



Application Note AN-T-074

自来水中的电导率、pH 值、碱度和硬度

Fully automated determination including sample preparation

The analysis of tap water plays an important role to assess the water quality or to identify its possible contamination. Parameters such as conductivity, pH value, alkalinity, and water hardness are routinely analyzed.

In this application note, a fully automated system is presented which allows the determination of several parameters according to various standards within one analysis. These include conductivity (ISO 7888, EN 27888, ASTM D1125, EPA 120.1), the pH value (EN ISO 10523, ASTM D1293, EPA 150.1), alkalinity (EN ISO

9963, ASTM D1067, EPA 310.1), and Ca/Mg content (ISO 6059, ASTM D1126, EPA 130.2). Additionally, the system transfers the required sample volume into an external titration vessel for the analysis, reducing manual sample preparation. Furthermore, all sensors can be automatically calibrated and the titer of each titrant can also be determined.

This high degree of automation minimizes errors and guarantees outstanding reproducibility by freeing up valuable time for operators.

SAMPLE AND SAMPLE PREPARATION

The method is demonstrated for a tap water sample. No sample preparation is required as the system automatically transfers the defined

sample volume to the external titration cell after conductivity measurement.

EXPERIMENTAL

This analysis is carried out automatically on an 815 Robotic USB Sample Processor XL in an external titration vessel which is equipped with an iAquatrode plus and a combined Ca-ISE. The samples are poured into beakers and then placed onto the rack. First, the conductivity measurement is performed directly in the beaker using a 5-ring conductivity measuring cell with integrated temperature sensor. Afterwards a sample aliquot is transferred into the external titration vessel, the pH measurement is taken, and then the alkalinity titration is performed using standardized HCl solution. Then, the pH value is adjusted via addition of TRIS buffer, and the sample is titrated with standardized EDTA titrant until after the second equivalence point. Finally, cleaning of the titration vessel and sensors is carried out automatically. The pH electrode and the conductivity measuring cell are calibrated prior to the analysis.

RESULTS

The system enables reproducible results for all analyzed parameters. The overall analysis time

for one sample is less than 15 minutes. All results are summarized in **Table 1**.



Figure 1. 815 Robotic USB Sample Processor XL with external titration vessel, 905 Titrande, and 856 Conductivity Module equipped with iAquatrode plus, combined Ca-ISE and 5-ring conductivity measuring cell for the analysis of tap water.

Table 1. Analyzed parameters for tap water (n = 10).

Parameter	Mean	SD(rel) in %
Conductivity	524.7 $\mu\text{S}/\text{cm}$	0.82
pH value	7.81	0.54
p-value	N/A	N/A
m-value	5.8 mmol/L	0.12
Calcium	88.8 mg/L	0.22
Magnesium	19.9 mg/L	1.4
Total hardness	3.9 mmol/L	0.4

CONCLUSION

The high degree of automation for water analysis allows an increase in sample throughput, minimizes errors, and guarantees outstanding reproducibility. As the presented system includes sample preparation capabilities,

the sample only needs to be placed in a beaker onto the rack, and the system runs all analyses (conductivity, pH value, alkalinity, and water hardness) autonomously.

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CONFIGURATION



815 Robotic USB Sample Processor XL (1T/2P)

Robotic USB Sample Processor XL 包括一个工作站和两台内置的隔膜泵,可用于自动处理大量常规样品系列以及完成复杂样品前处理或并列处理流程。还可再连接多达三台加液器用来进行 LQH 加液处理。

由于其应用范围很广,因此必须根据具体应用来选择合适的样品盘、搅拌器、滴定头、机械臂和 Swing Head 以及样品容器并单独订购。

通过 Touch Control 实现单机控制。有以下 PC 控制用软件产品可供选择: 滴定软件 tiamo™、色谱分析软件 MagIC Net、伏安法软件 viva 或 OMNIS。



856 Conductivity Module

电导率测量模块作为现有 Titrandos 系统的扩展设备或作为«独立设备»与 900 Touch Control 一起使用。通过 856 Conductivity Module 模块即可测定电导和温度也可测定总溶解固体值和盐度。它也支持五环电导电极。

该 Conductivity Module 有 2 个 USB 接口,用于连接打印机、条形码读取器或自动进样器,以及 4 个 MSB 接口用于连接搅拌器或 Dosino。

使用 OMNIS-Software、tiamo-软件或 Touch Control。如果需要,满足 GMP/GLP 和 FDA 要求,比如 21 CFR 第 11 部分。



905 Titrandos

用于使用两个测量接口和内部滴定管驱动滴定分析的电位滴定仪。

- 多达四套 800 Dosino 加液系统
- 动态等当点滴定(DET)、等量等当点滴定(MET)和终点设定滴定(SET)
- 使用离子选择性电极测量(MEAS CONC)
- 带监控的加液功能,LQH
- 用于额外搅拌器或加液器系统的四个 MSB 接口
- 智能电极“iTrode”
- USB 接口
- 使用 OMNIS-Software、tiamo-软件或 Touch Control
- 如果需要,满足 GMP/GLP 和 FDA 要求,比如 21 CFR 第 11 部分



5 c= 0.7 cm⁻¹ Pt1000

带池常数的 5 环电导电极 $c = 0.7 \text{ cm}^{-1}$ (指导数值),集成有温度探针 Pt1000 和固定电缆 (1.2 m),用于连接到 856 电导率模块上。

该传感器适用于测量中等的电导率(5 $\mu\text{S/cm}$ 至 20 mS/cm),例如:

- 饮用水
- 地表水
- 废水



iAquatrode Plus Pt1000

集成了传感器数据存储芯片和 Pt1000 温度传感器的用于在离子含量低的含水介质(例如,饮用水、工艺用水)中进行 pH 测量/滴定的数字组合 pH 电极。这种电极在这些样品中显示出非常快的反应时间。

固定磨口隔膜对污染不敏感。

当使用 $c(\text{KCl}) = 3 \text{ mol/L}$ 作为中间电解质时,建议在储存溶液中储存。

中间电解质可以用不含氯离子的电解质(例如,硝酸钾 $c(\text{KNO}_3) = 1 \text{ mol/L}$ (6.2310.010))代替。存储在用过的电解质中。

iTrodes 可用于 Titrand, Ti-Touch 或 913/914 米。



Ca

带聚合物膜的组合式钙选择性电极。

该 ISE 电极适用于:

- 水性溶液中 Ca^{2+} 的离子滴定(5×10^{-7} 至 1 mol/L)
- 络合滴定(复)滴定(例如:测定水硬度)

得益于坚固/为易碎的聚丙烯塑料杆和分子膜片衬垫,传感器可以承受较高的机械载荷。

使用的参考电解液为 $c(\text{NH}_4\text{NO}_3) = 1 \text{ mol/L}$ 。