorously mix, include or comment in the reporting documentation.

9.1.3 Transfer 50 mL ± 1 mL of sample into clean beaker or Erlenmeyer flask.

9.1.4 Add approximately 50 mL ± 1 mL of petroleum ether to beaker containing sample.

9.1.5 Stir sample for approximately 30 ± to ensure that a complete solution (and complete mixing) is attained.

9.1.6 Pour sample into filter funnel within 1–2 minutes of initial mixing.

9.2 *Filtration Process:*

9.2.1 Using forceps, mount the filter on the center of the filter holder.

9.2.2 Mount and securely clamp the filter funnel to the filter.

9.2.3 Apply a vacuum and ensure a vacuum of less than 76 kPa is attained and held.

9.2.4 Rinse the beaker twice with a minimum of 35 mL of petroleum ether and pour the rinsing into the filter funnel.

9.2.5 Permit the filtrate to completely flow through.

9.2.6 Carefully remove the clamp and funnel. Wash any adhering insolubles from the funnel onto the membrane with petroleum ether. Wash the membrane gently, particularly the edges, with petroleum ether from the wash bottle.

Note 3—If any of the deposit fails to remain on (or falls off) the dry membrane the test must be repeated.

9.2.7 Carefully release the vacuum.

9.2.8 Remove the clamp and filter holder.

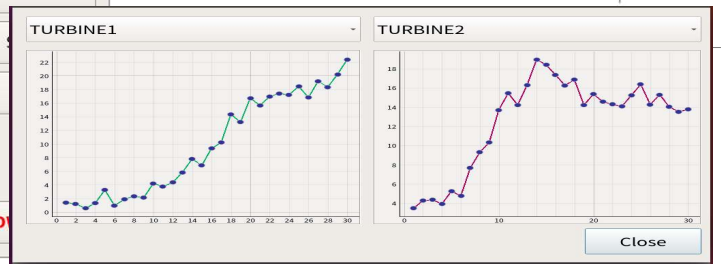
9.2.9 Using forceps carefully remove the filter from the filter holder and place into a clean dry petri-dish. To facilitate handling, the membrane filters might be rested on clean glass rods in the petri-dish.

9.2.10 Dry the membrane by placing it in a low-level heat source free of ignition sources for flammable vapors, or air dry (typically, 3 h) in a dust-free location. Dryness can be estimated by comparing the white color of the outer edge of the test membrane with a new membrane.

9.3 *Color Determination of the Membrane Patch:*

9.3.1 Standardize the instrument using a patch developed from clean solvent application of the method to establish the background color white.

9.3.2 Follow the standardization procedure defined by the instrument manufacturer.



Lubrication Plus

VARTECTOR

Features	Specification
Appearance	
Dimension	214(W) x 306 (L) x 254 (H) / 5.5kg
Power	DC 220V with 24V, 5A
Measuring Principle	
Measuring Geometry	0°/45° measuring geometry (in full compliance with ASTM D7843)
Measurement Condition	Observer: CIE 10° Standard Observer
Light Source	LED Light
Receiver	Spectrum scan
Detector	Spectrophotometer
Measuring Time	3 Seconds
Operating Temperature	0° C ~ 50° C
Output Value	CIE delta E, delta L, a, b
Patch Color Capturing	YES
Interface	
OS	Linux
Analog Peripherals	7” Touch Screen LCD,

Product Video Site

YouTube lubricationplus

https://www.youtube.com/channel/UCjmfBIeu4qhZBOfGkvoMKkw

Additional Features:

- Convenient sample loading system
- Self-diagnosis and verification
- Output: Delta E and L can be output for MPC measurement, Delta E for Turbine and Delta L for EHC
- Unique calibration function
- Keyboard connection
- Automatic save and export of measured result values, USB storage
- Automatic diagnosis evaluation report function (option: printer)