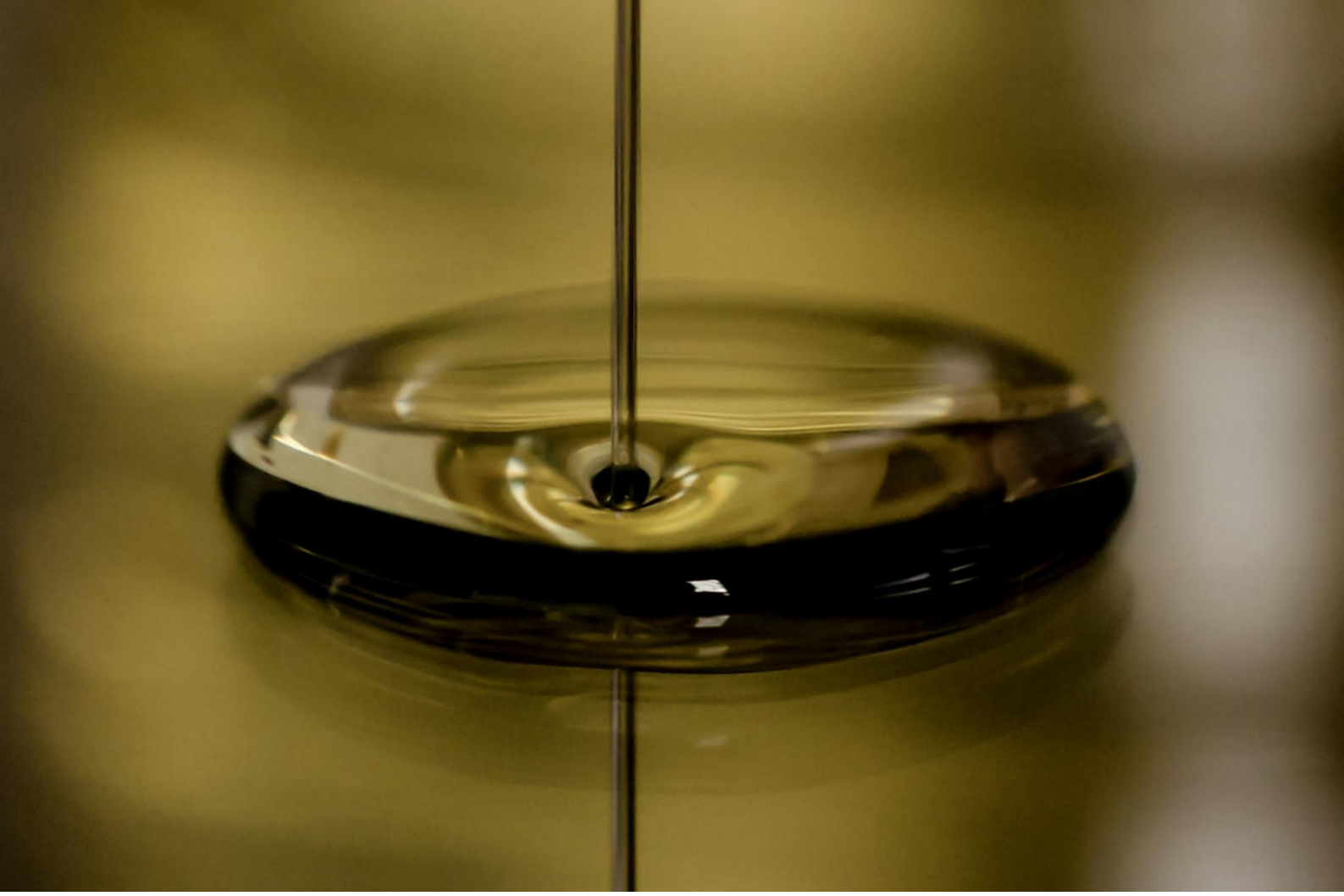

Application Note AN-V-220

Durée de vie opérationnelle totale des lubrifiants

Fully automated determination of remaining antioxidant content using voltammetry

Testing of in-service lubricating oils for their remaining antioxidant content is critical for capital equipment uptime as well as reducing running costs and repair expenses. Test methodologies such as RPVOT (rotating pressure vessel oxidation test) are time consuming and expensive to perform. Remaining Useful Life is a proven voltammetric method for testing the remaining active antioxidant content in minutes. Depending on the electrolyte, aromatic amine and phenolic antioxidants or hindered phenolic antioxidants can be determined.

For the first time, a fully automated system is demonstrated, showing dramatically improved repeatability of data for confidence in reporting. Operator time is saved during sample preparation and irreproducible manual interpretation is eliminated via completely autonomous software processing. The user adds the sample into the vials, then the determination process of the sample series (including sample preparation and result calculations) is carried out automatically.

The system is based on methods ASTM D6810, ASTM D6971, ASTM D7527, and ASTM D7590.

SAMPLES

Lubricating oils, hydraulic oils, turbine oils, and motor oils.

ANALYSIS

The oil samples are added into the sample vials on the rack of the sample processor. During the determination procedure, supporting electrolyte is automatically added to the sample and mixed. Either a neutral or alkaline supporting electrolyte is used depending on the type of antioxidants in the sample.
The sample solution is transferred into the measuring vessel of the 884 Professional VA and the antioxidant determination carried out using the voltammetric parameters listed in either Table 1 or 2.
The resulting peaks are automatically evaluated, and the concentration is calculated using a 1-point calibration, reporting the result as % remaining antioxidant compared to an unused fresh oil.
The complete system is then rinsed before the next sample is started.

Figure 1. 884 Professional VA fully automated: 884 Professional VA with 858 Professional Sample Processor, three Dosinos, and 843 Pump Station

Table 1. Parameters for determination of aromatic amine and phenolic antioxidants in neutral supporting electrolyte

Parameter	Setting
Mode	DP – Differential Pulse
Start potential	0 V
End potential	+1.3 V
Peak potential amine	+0.5 V
Peak potential phenol	+1.0 V

Table 2. Parameters for determination of hindered phenolic antioxidants in alkaline supporting electrolyte

Parameter	Setting
Mode	DP – Differential Pulse
Start potential	-0.1 V
End potential	+1.0 V
Peak potential phenol	+0.2 V

ELECTRODES

- Working electrode: Glassy carbon electrode tip with driving axle for RDE
- Reference electrode: Platinum rod electrode
- Auxiliary electrode: Platinum rod electrode

RESULTS

The described method can be used to determine the remaining antioxidant content in various types of lubricating oils such as hydraulic oils, turbine oils, or motor oils.
The fully automated system setup allows unattended automatic runs of sample series.
The automated determination process includes the sample preparation steps that are carried out automatically. In addition, curve evaluation and result calculation are carried out automatically in the viva software. These unique features significantly reduce the workload for the operators in the lab and increase reproducibility of the obtained results.

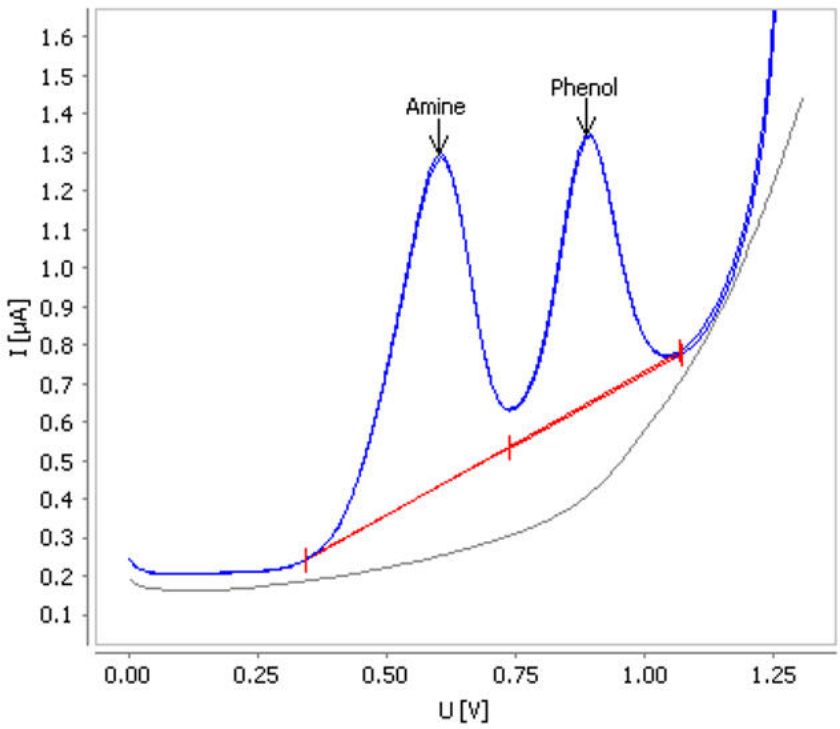

Figure 2. Aromatic amine and phenolic antioxidants compressor oil with neutral supporting electrolyte

Table 3. Results compressor oil in neutral electrolyte

Antioxidant	Remaining content
Aromatic amine antioxidants	15.8%
Phenolic antioxidants	83.5%

RESULTS

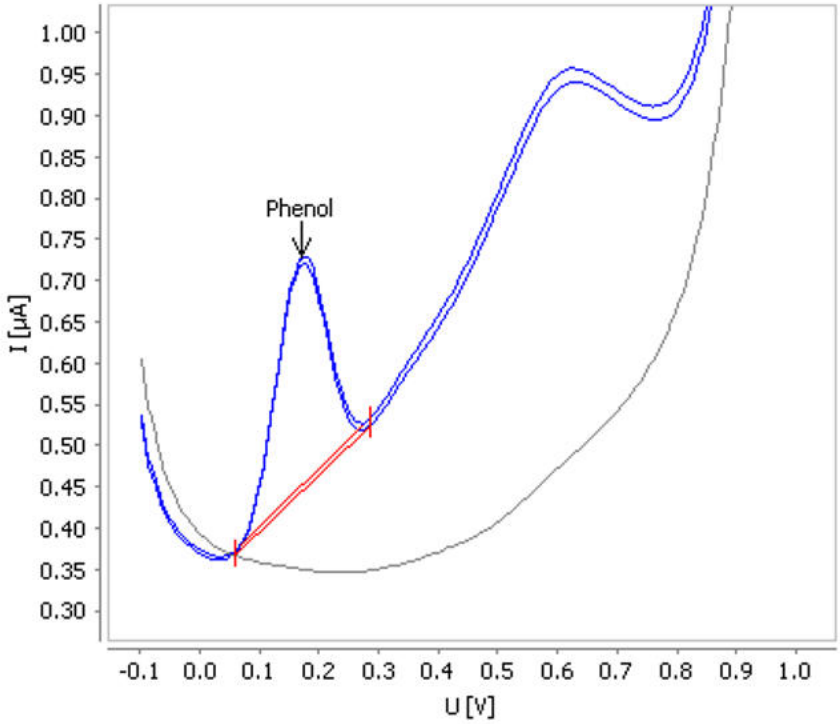

Figure 3. Hindered phenolic antioxidants in turbine oil with alkaline supporting electrolyte

Table 4. Result for turbine oil in alkaline electrolyte

Antioxidant	Remaining content
Hindered phenolic antioxidants	83.6%

REFERENCES

1. ASTM D6971-09(2014) Standard Test Method for Measurement of Hindered Phenolic and Aromatic Amine Antioxidant Content in Non-zinc Turbine Oils by Linear Sweep Voltammetry
2. ASTM D6810-21 Standard Test Method for Measurement of Hindered Phenolic Antioxidant Content in Non-Zinc Turbine Oils by Linear Sweep Voltammetry
3. ASTM D7527-10(2018) Standard Test Method for Measurement of Antioxidant Content in Lubricating Greases by Linear Sweep Voltammetry
4. ASTM D7590-09(2014) Standard Guide for Measurement of Remaining Primary Antioxidant Content In In-Service Industrial Lubricating Oils by Linear Sweep Voltammetry

Internal references: AW VA CH4-0580-042019; AW VA CH4-0581-042019

CONTACT

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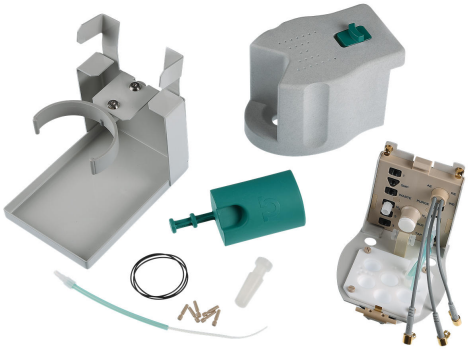
CONFIGURATION

884 Professional VA

Le 884 Professional VA représente l'appareil universel d'entrée de gamme de la série d'appareils Professional VA/CVS. Lorsqu'il est associé à la tête de mesure et au jeu d'électrodes appropriés, des déterminations d'analyses de traces par voltampérométrie et polarographie sont réalisables à l'aide de l'électrode Multi Mode pro, du scTrace Gold, de l'électrode goutte à goutte au bismuth ou des déterminations d'additifs organiques dans des bains galvaniques avec la voltampérométrie cyclique inverse (Cyclic Voltammetric Stripping = CVS), la voltampérométrie cyclique inverse pulsée (Cyclic Pulse Voltammetric Stripping = CPVS) et la chronopotentiométrie (CP). La technique éprouvée des électrodes de Metrohm associée à un potentiostat/galvanostat performant et le logiciel viva extrêmement flexible fait entrevoir de nouvelles perspectives. Le potentiostat avec un calibrateur certifié se réajuste avant chaque mesure automatiquement et garantit la plus grande exactitude possible. La tête de mesure amovible permet de passer rapidement d'une application à l'autre avec différentes électrodes.

Le logiciel viva est nécessaire pour contrôler, collecter et évaluer les données.

Le 884 Professional VA est fourni avec des accessoires en nombre réduit, sans tête de mesure ni électrodes. Le jeu d'électrodes et la licence viva doivent être commandés séparément.



Tête de mesure à électrode à disque tournante pour appareils Professional VA/CVS avec résistance chimique élevée

Tête de mesure pour le fonctionnement avec des électrodes à disque tournantes. Modèle résistant aux solvants pour applications en milieu non aqueux.

Pointe d'électrode en platine de 2 mm pour CVS

Pointe d'électrode métallique en platine (Pt), diamètre du disque d'électrode 2 mm ±0,05 mm, surface polie, tige en verre, raccord fileté M3. Erreur de concentricité : < 0,3 mm. Gamme de température : 0 à 50 °C.