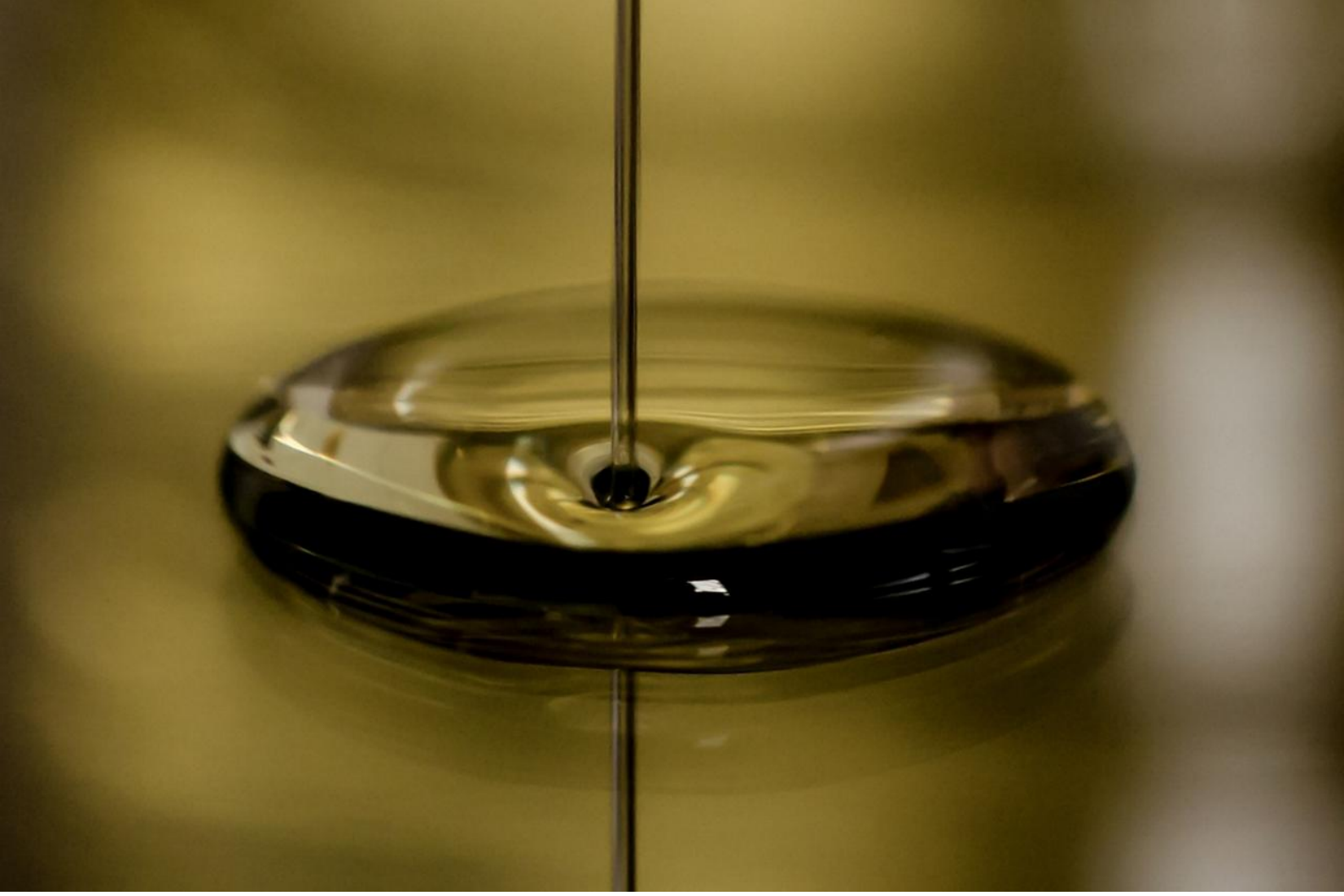

Application Note AN-V-220

Remaining Useful Life of lubricants

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.

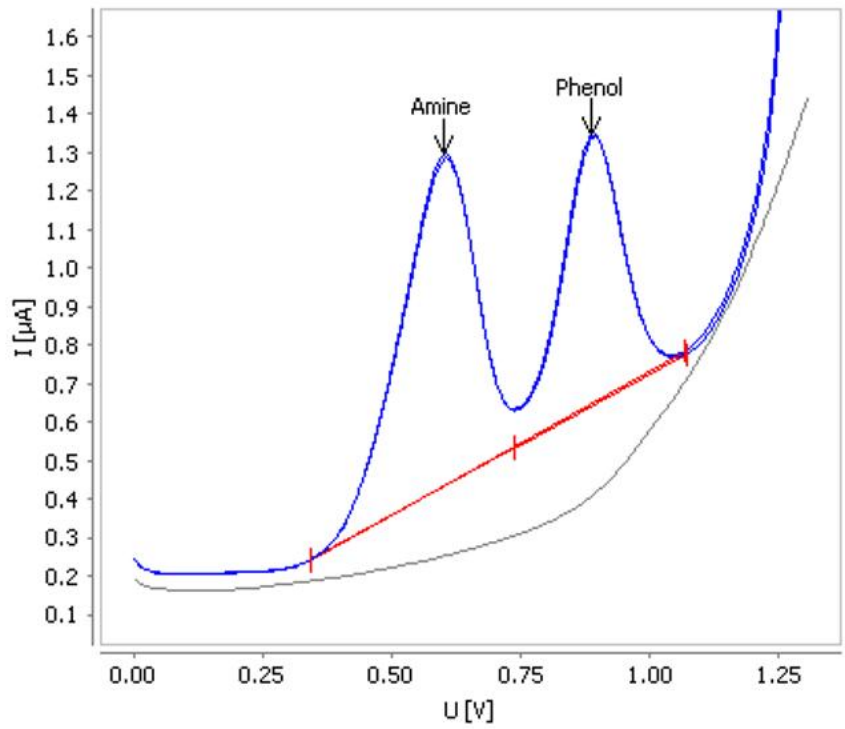

Figure 2. Aromatic amine and phenolic antioxidants compressor oil with neutral supporting electrolyte

Table 3. Results compressor oil in neutral electrolyte

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

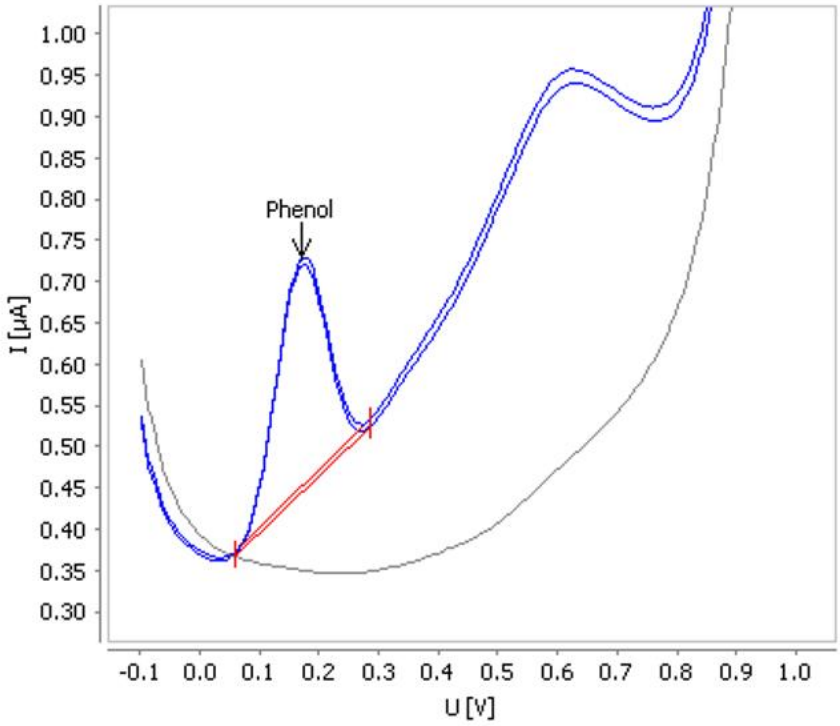

Figure 3. Hindered phenolic antioxidants in turbine oil with alkaline supporting electrolyte

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

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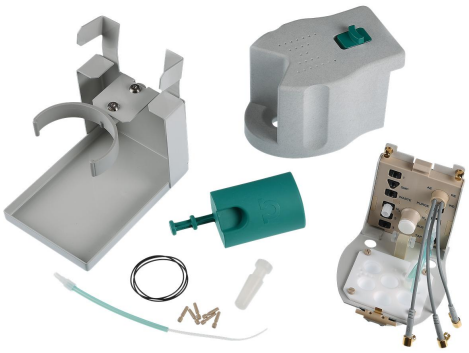
CONFIGURATION

884 Professional VA

884 Professional VA は、Professional-VA/CVS 装置シリースへのユニハーサルなエントリーレヘル装置てす。適切な計測ヘットおよひ適切な電極セットと組み合わせて、マルチモート電極 pro、scTRACE Gold、滴下ヒスマス電極を使用したホルタンメトリーおよびホーラロクラフィーによる微量分析の測定、またはCVS(サイクリックホルタンメトリーストリッヒンク)、CPVS(サイクリックハルスホルタンメトリーストリッヒンク)、CP(クロノホテンショメトリー)による電気めっき浴内の有機添加物の測定を実施することかてきます。高性能のホテンショスタット/カルハノスタットと、非常に柔軟な viva ソフトウェアとのコンヒネーションにおける熟練した Metrohm の電極技術か新たな展望を開きます。性能か認証されたキャリフレータの付いたホテンショスタットは、各測定前に自動的に新たに調整を行い、可能な限り高い精度を保証します。交換可能な測定ヘットにより、異なる電極を持つ様々なアフリケーション間の迅速な交換か可能となります。
コントロール、テータ処理および評価のためにソフトウェア viva か必要となります。
884 Professional VA は、付属品は少なくなっており、測定ヘットと電極は付属せすに納品されます。電極セットおよひ viva ライセンスは別途こ注文ください。



Professional-VA/CVSRDE

回転ティスク電極て動作する測定ヘット。非水系媒体ての用途に適した耐溶剤性ハーション。

2 mm platinum electrode tip for CVS

Metal electrode tip made of platinum (Pt), diameter of electrode disk 2 mm ±0.05 mm, polished surface, shaft made of glass, M3 thread connection. Concentricity error: < 0.3 mm. Temperature range: 0 - 50 °C.