Application Note AN-D-002

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Streamlining beverage analysis with ion chromatography

Beverage analysis methods must be fast and robust to fulfill many quality control regulations. Optimal product quality is critical for consistent taste and other sensory characteristics in mass produced beverages.

In the case of beer, the ionic composition heavily influences the taste. For example, potassium chloride salts lead to a bitter, astringent, and soapy taste while magnesium sulfates form more sweet-sour flavors. Therefore, analytical control of anions and cations in beer is essential to guarantee the quality and meet consumer needs.

Major anions in beer are precisely determined with ion chromatography (IC) and suppressed conductivity detection, while cations are quantified with non suppressed conductivity. With a two-channel system, cations and anions can be determined simultaneously for the same sample. To reduce manual preparation steps, beer samples are automatically filtered with Inline Ultrafiltration. Features like automatic calibration and logical sample dilution streamline such beverage analyses and ensure the fast analysis of samples in high-throughput laboratories.

Beer samples from different providers (e.g., Warsteiner™) were automatically diluted and filtered through a 0.22 m membrane in the Ultrafiltration cell (**Figure 1**). Analyte concentrations outside of the calibration range are diluted with an optimal dilution factor and analyzed again with logical dilution, a feature of the chromatographic software MagIC Net. Hence, the results always fit within the calibration range.

After Inline Sample Preparation is performed, the sample is injected into two analytical channels that simultaneously analyze cations and anions under **isocratic elution** conditions (**Table 1**). Conductivity is a universal and sensitive detector to determine all relevant ions present in the beer sample. The MagIC Net software offers time-saving reliable calibration from a single standard solution by injecting increasing volumes on to the separation column (MiPT – Metrohm intelligent Partial Loop Injection Technique). This avoids pipetting errors during standard preparation. Furthermore, samples can be injected with the most suitable injection volume. Together with logical dilutions, sample concentrations in the range 1:10,000 can be analyzed reliably. High accuracy of results is achieved by an optimal fit for the calibration points (feature: high-low calibration).

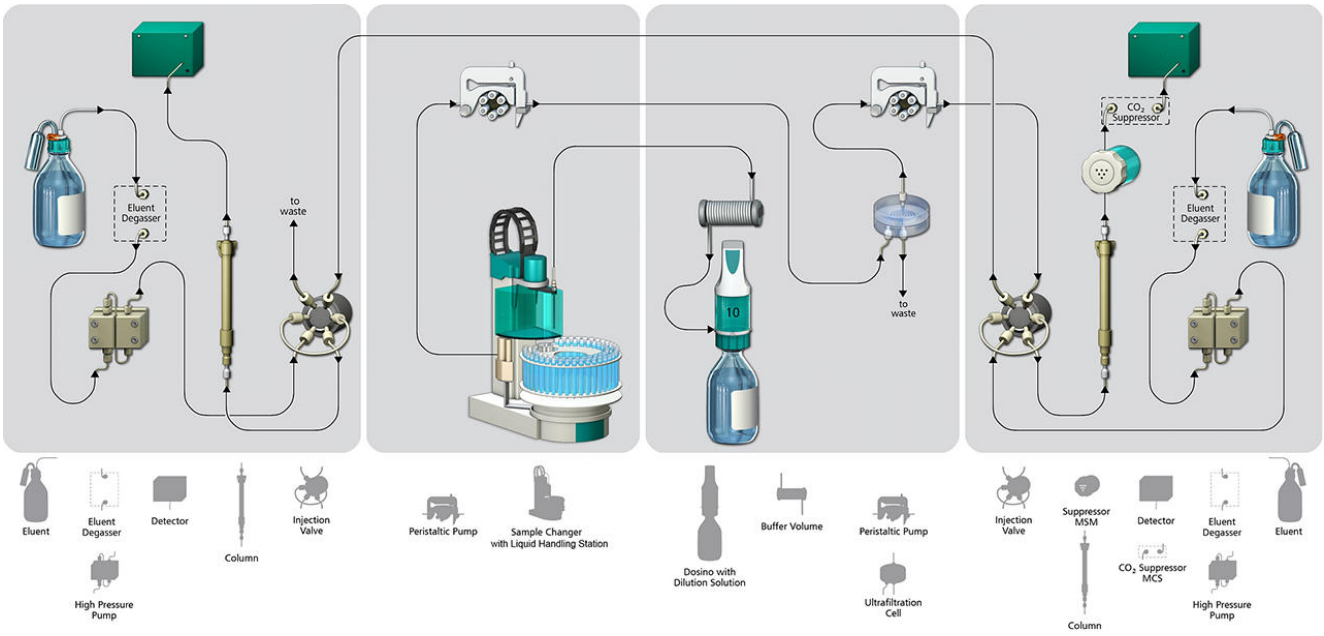

Figure 1. One autosampler (including filtration and dilution equipment) prepares the sample for two analysis channels such that anions and cations are determined in parallel from the same sample. The IC for cation analysis is displayed on the left side, and the IC used for anion analysis is shown on the right side.

Table 1. Measuring conditions for the determination of anions and cations in beer with ion chromatography.

Method parameter	Anions	Cations
Column	Metrosep A Supp 10 - 100/4.0	Metrosep C 6 - 150/4.0
Eluent	4 mmol Na_2CO_3 + 6.0 mmol/L $NaHCO_3$ + 5.0 mol/L $NaClO_4$	2.3 mmol HNO_3 + 1.7 mmol/L dipicolinic acid
Flow rate	0.7 mL/min	0.9 mL/min
Temperature	30 °C	35 °C
Injection	20 L	20 L
Detection	Suppressed conductivity	Non-suppressed conductivity

Potassium was identified as a major cation in all beer samples, while the concentration of other cations (e.g., Na^+, Ca^{2+}, and Mg^{2+}) was lower than 100 mg/L (**Figure 2**). The results reveal the effect of K^+ in beer, as it provides a bitter and astringent taste. Other ions such as ammonium (eluting between Na^+ and K^+) can also be determined.

Chloride, phosphate, nitrate, and sulfate were the main anions detected in beer (**Figure 2**). Sulfite, a common preservative, can be determined next to other anions in the same run (retention time approximately 11 minutes).

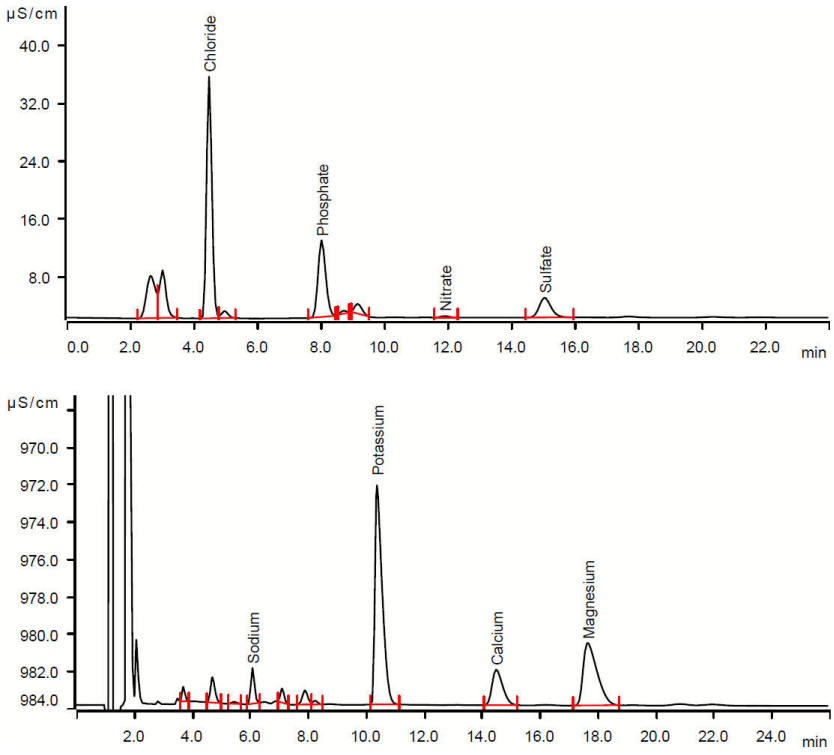

Figure 2. Analysis of a Warsteiner Pils sample (10-fold dilution) containing chloride (229 mg/L), phosphate (352 mg/L), nitrate (5 mg/L), and sulfate (60 mg/L) as major anions (top), and sodium (13 mg/L), potassium (365 mg/L), calcium (53 mg/L), and magnesium (56 mg/L) as major cations (bottom).

CONCLUSION

Ion chromatography is a robust and straightforward analytical technique to monitor beer production and to control its quality. Beverage samples are automatically diluted and filtered prior to analysis to protect the analytical system. All essential anions and cations are simultaneously quantified in one analysis run. Features like logical dilution further save time and reduce manual work.

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CONFIGURATION

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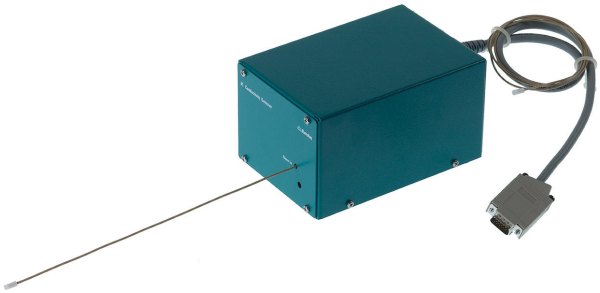

IC Conductivity Detector

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Metrosep C 6 - 150/4.0

C 6 Metrosep C 6 - 150/4.0

858 Professional Sample Processor

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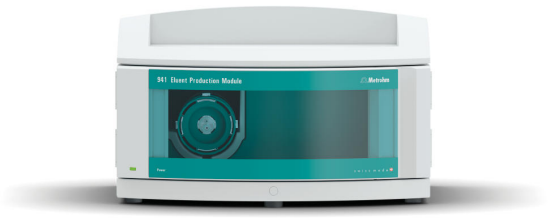

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