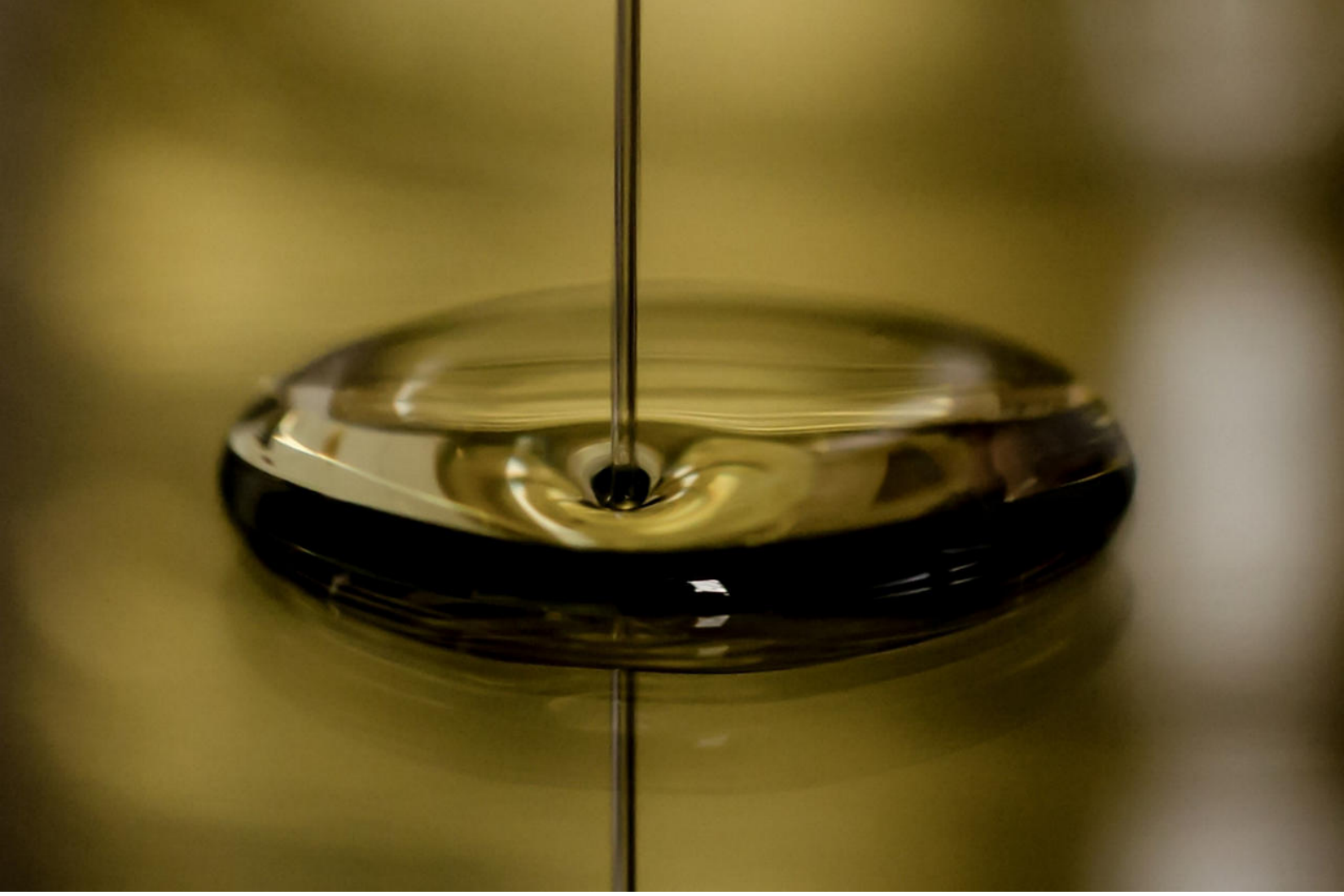

Application Note AN-V-220

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.

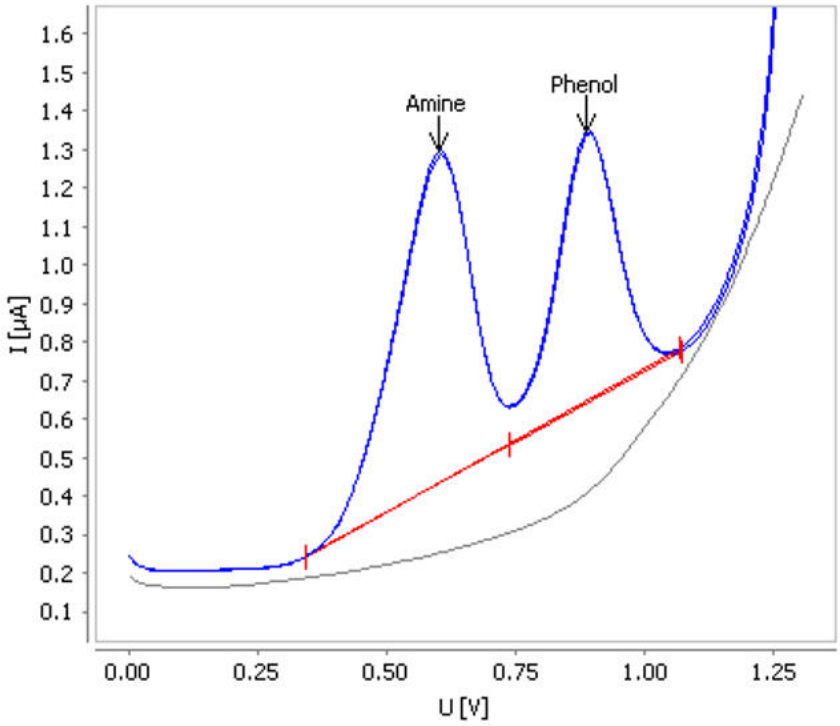

Figure 2. Aromatic amine and phenolic antioxidants compressor oil with neutral supporting electrolyte

Table 3. Results compressor oil in neutral electrolyte

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

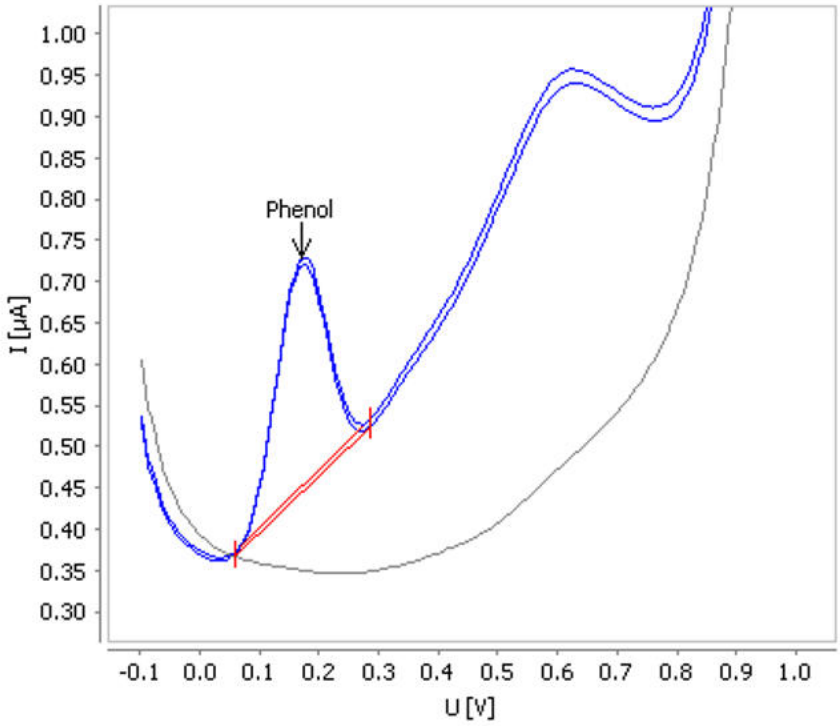

Figure 3. Hindered phenolic antioxidants in turbine oil with alkaline supporting electrolyte

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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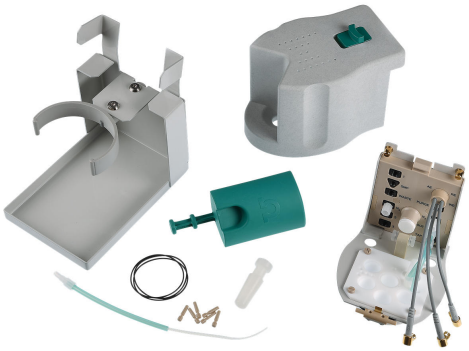
CONFIGURATION

884 Professional VA

884 Professional VA 是 Professional VA/CVS 仪器系列的通用入门级设备。与合适的测量头和电极组联用,可使用伏安测量和极谱法借助多模式电极 pro、scTRACE Gold、铋液滴电极进行痕量分析测定,或通过 «循环伏安溶出法»(CVS)、«循环脉冲伏安溶出法»(CPVS)和计时电位法(CP)在电镀池中对有机添加剂进行测定。此项已经证实的瑞士万通电极技术与恒电位/恒电位仪以及外接的灵活 viva 软件联用,展现了新的前景。带有经认证的校准器的恒电位仪在每次测量之前均自动冲洗进行校准,确保精度。借助可更换的测量头,可在使用不同电极的各种应用之间实现快速切换。

使用 viva 软件进行控制、数据采集和评估。

884 Professional VA 供货时减少了附件,没有测量头和电极。电极组和 viva 许可证则须单独订购。



RDE Professional VA /CVS

用于旋转圆盘电极运行的测量头。耐溶剂仪器型号,适用于非水介质。

2 mm CVS

铂(Pt)制金属电极,电极片直径为 2 mm ±0.05 mm,表面经打磨,玻璃制电极杆,螺纹接头 M3。同心度误差 0.3 mm。温度范围:0-50° C。