The Rapid Analysis of Wastewaters Following U.S. EPA Method 200.7

Authors: Andrea Palpini – PerkinElmer, Inc. Shelton, CT

1 Introduction

The prevention and control of water pollution is of critical importance to protecting both human and environmental health. As a result, water must be monitored for pollutants at various stages, starting with the discharge of wastes and wastewaters, all the way through the production of drinking water. Analytical techniques and methods vary depending on the pollutant and type of water being analyzed.

With industrial growth, there is an increasing number of samples which require analysis via the U.S. Environmental Protection Agency (EPA) Method 200.7. To accommodate this growth, there is a need to increase sample throughput while maintaining data quality objectives. By employing a technique which allows rapid sample to sample analysis time, laboratories can process more samples and continue to meet the growing demand.

This work focuses on the rapid analysis of wastewaters in accordance with EPA Method 200.7 for the determination of metals and trace elements in waters and wastes by ICP-OES equipped with a high throughput sample introduction system.

Figure 1. PerkinElmer Avio 560 Max ICP-OES with integrated High Throughput System (HTS) and S23 Autosampler.

2 Experimental

Sample and standard preparation procedures were performed in accordance with those specified in Method 200.7.

Four different wastewater certified reference materials were used: Wastewaters C, D, and H (High Purity Standards™, Charleston, South Carolina, USA) and WasteWatR™, Trace Metals (ERA, Golden, Colorado, USA).

All measurements were made against external calibration curves using yttrium (Y) as the internal standard. Interelement corrections (IECs) were applied to all measurements.

3 Instrument Conditions and Method Parameters

Analyses were performed on a PerkinElmer Avio 560 Max ICP-OES which is equipped with a High Throughput System (HTS) for sample introduction connected to a S23 Autosampler (Figure 1). Instrument conditions are listed in Table 1. Using these conditions, sample-to-sample time was approximately 60 seconds with a total argon flow of 9 L/min.

Table 1. PerkinElmer Avio 560 Max Instrument Conditions.

Parameter	Value	
Nebulizer	Meinhard® Glass Type K1	
Spray Chamber	Glass Cyclonic Baffled	
Carrier Flow Rate	0.80 mL/min	
Sample Loop Volume	1 mL	
RF Power	1500 Watts	
Nebulizer Gas	0.70 L/min	Low Argon Flows
Auxiliary Gas	0.2 L/min	
Plasma Gas	8 L/min	
Loop Fill Time	4 sec	
Loop Rinse Time	3 sec	
Replicates	2	

All analytes were calibrated using a two-point curve. 0.5 mg/L and 1 mg/L was used for all analytes except Na, Mg, K, and Ca which were calibrated at 10.5 mg/L and 21 mg/L.

4 Results and Discussion

For Method 200.7 compliance, quality control (QC) criteria accounting for sample handling/preparation and instrument analysis must be satisfied. To evaluate the Avio 560 Max system the following tests were performed: instrument performance checks (IPCs), method detection limits (MDLs), linear dynamic range, spectral interference checks (SICs), accuracy, and stability.

Initial QC: Initial Performance Check (IPC) and Quality Control Sample (QCS)

The IPC, made from the same stock standard as the calibration standards, was run immediately after the calibration to verify the quality of the calibration curve. Following the IPC, the QCS, made from a second source standard, was analyzed at the same concentration. Method 200.7 requires both the IPC and QCS recover within 5% of their true values. Figure 2 shows that both the IPC and QCS satisfied this criteria.

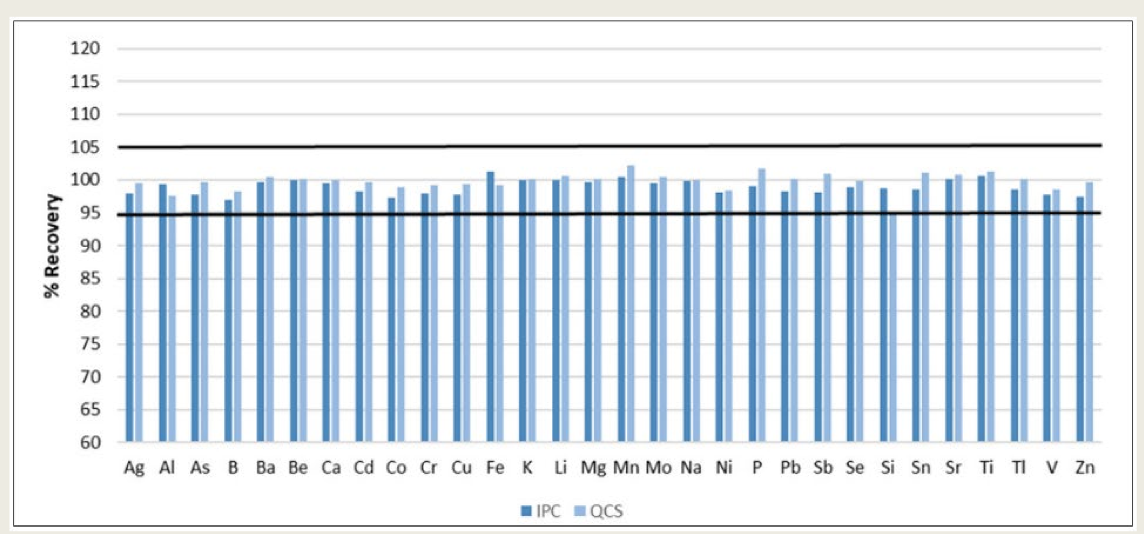

Figure 2. Recoveries from the initial IPC and QCS.

Method Detection Limits (MDLs)

Determined by measuring a standard seven times and multiplying the standard deviation by 3.14 for a 99% confidence interval. Figure 3 shows the determined MDLs alongside the certified reference material analyzed in this study. Note that not all analytes were contained in the reference materials.

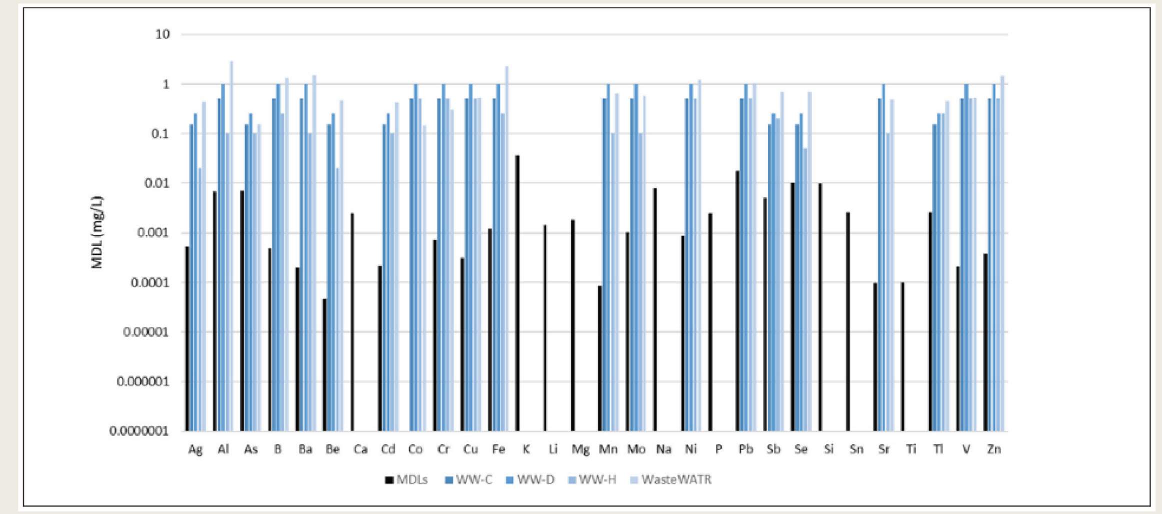

Figure 3. MDLs (black) and certified concentrations in four reference materials.

Linear Dynamic Range (LDR)

Defined as the highest concentration which recovers within 10% of its true value as measured against the calibration curve. Table 2 shows the determined linear ranges for each analyte.

Table 2. Linear Dynamic Range

Elements	Linear Range (mg/L)
Cd, Mn, Sr	30
Ba	40
Co, Cr, Ni, Sn, Ti, Tl	50
Be	70
Ag, Al, As, B, Cu, Fe, Li, Mg, Mo, P, Pb, Sb, Se, Si, V, Zn	100*
Ca, K, Na	500*

*= highest concentration evaluated

Accuracy

Determined by analyzing 4 reference materials. As seen in Figure 4, all recovered within 10% of their true value.

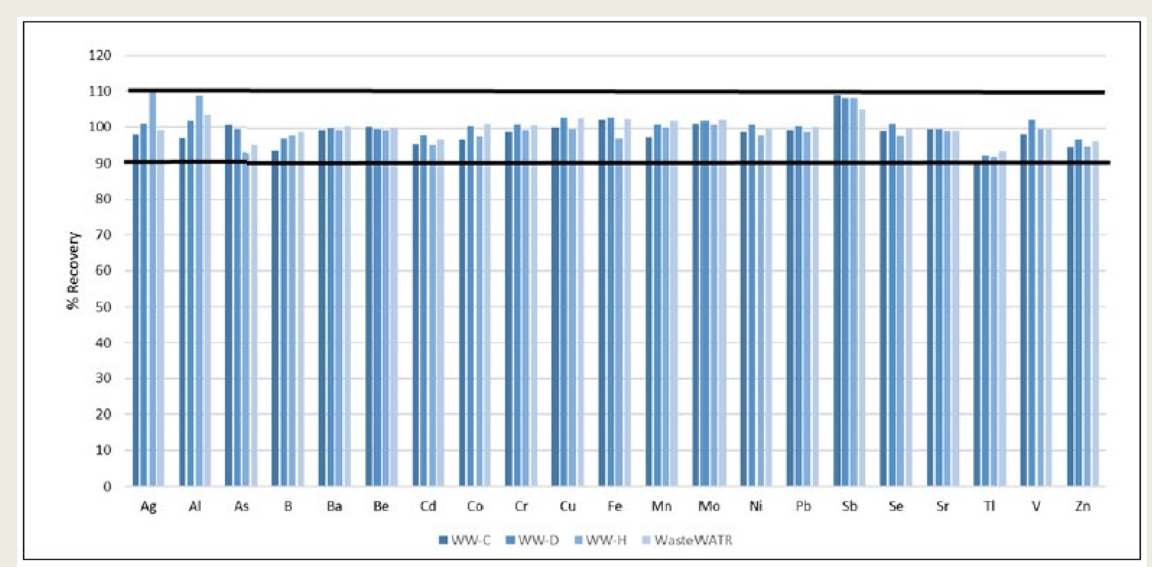

Figure 4. Recoveries of four wastewater reference materials.

Stability

Determined by analyzing samples while monitoring IPC recoveries over a four-hour run with an average of one minute sample-to-sample time. Figure 5 shows all recovering within 10% demonstrating exceptional stability.

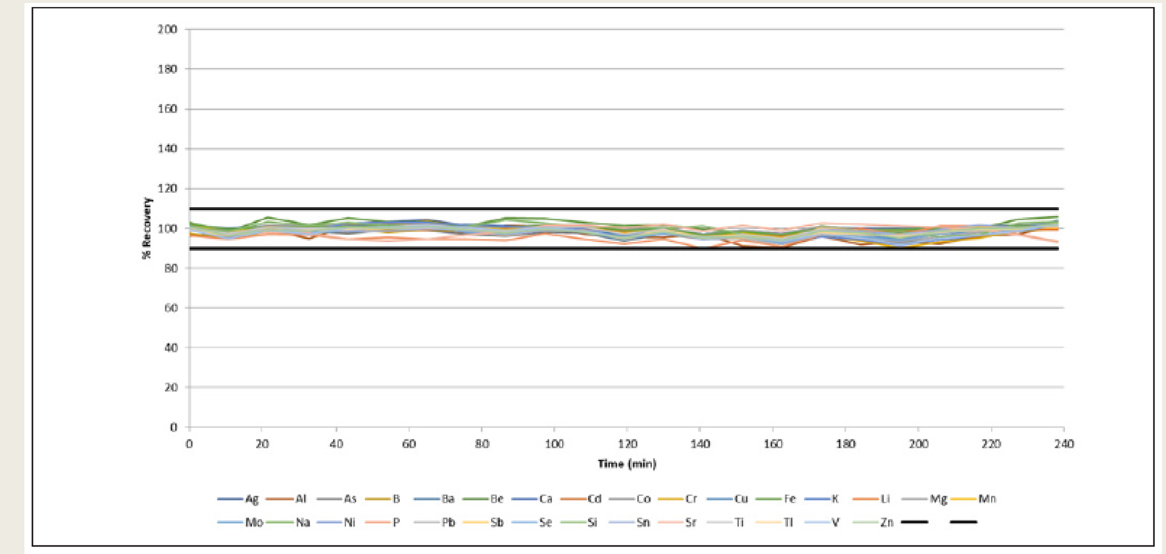

Figure 5. IPC recoveries during a 4-hour run of wastewaters.

5 Conclusion

This work demonstrates the ability of the Avio 560 Max ICP-OES to perform the rapid analysis of wastewater samples following U.S. EPA Method 200.7 with a sample-to-sample time of approximately 60 seconds. With accuracy, reliability, robustness, and stability demonstrated through the analysis of reference materials and QC checks, the Avio 560 Max ICP-OES provides a robust solution for wastewater analysis.

The Avio 560 equipped with a built-in HTS enables laboratories to improve workflow and turn-around-times when compared to conventional sample introduction systems without sacrificing data quality.

Key Features of the Avio 560 Max for EPA Method 200.7:

- Robust ICP-OES system
- Built-in HTS improves sample throughput 3-5x
- Superb data quality
- Ease-of-use

PerkinElmer, Inc., 940 Winter Street, Waltham, MA USA (800) 762-4000 or (+1) 203 925-4602 www.perkinelmer.com