Application Note AN-C-195

# 使用微孔子色法行子定量分析,性能提升

## Benefits of microbore ion chromatography for cation analysis


## SUMMARY

Analytical performance with ion chromatography (IC) is typically determined by the signal-to-noise (S/N) ratio that the analytical equipment can reach. The S/N ratio strongly depends on chromatographic peak shapes. Peak shapes improve in miniaturized IC systems with less dead volume [1].

Microbore IC combines 2 mm separation columns, microbore capillaries, and a conductivity detector with reduced cell volume to create a miniaturized IC system with optimal sensitivity [2]. Such systems provide shorter retention times and consume less eluent, increasing sample throughput and reducing the costs of daily routine analytics.

In this Application Note, a microbore IC system

(MB) was compared to a standard bore IC system (SB). The microbore IC system showed improved resolution and better peak heights (a factor of ~30% more for lithium ions). Microbore IC uses less solvents and can result in cost reductions of up to 75% compared to using standard bore ion chromatography systems. Using MB systems has the potential to improve the performance of many typical IC applications.

## SAMPLE AND SAMPLE PREPARATION

This study was conducted with alkali metal ions, alkaline earth metal ions, and ammonium. A mixed standard solution ($c(Li^+)$ = 25 µg/L, $c(Na^+, NH_4^+)$ = 125 µg/L, $c(K^+, Mg^{2+}, Ca^{2+})$ = 250 µg/L) was prepared from 1000 mg/L stock solutions (Standards for IC, *Trace*CERT®, Sigma-Aldrich, Merck) by dilution in ultrapure water.

## EXPERIMENTAL

A microbore IC system comprised of a 930 Compact IC Flex Oven/DEG/MB together with an IC conductivity detector MB (**Figure 1**) was compared to its respective standard bore IC system configuration (930 Compact IC Flex Oven/DEG).

The MB setup from Metrohm has a reduced dead volume with shorter capillaries and smaller capillary inner diameters (0.18 mm) wherever possible.

The microbore conductivity detector has a small inner cell volume (0.3 µL) and a low noise level (<0.1 nS). Furthermore, it even tolerates challenging eluents such as methanesulfonic acid (MSA). Microbore columns, which have a 2 mm inner diameter and associated reduced eluent flow rates, lead to better S/N. This increases sensitivity even further and lowers limits of detection.

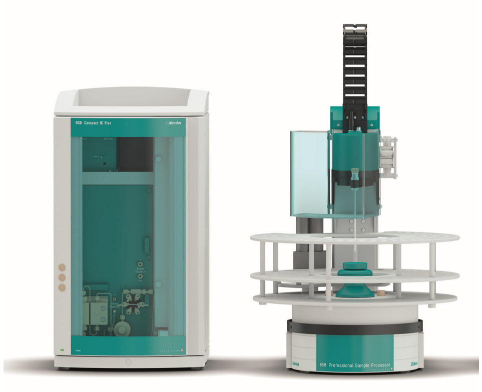

**Figure 1.** nstrumental setup including a miniaturized 930 Compact IC Flex Oven/Deg/MB and an 858 Professional Sample Processor.

The mixed cation standard solution was injected using a 5 µL loop and then separated on a 2 mm version of the Metrosep C 6 column on both tested IC systems. The conductivity was directly recorded (non-suppressed cation analysis, **Table 1**).

**Table 1.** IC method parameters for both standard bore and microbore IC systems.

| Column | Metrosep C 6 - 150/2.0 |
|---|---|
| Eluent (from Merck concentrate Sigma-Aldrich, Merck 19399) | c($HNO_3$) = 1.7 mmol/L c(DPA) = 1.7 mmol/L |
| Flow rate | 0.25 mL/min |
| Temperature | 30 ° C |
| Injection volume | 5 µ L |
| Detection | Direct conductivity |

For performance comparison reasons, the retention times, resolution, peak heights, and repeatability were evaluated with MagIC Net software (version 4.1).

## RESULTS

Overall performance was improved when using the MB system for analysis. Retention times were shorter with the MB system (approximately 0.2 minutes in this case) than with the SB system (**Figure 2**).

Resolution with the MB system was ~115% better than with the SB system (**Table 2**). Peak heights were higher, with most improvement shown for the early-eluting peaks (lithium, sodium, ammonium) on the MB system (**Table 3**). The noise was comparable for both tested IC setups.

Minimal improvement effects were observed for later eluting peaks (e.g., potassium, magnesium, and calcium). For all other relevant parameters, MB and SB showed similar results (e.g., repeatability).

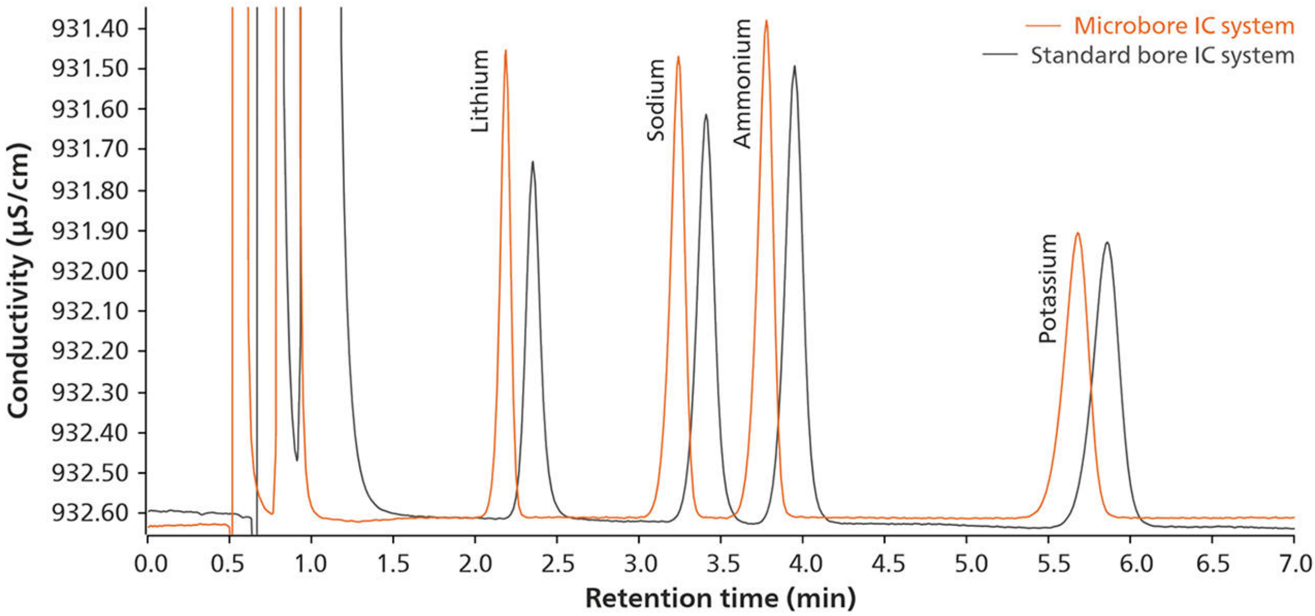


**Figure 2.** Comparison of the chromatograms for alkali metal ions (lithium, sodium, and potassium) and ammonium on a Metrosep C 6 microbore column with microbore IC (MB, orange chromatogram) and on a standard bore IC system (SB, grey chromatogram). The microbore IC system shows improved peak shapes, increased peak heights, and shorter retention times.

**Table 2.** Comparison of peak resolution for alkali metal ions and ammonium as measured by MB and SB systems.

| Resolution | MB | SB |
|---|---|---|
| Lithium | 5.6 | 5.6 |
| Sodium | 3.0 | 2.6 |
| Ammonium | 7.9 | 7.3 |
| Potassium | 6.0 | 5.8 |

**Table 3.** Comparison of peak heights and associated improvement factors for MB vs. SB systems.

| Peak height [µS/cm] | MB | SB | Improvement factor |
|---|---|---|---|
| Lithium | 1.16 | 0.88 | 131% |
| Sodium | 1.14 | 1.01 | 113% |
| Ammonium | 1.23 | 1.13 | 108% |
| Potassium | 0.71 | 0.70 | 100% |

## CONCLUSION

The MB system combines microbore capillaries, a conductivity detector with reduced cell volume, and a 2 mm separation column—all of which lead to improved peak shapes and shorter retention times. This enables increased sensitivity and lower limits of detection. Lower flow rates reduce eluent consumption and overall running costs.

Non-suppressed MB systems in combination with 2 mm columns deliver significant improvements with respect to resolution and sensitivity. For sequentially suppressed IC systems (SES) including a microbore $CO_2$ suppressor (MCS) with reduced dead volume, the main improvement is shorter retention times. This is helpful with low flow rates, and especially in combination with gradient applications as changes in the eluent composition will quickly impact the analysis and the effect will not be delayed by unnecessary dead volume.

MB systems can be used with 2 mm as well as 4 mm separation columns. These systems are suitable for all IC applications.

## REFERENCES


1. Diederich, V.; Riess, A. K. Best Practice for Separation Columns in Ion Chromatography (IC) – Part 2. *Analyze This – The Metrohm Blog*, 2021.
2. Metrohm AG. Metrohm Microbore Ion Chromatography – Maximize the Efficiency of Your Ion Chromatography!, 2023.


## CONTACT


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## CONFIGURATION

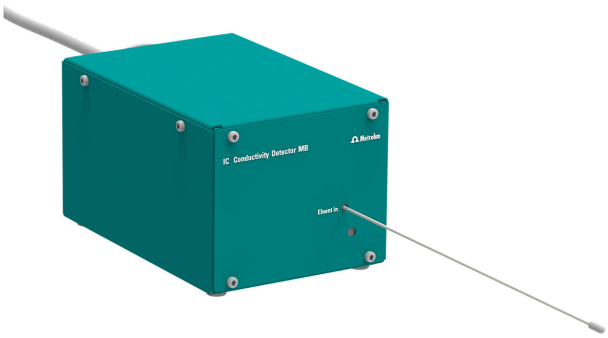
**930 Compact IC Flex Oven/DEG/MB**

930 Compact IC Flex Oven/DEG/MB 是智能型**柱加炉、无抑制**的 Compact 子色,并且内置**脱气装置。**器可使用任意分和方法。

**典型的用范:**

- 子和子定,无抑制的
- 使用 UV-VIS 或安培的用
- 微孔 (2mm) 用化,尤其合合技(IC-MS 或 IC-ICP/MS)

支持 MagIC Net 4.1 和以上版本




## IC Conductivity Detector MB

用于智能型子色的智能型高性能器。微孔柱化。卓越的温度定性,在受保的器端子板内完成整个信号理程以及最新一代的 DSP(数字式信号理)均能保量的最高精性。功于工作范,无需行(也包括非自)范更。

**典型的用范:**

- 子或子定,化学抑制、序列抑制法或无抑制及
- 微孔 (2mm) 用化,尤其合合技(IC-MS 或 IC-ICP/MS)

**格明概:**

- 0 ... 15000 μS/cm 无区段切
- 量池容量:0.3 μL
- 由不 X2CrNiMo17-12-2 (316 L) 制成的形,与 MSA 兼容
- 最大工作力:10.0 MPa (100 bar)
- 池温:20 ... 50 ° C,步幅 5 ° C
- 温度定性:< 0.001 ° C
- 基噪音:<° 0.2° nS/cm,是使用序列抑制法的典型
- 毛管:ID 0.18 mm

支持 MagIC Net 4.1 和以上版本

## Metrosep C 6 - 150/2.0

高容量的 C-6 材料使微孔径版本的 Metrosep C 6 - 150/4.0 柱成在度差很高的正常保留内分准子的解决方法。可用此柱定含量很高的用水。

柱合用在 IC-MS 用中。


## Metrosep C 6 Guard/2.0

Metrosep C 6 Guard/2.0 包含 C-6 柱材料,用于防微粒和防染。用它可著延分析用分柱的使用寿命。Metrosep C 6 Guard/2.0 按照 «On Column Guard System» 来行,可几乎无死点容地直接安装到相分柱上。

MiPT

用于安装 Dosino 以行局部循的附件。