Technical Note 90

Mass Sensitivity of Capillary IC Systems Explained

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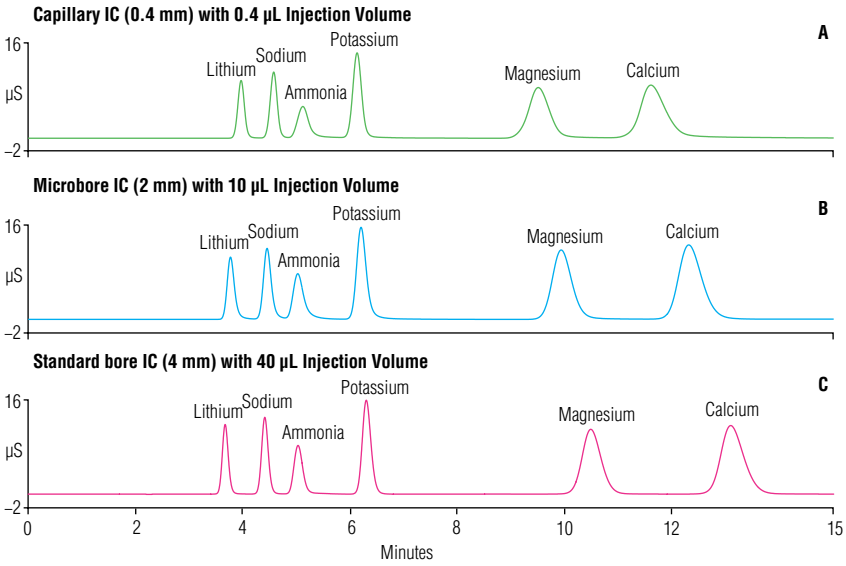
This work describes the increased mass sensitivity of a Thermo Scientific™ Dionex™ ICS-5000 capillary system relative to a standard ion chromatography system.

Chromatography detectors are generally classified as either mass- or concentration-sensitive. A mass-sensitive detector responds to the mass of the target analyte passing through the detector per unit of time. A concentration-sensitive detector responds to the concentration of the target analyte passing through the detector (i.e., the mass of the target analyte per unit volume of the eluent). The conductivity detector commonly used in ion chromatography is a concentration-sensitive detector, whereas both the flame ionization detector used in gas chromatography and the Thermo Scientific™ Dionex™ Corona™ Charged Aerosol Detector used in high-performance liquid chromatography are mass-sensitive detectors.

To illustrate that a conductivity detector is a concentration-sensitive detector, Figure 1A depicts a 0.4 µL sample of a six-cation standard injected onto a 0.4 mm Thermo Scientific™ Dionex™ IonPac™ CS12A column, Figure 1B shows a 10 µL sample of the same standard injected onto a 2 mm column, and Figure 1C shows a 40 µL sample injected onto a 4 mm column. The flow rates are 10 µL/min, 0.25 mL/min, and 1.0 mL/min for the 0.4, 2, and 4 mm columns, respectively.



Column:	Dionex IonPac CS12A A–0.4 × 250 mm B–2 × 250 mm C–4 × 250 mm
Eluent:	20 mM Methanesulfonic acid (MSA)
Eluent Source:	EGC III (MSA) or EGC-MSA (Capillary)
Flow Rate:	A–10 µL/min B–0.25 mL/min C–1.00 mL/min
Inj. Volume:	A–0.4 µL B–10 µL C–40 µL
Column Temp.:	30 °C
Detection:	Suppressed Conductivity (recycle mode) A–CCES 300, 10 mA current B–CSRS 300 (2 mm), 15 mA current C–CSRS 300 (4 mm), 59 mA current
Detector Temp.:	35 °C
Sample:	6 Cation Standard II (diluted 100-fold)

Peaks:		
	Lithium	0.5 mg/L (ppm)
	Sodium	2.0 mg/L
	Ammonium	2.5 mg/L
	Potassium	5.0 mg/L
	Magnesium	2.5 mg/L
	Calcium	5.0 mg/L

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Figure 1. Comparison of chromatograms obtained using 0.4 mm, 2 mm, and 4 mm Dionex IonPac CS12A columns with injection volumes proportionally adjusted to the column diameters.

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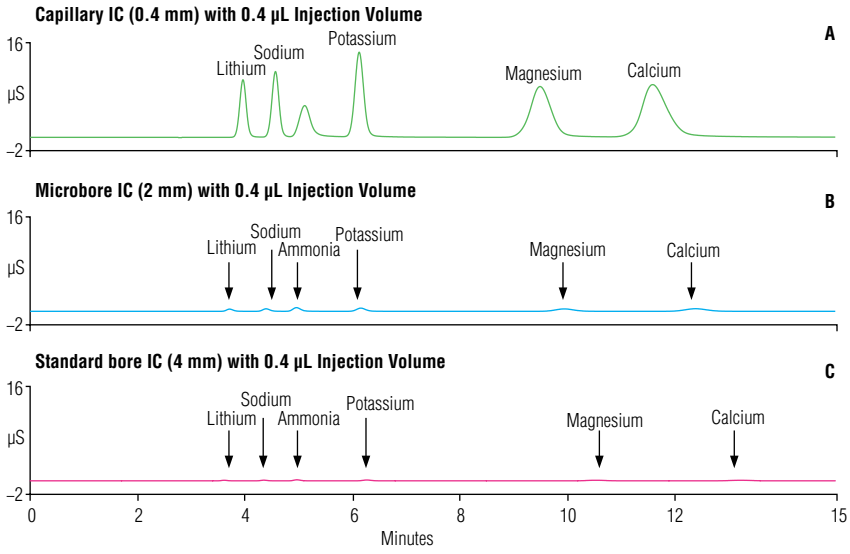
The amount of analytes injected on the 4 mm column is 100× greater than that injected onto the 0.4 mm column, just as the flow rate with the 4 mm column is 100× greater than that of the 0.4 mm column. The concentrations of separated analytes passing through the conductivity detector in the 0.4 mm column system are the same as those in the 4 mm column system. Because the conductivity detector is a concentration-sensitive detector, it generates the same detector response for each of the three separations; a Dionex ICS-5000 capillary system using 0.4 mm columns provides the *same concentration sensitivity* as a Dionex ICS-5000 standard-bore system using 4 mm columns.

In the second example, 0.4 µL of the same six-cation standard is injected onto a 0.4 mm and a 4 mm Dionex IonPac CS12A column so that both columns separate the same amount of analytes. Because of the difference in separation flow rates, the concentration of separated analytes going through the conductivity detector in the 0.4 mm column system is greater than that in the 4 mm column system. Figure 2 shows a 100-fold increase in conductivity response because the conductivity detector is a concentration-sensitive detector. Therefore, a Dionex ICS-5000 capillary system using 0.4 mm columns provides *increased mass sensitivity*. This is beneficial for applications with samples of limited volumes when compared to a Dionex ICS-5000 system using 4 mm or 2 mm columns.

In summary, the Dionex ICS-5000 capillary IC system provides the *same concentration sensitivity* as the Dionex ICS-5000 standard-bore IC system. In addition, the capillary IC system offers the benefit of *increased mass sensitivity* for applications with limited sample volumes. This enables analysts to either use smaller sample volumes and yet still obtain the same sensitivity as a 4 or 2 mm system, or concentrate smaller sample volumes to get the same sensitivity (i.e., 100-fold less sample required).



Column:	Dionex IonPac CS12A	
	A–0.4 × 250 mm	
	B–2 × 250 mm	
	C–4 × 250 mm	
Eluent:	20 mM Methanesulfonic acid (MSA)	
Eluent Source:	EGC III (MSA) or EGC-MSA (Capillary)	
Flow Rate:	A–10 µL/min	
	B–0.25 mL/min	
	C–1.00 mL/min	
Inj. Volume:	A–0.4 µL	
	B–0.4 µL	
	C–0.4 µL	
Column Temp.:	30 °C	
Detection:	Suppressed Conductivity (recycle mode)	
	A–CCES 300, 10 mA current	
	B–CSRS 300 (2 mm), 15 mA current	
	C–CSRS 300 (4 mm), 59 mA current	
Detector Temp.:	35 °C	
Sample:	6 Cation Standard II (diluted 100-fold)	
Peaks:	Lithium	0.5 mg/L (ppm)
	Sodium	2.0 mg/L
	Ammonium	2.5 mg/L
	Potassium	5.0 mg/L
	Magnesium	2.5 mg/L
	Calcium	5.0 mg

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Figure 2. Comparison of chromatograms obtained using 0.4 mm, 2 mm, and 4 mm Dionex IonPac CS12A columns and 0.4 µL injection volumes.

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TN70468_E 1/13S