Microbore columns: a contribution to green chemistry

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Ion Chromatography

Summary

Available sample size, mass sensitivity, efficiency, and the detector type are important criteria in the selection of separation column dimensions. Compared to conventional 4 mm i.d. columns, microbore columns excel, above all, by their low eluent consumption. Once an eluent is prepared, it can be used for a long time. Additionally, the lower flow rates of microbore columns facilitate the hyphenation to mass spectrometers due to the improved ionization efficiency in the ion source.

With the same injected sample amount, a halved column diameter involves a lower eluent flow and results in an approximate four-fold sensitivity increase. In a converse conclusion, this means that with less sample amount, microbore columns achieve the same chromatographic sensitivity and resolution than normal bore columns. This makes them ideally suited for samples of limited availability.

Introduction

Industries` impact on the environment is steadily growing. Therefore, ecological approaches and sustainable procedures are needed. In response to the environmental challenges, several important laws such as the Clean Air Act and Clean Water Act, or the Pollution Prevention Act have been approved. While the first two acts rather focus on remediation in the sense that pollution is treated after it is formed, EPA`s green chemistry attempt aims at pollution prevention. It encourages the design of chemical products and processes that minimize the use and generation of hazardous substances.

Microbore chromatography employs columns that have a smaller inner diameter (e.g., 2 mm i.d.) than the normal bore columns (e.g., 4 mm i.d.) and are thus operated with lower eluent flow rates (0.2 mL/min compared to 0.7…1.0 mL/min). Not least because of their decreased solvent consumption, they comply with EPA`s green chemistry philosophy. Moreover, environmentally benign carbonate/bicarbonate solutions are important eluents for most anion separations. In the course of system miniaturization, not only columns got thinner, but also the suppressor module was scaled down, leading to reduced consumption of regenerant solution: for complete regeneration, as little as 2 mL acid (1 mol/L) is sufficient and no exchange of cartridges or membranes is necessary. With 2 mm microbore columns and the adapted suppressor module, lower overall flow rates are achieved. Besides the ecological benefits, microbore columns require less frequent eluent preparation and thus improve accuracy and save time. Additionally, they get along with only limited sample material and can be perfectly interfaced with various inline detectors.

This poster presents several applications that demonstrate the benefits of a 2 mm i.d. column packed with a high-capacity anion exchange resin.

Intelligent microbore columns

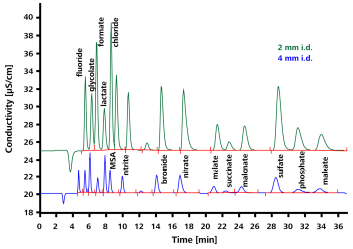
All intelligent Metrohm ICs – whether you use the 850 Professional IC, the 881 Compact IC pro or the 882 Compact IC plus – can be equipped with a 2 mm i.d. column.

Diversity

Assuming identical sample amounts, microbore-based separations show a better mass sensitivity than standard bore separations. Compared to the latter, microbore ion chromatography achieves higher sensitivities but a poorer chromatographic resolution. If, according to the reduced column capacity, the sample amount is reduced to a fourth, column overloading is avoided and the same chromatograms are obtained.

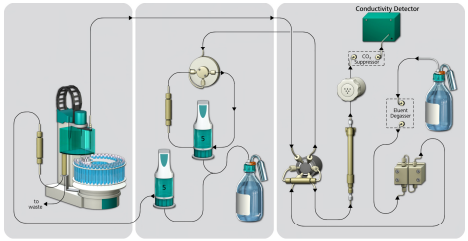
2…10 mg/L anion and organic acid standard

Column:	Metrosep A Supp 16 - 250/2.0 Metrosep A Supp 16 - 250/4.0
Column temp.:	65 °C
Eluent:	7.50 mmol/L sodium carbonate 0.75 mmol/L sodium hydroxide
Flow:	0.2 mL/min 0.8 mL/min
Loop:	20 µL



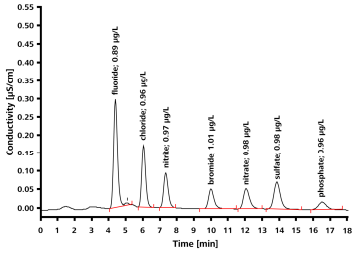
Eluent saving

Changing from a 4.0 to a 2.0 i.d. column will reduce the consumption of eluent and auxiliary solutions to about a quarter. This is highly favorable for the operation of ion chromatographs in nuclear power plants that run around the clock and where incoming and outgoing goods pass laborious inspections and should therefore be minimized.



1 µg/L anion standard

Sample prep.:	Anion preconcentration in complex matrices is achieved by using Metrohm`s intelligent Preconcentration Technique with additional Matrix Elimination (MiPCT-ME).
$Volume_{precon.}$:	4 mL
Column:	Metrosep A Supp 16 - 150/2.0
Column temp.:	45 °C
Eluent:	7.50 mmol/L sodium carbonate 0.75 mmol/L sodium hydroxide
Flow:	0.25 mL/min

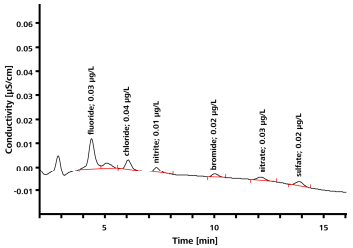


Small sample amounts

Small diameter columns provide an increased absolute mass sensitivity and are mainly used for clinical, pharmaceutical, toxicological, and environmental samples with limited sample amounts. By reducing the column diameter to half, a four-fold decrease in column volume and thus a lower flow rate is achieved. Consequently, the dwell time in the detector is prolonged and signal intensities are increased. When combined with upstream MiPCT-ME, analyte concentrations in the sub-ppt range can be accurately analyzed.

0.01 µg/L anion standard

Sample prep.:	MiPCT-ME
$Volume_{precon.}$:	4 mL
Column:	Metrosep A Supp 16 - 150/2.0
Column temp.:	45 °C
Eluent:	7.50 mmol/L sodium carbonate 0.75 mmol/L sodium hydroxide
Flow:	0.25 mL/min



Better hyphenation

Mass spectrometric (MS) detectors are sensitive and by adding an extra dimension of selectivity, they can identify components that often can not be chromatographically resolved.

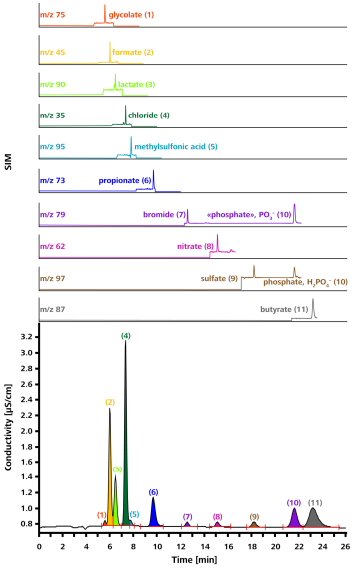
The challenge in coupling IC to MS consists in adjusting the generally higher column flow rate to the required lower flow rate for the ion source of the MS. This problem can be overcome by using flow splitters. More advantageous, however, is the use of microbore columns that due to their reduced flow can be directly interfaced to online electrospray mass spectrometers.

0.1…2.0 mg/L organic acid and anion standard

Column:	Metrosep A Supp 16 - 150/2.0
Column temp.:	45 °C
Eluent:	7.50 mmol/L sodium carbonate 0.75 mmol/L sodium hydroxide
Flow:	0.3 mL/min
Loop:	20 µL

MS ESI + single quadropol

Drying gas:	13 L/min
Gas temp.:	350 °C
Quad temp.:	100 °C



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