



Application Note AN-T-076

Conductivity, pH value, alkalinity, hardness, and chloride in tap water

Fully automated determination including sample preparation

The analysis of tap water plays an important role to assess the water quality or to identify possible contaminants. Parameters such as conductivity, pH value, alkalinity, water hardness, and chloride content 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), pH value (EN ISO 10523, ASTM D1293, EPA 150.1), alkalinity (EN ISO

9963, ASTM D1067, EPA 310.1), Ca/Mg (ISO 6059, ASTM D1126, EPA 130.2), and chloride (ISO 9297, ASTM D512, EPA 325.3). Additionally the system transfers the required volume of sample into external titration vessels for the different analyses, 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

external titration vessels after conductivity measurement.

EXPERIMENTAL

This analysis is carried out automatically on an 815 Robotic USB Sample Processor XL equipped with two external titration vessels. One is set up with an iAquatrode plus and a combined Ca-ISE, and the second vessel is set up with an iAg-Titrode.

The samples are poured into beakers and then placed onto the rack. First, the conductivity measurement is directly performed in the beaker with a 5-ring conductivity measuring cell with integrated temperature sensor. Afterwards, a sample aliquot is transferred into the first external titration vessel to perform the pH measurement and then the alkalinity titration (using standardized HCl solution). Next, the pH value is adjusted by the addition of TRIS buffer, and the sample is titrated with standardized EDTA titrant until after the second equivalence point is reached. A second portion of the sample is transferred into the second titration vessel for the chloride determination with standardized silver nitrate titrant (after an acidification step). Finally, cleaning of both titration vessels 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



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

summarized in **Table 1** and exemplary titration curves are given in **Figures 2, 3, and 4**.

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

Parameter	Mean	SD(rel) in %
Conductivity	567.4 S/cm	0.84
pH value	7.83	0.32
p-value	N/A	N/A
m-value	5.44 mmol/L	0.09
Calcium	84.57 mg/L	0.50
Magnesium	19.66 mg/L	1.74
Total hardness	2.92 mmol/L	0.62
Chloride	10.87 mg/L	1.51

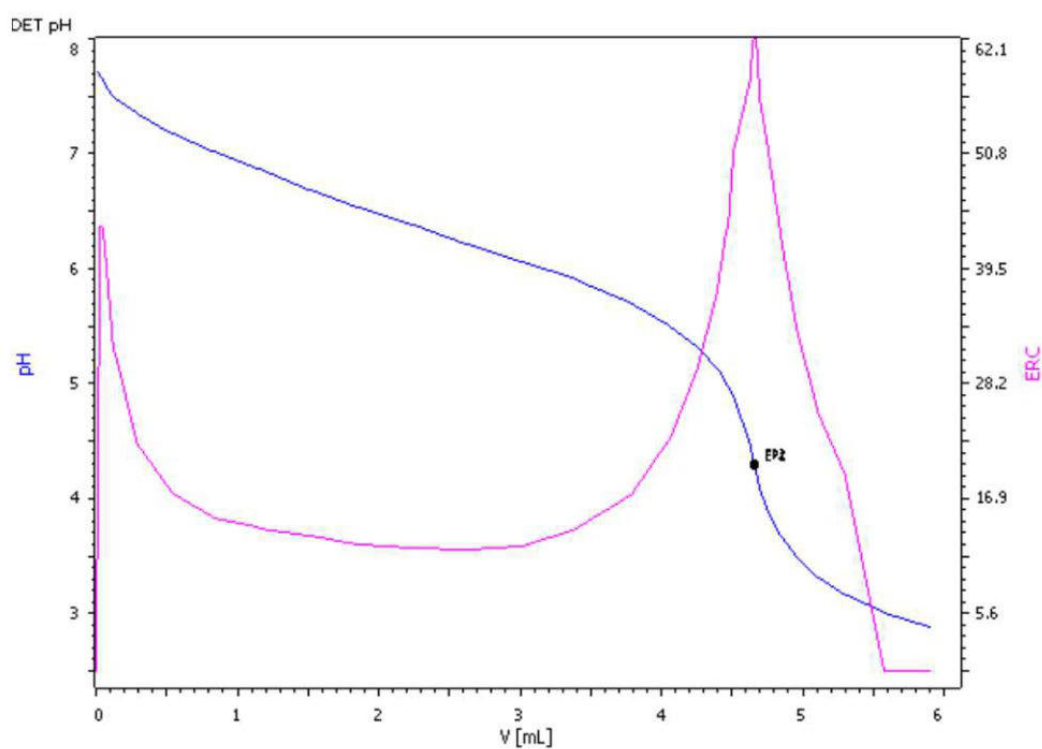


Figure 2. Example of a titration curve for alkalinity measurement in tap water.

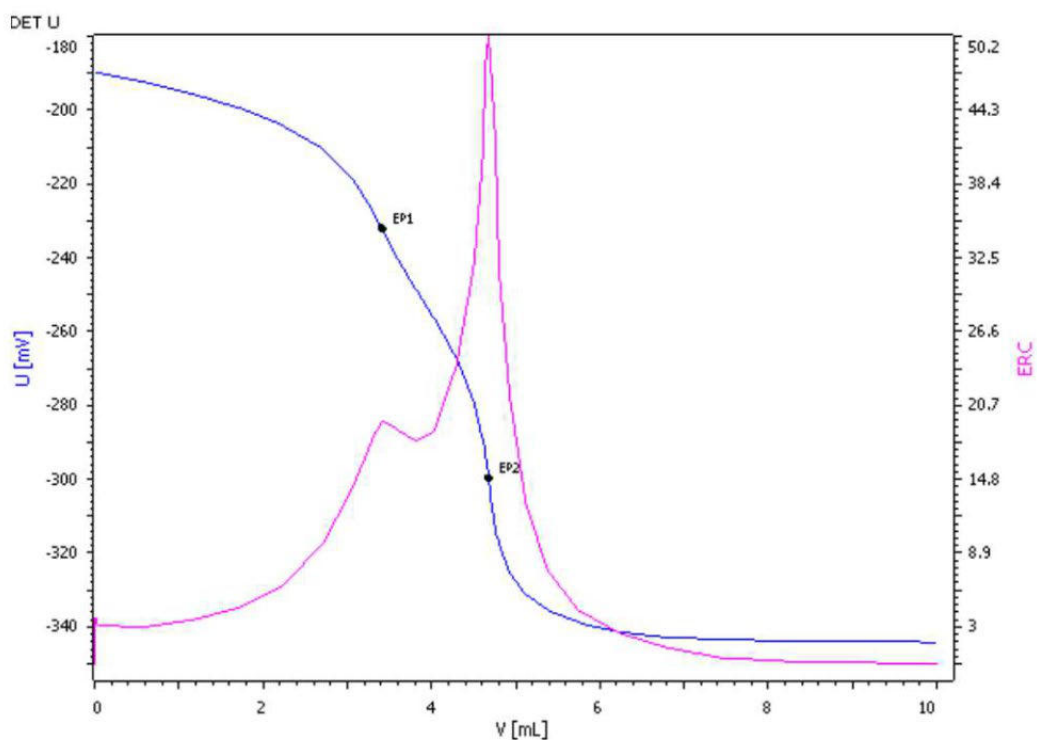


Figure 3. Titration curve for the determination of water hardness, the first EP corresponds to the Ca content and the difference obtained by EP2-EP1 corresponds to the Mg content.

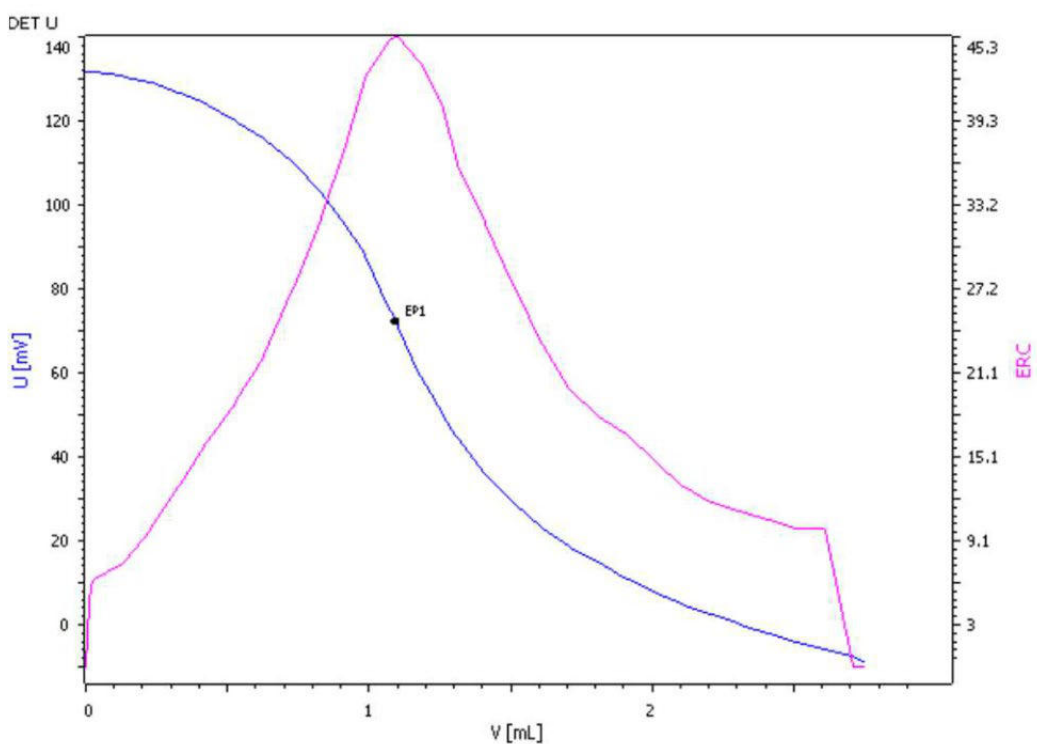


Figure 4. Titration curve for the determination of chloride in a tap water sample.

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, the sample only needs to be placed in a beaker onto the rack and the system runs all

analyses (conductivity, pH value, alkalinity, water hardness, and chloride) autonomously in one run. The automatic and accurate addition of the solutions combined with the automated system frees up valuable time of the operator and therefore increases the productivity in the lab.

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CONFIGURATION



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

検体数が多量なルーチンサンプルの連続自動処理、複雑なサンプル前処理、並行作業のためのワークステーション1つおよび内蔵式ダイヤフラムポンプが2つ付いたロボテックUSBサンプルプロセッサXL。LQH(リキッドハンドリング)作業のためのドージングデバイスを3つまで接続することができます。

様々な用途に対応するため、サンプルラック、スターラー、滴定ヘッド、スイングアーム、Swing Head、サンプル容器はアプリケーションに合わせて別途ご注文ください。

制御はTouch Controlにより「スタンドアローン」で動作します。PC制御には以下のソフトウェア製品を選択することができます：滴定ソフトウェア tiamo™、クロマトグラフィーソフトウェア MagIC Net、ボルタンメトリーソフトウェア viva、または OMNIS。



843 Pump Station (peristaltic)

The 843 Pump Station (peristaltic) has two built-in peristaltic pumps. These can be controlled directly via the interface using remote signals or manually by pressing a button.



856 Conductivity Module

Titrando900 Touch Control856 Conductivity Module
TDS5

Conductivity ModuleUSB2DosinoMSB4

OMNISTiamoTouch ControlGMP/GLPFDA 21 CFR Part
11 ()



905 Titrando

Dosino2

- 800 Dosino4
- (DET) (MET) (SET)
- (MEAS CONC)
- LQH
- 4MSB
- iTrode
- USB
- OMNISTiamoTouch Control
- GMP/GLPFDA 21 CFR Part 11()

5 c = 0.7cm-1Pt1000 ()

c = 0.7 cm⁻¹ () 5Pt1000856 Conductivity Module (1.2
m)

(5 S/cm20 mS/cm) :

-
-
-



Pt1000iAquatrode Plus

() pH/Pt1000pH

$c(\text{KCl}) = 3 \text{ mol / L}$

($c(\text{KNO}_3) = 1 \text{ mol/L}$ (6.2310.010))

iTrodeTitrandotTi-Touch913/914



Ca

:

- Ca^{2+} ($5 \cdot 10^{-7} \sim 1 \text{ mol/L}$)

- ()

$c(\text{NH}_4\text{NO}_3) = 1 \text{ mol/L}$



iAg-Titrode

pH

pH () :

-

-

-

-

-

Ag_2S Ag Titrode

iTrodes TitrandotTi-Touch 913/914