Nitrosamine Analysis in Drinking Water using GC/MS/MS for Performance Equivalent to EPA Method 521

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Agilent

Introduction

EPA Method 521 (2004)

"Determination of nitrosamines in drinking water by solid phase extraction and capillary column gas chromatography with large volume injection and chemical ionization tandem mass spectrometry"[1]

Background

Ion Trap GC/MS is the approved instrumentation for Method 521 but it is being obsoleted

EPA might regulate nitrosamines due to the occurrence in drinking water and waste water (particularly NDMA)

EPA Office of Groundwater/Drinking Water (OGWDW) considers alternate detection techniques without changing the guidelines for sample preparation

Purpose of the Project

Directly compare Triple Quadrupole GC/MS (GC/MS/MS) and the currently used Ion Trap GC/MS (GC/IT) method using split samples set

Poster highlights:

Phase I: Varian 4000 GC/IT vs Agilent 7010 GC/MS/MS

Phase II: Three Laboratory Validation Studies of GC/MS/MS method

Phase III: Data Pack sent to the EPA for Technical Review (Feb 2018)

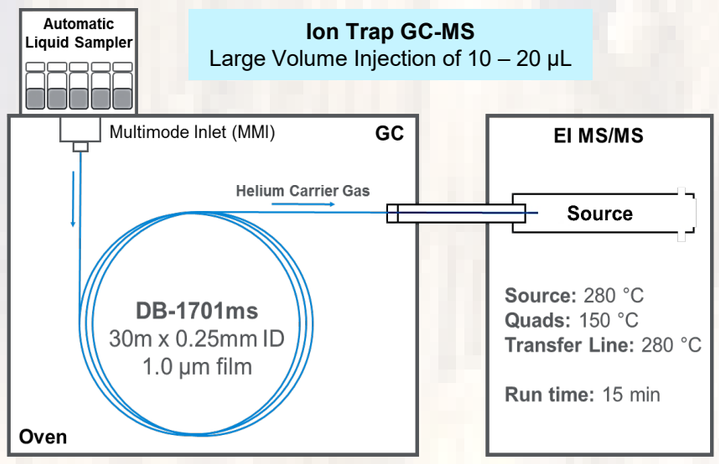
Final Product: A more sensitive method with equivalent performance

GC/MS/MS Parameters

GC/MS/MS provides 10-20x lower injection volume

EI mode provides easier operation and increase reliability

Inlet Parameters
Splitless
1 µL injection
35 °C (0.1 min) → ramp to 280 °C at 100 °C/min → 280 °C (20 min)
Purge Flow to Split Vent: 100 mL/min at 0.8 min
Inlet liner: 4 mm double-tapered, ultra-inert



Ion Trap GC-MS
Large Volume Injection of 10 – 20 µL

Oven Parameters
MMI Inlet → MSD
Constant Flow at 1.2 mL/min

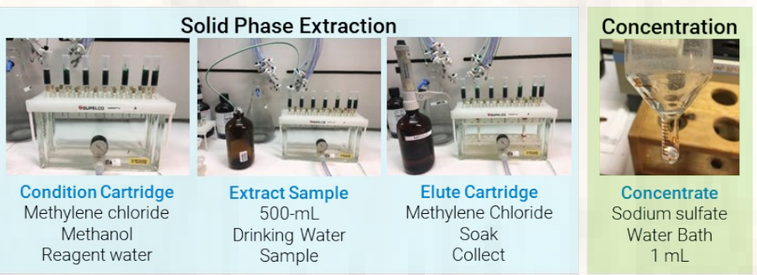
Temperature Program
33 ºC (1 min)
35 ºC/min to 80 ºC (2 min)
10 ºC/min to 140 ºC (0 min)
50 ºC/min to 280 ºC (2 min)
50 ºC/min to 300 ºC (3 min)

Ion Trap GC-MS
Chemical Ionization
Run time: 40 min

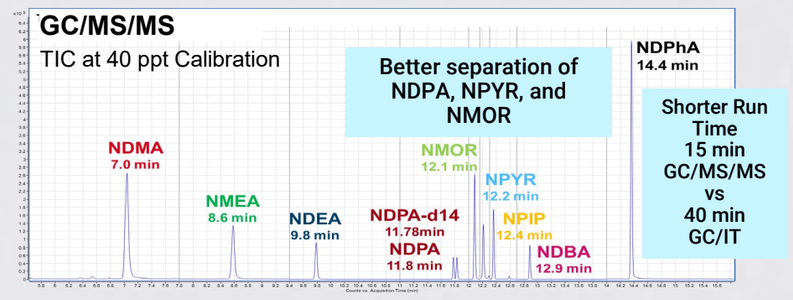
Ion Trap GC-MS
Similar Oven Parameters
VF-5ms

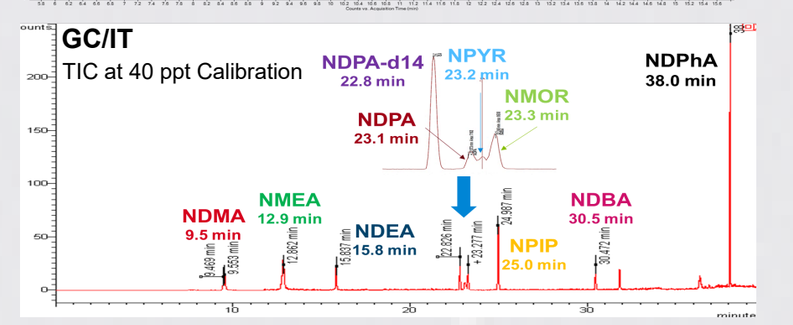
Experimental

All drinking water samples were extracted manually
No changes made to Method 521 sample preparation

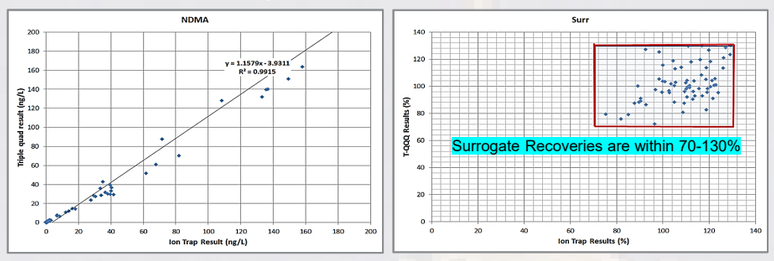


Phase I: GC/MS/MS vs GC/IT (Lab A)

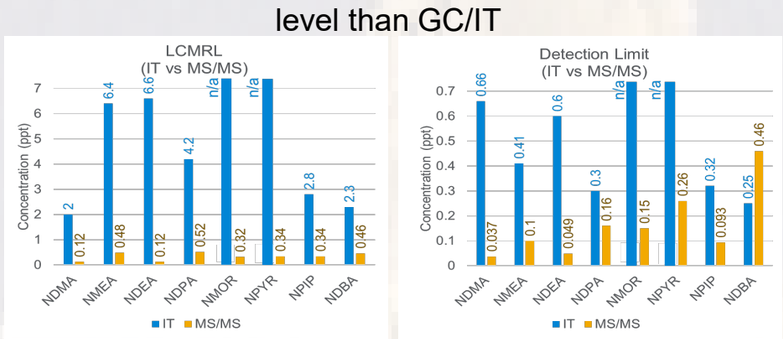




Good Correlation between GC/MS/MS and GC/IT
Field Sample of Real Extracted Water



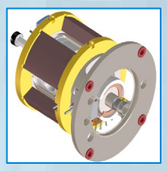
GC/MS/MS achieves **lower** LCMRL and Detection level than GC/IT



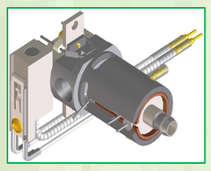
Phase II: Interlaboratory Validation

Method Compliance! Both Systems Work!

LAB A and LAB B
7010 GC/MS/MS
High Efficiency Source



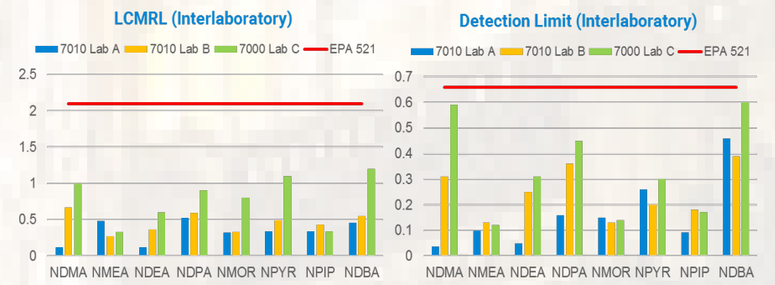
LAB C
7000 GC/MS/MS
Extractor Source



Complete Source Redesign on the 7010 GC/MS/MS

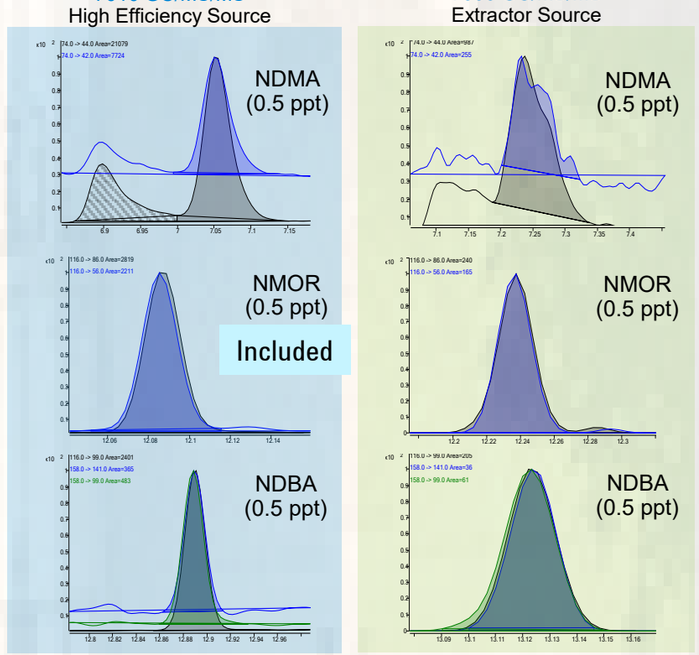
20x MORE IONS

Both, 7010 and 7000 GC/MS/MS can achieve
Lower LCMRL and Detection limit than EPA 521

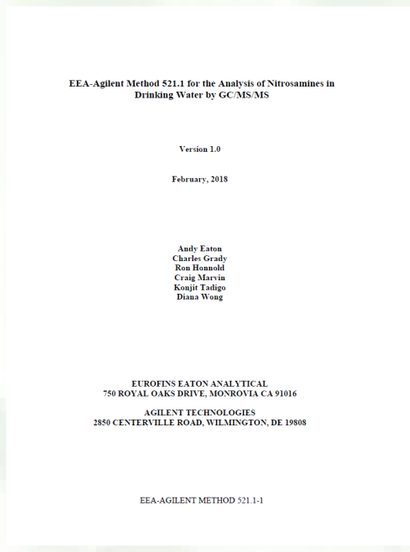


Note: LCMRL and DL for NMOR and NPYR is above the highest spiking level of 10 ppt. Four replicates at 0.1, 0.25, 0.50, 1.0, 2.0, 3.0, 4.0, 5.0, 8.0 and 10.0 ppt.

Baseline Separation in Water Sample Extracts



Phase II: Data Pack sent to EPA


EEA-Agilent Method 521.1 for the Analysis of Nitrosamines in Drinking Water by GC/MS/MS

Version 1.0

February, 2018

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EEA-AGILENT METHOD 521.1-1

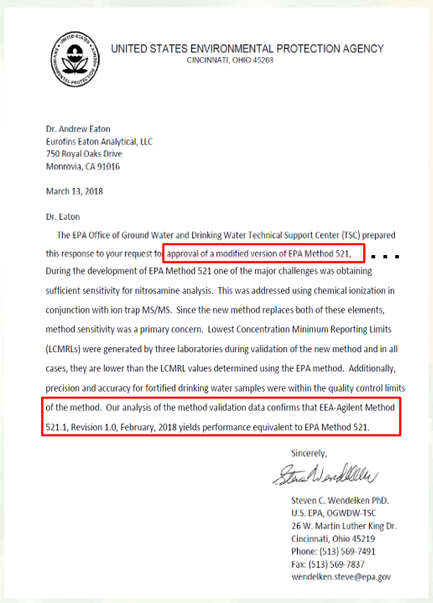
LCMRLs (3 lab)

Matrix Spike/Matrix Spike Duplicate Data

Holding Time Studies (samples and extracts)

Split sample results from multiple matrices comparing GC/IT and GC/MS/MS

EEA-Agilent Method 521.1


UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
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March 13, 2018

Dr. Eaton

The EPA Office of Ground Water and Drinking Water Technical Support Center (TSC) prepared this response to your request for approval of a modified version of EPA Method 521. . . .
During the development of EPA Method 521 one of the major challenges was obtaining sufficient sensitivity for nitrosamine analysis. This was addressed using chemical ionization in conjunction with ion trap MS/MS. Since the new method replaces both of these elements, method sensitivity was a primary concern. Lowest Concentration Minimum Reporting Limits (LCMRLs) were generated by three laboratories during validation of the new method and in all cases, they are lower than the LCMRL values determined using the EPA method. Additionally, precision and accuracy for fortified drinking water samples were within the quality control limits of the method. Our analysis of the method validation data confirms that EEA-Agilent Method 521.1, Revision 1.0, February, 2018 yields performance equivalent to EPA Method 521.

Sincerely,

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Method "officially" includes NMOR, which is not listed in EPA 521.

NDPhA was included in the studies but because it was not stable as long as the others it was excluded from the final method so as to not shorten the holding time.

Original datapack showed stability of the nitrosamines to 28 days but EPA would not allow a change in Holding Time.

Extracts were only tested out to 14 days.

Noteworthy Modifications!

Method 521 Section	EEA-Agilent Modification
1) Scope and Application	Added the analyte N-Nitrosomorpholine
6) Equipment and Supplies	Updated to reflect the use of GC/EI/MS/MS
8) Sample Collection, Preservation and Storage	Extract holding times are updated to 14 days
10) Calibration and Standardization	Updated to reflect the use of GC/EI/MS/MS
13) Method Performance	LCMRLs and performance data were updated using the new method conditions

References

[1]EPA Method 521 Version 1.0, September 2004, EPA Document #: EPA/600/R-05/054

Letter of Equivalency for EEA-Agilent 521.1 for The Analysis of Nitrosamines in Drinking Water by GC/MS/MS. *U.S. EPA Letter* March 13, **2018**.

Agilent Application Note: 5991-9224EN in collaboration with Eurofins Eaton Analytical (Monrovia, CA), Eurofins Eaton Analytical (South Bend, IN) and Vogon Laboratories