

Analytical Instruments for Industrial Process Water Analysis

Comprehensive Laboratory Solutions for Industrial Process Water



Processing and refining of industrial chemicals and petrochemicals are water-intensive processes, with water employed for heat transfer, product washing, and catalyst regeneration, among other uses. Analysis of total organic carbon, metals, organic contaminants, inorganic ions, and organic acids in industrial process waters is critical to ensure efficiency of operations, minimize deterioration of facility plumbing and expensive catalysts, and to comply with environmental regulations when the water is discharged from the facility.

Shimadzu offers a comprehensive portfolio of analytical solutions to address methodologies and workflows for analysis of industrial process water during its use and discharge.



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Benchtop Total Organic Carbon and Total Nitrogen

Total organic carbon, or TOC, analyses are widely used to assess process inefficiencies, leaks within plumbing, and for regulatory compliance when process water is discharged from the facility. As organic precursors, reactants, and products come into contact with process water, some of those materials are incorporated into the water and can be detected by using TOC as a non-specific proxy for the overall organic contamination within the sample.

Shimadzu is the industry leader in combustion TOC analyzers and offers benchtop and online versions to suit a variety of applications and needs. They are built around the industry-first and time-proven 680° C furnace for efficient oxidation of carbon within the sample. Shimadzu's TOCs are the sure solution for TOC and other sum parameters analysis of process water, wastewater, sludges, and brines.

Total Organic Carbon Analyzer TOC-L

The TOC-L series is Shimadzu's flagship benchtop combustion TOC analyzer. Its simple, reliable operation is the benchmark for the combustion TOC market. It features:

- Color screen on instrument for stand-alone operation or control from local PC
- Autosampling options for up to 96 samples
- Low cost of operation with no proprietary reagent cartridges
- Optional total nitrogen (TN) unit for TOC and TN analyses
- Accurate, precise results, even with high-salt / brine sample matrices





Repeated analyses of TOC in 28% NaCl

brine, showing analytical stability over



more than 1700 injections without changing catalysts or combustion tubes, even as they become fouled by salt build-up.

Online Total Organic Carbon, Nitrogen, and Phosphorus

Total Organic Carbon Analyzer TOC-4200 and TNPC-4110c

The TOC-4200 and TNPC-4110c takes all of the functionality of the TOC-L and places it in a rugged, industrial housing. The TNPC-4110c adds online total nitrogen and total phosphorus analysis capabilities in addition to total carbon. Both instruments automate online analysis; samples from up to six different streams are automatically analyzed at your desired frequency. They feature:

- Automated sampling from up to to six process streams for real-time analysis •
- Durable housing for instrument placement in hostile conditions •
- Independent control from instrument screen or remote via PC •
- Optional total nitrogen (TN) unit for TOC and TN analyses for TOC-4200 •
- Accurate, precise results, even with high-salt / brine sample matrices

Nutrients, Metals, and Physical **Parameters**

UV-Vis Spectrophotometer UV-1280

UV-Vis spectrophotometry can be used to assess a variety of chemical and physical parameters of water and wastewater. Shimadzu's UV-1280 is a versatile and lowmaintenance, single-beam spectrophotometer - ideal for routine analysis of environmental samples. The Water Analysis Package offers easy-to-use and convenient built-in methods for analysis of 39 analytes in the ppm concentration range, including

nitrate, nitrite, and o-phosphate.

This makes the UV-1280 an ideal solution for quick detection of ionic compounds, metals, and other water quality parameters.

Name		Name	Name		
CIO	Chlorine (Free)	NO ₂	Nitrite		
CN	Cyanide (Free)	NO ₃ (1)	Nitrate (NO ₂ =0)		
CNT	Total Cyanide	NO ₃ (2)	Nitrate (NO₂≦0.05mg/L)		
COD	COD	NO ₃ (3)	Nitrate (NO₂≦5mg/L)		
Color	Color	NO ₂ -N	Nitrite Nitrogen		
Cr6+	Hexavalent Chromium	NO ₃ -N (1)	Nitrate Nitrogen(NO ₂ -N=0)		
Cr ⁶⁺ -50	Hexavalent Chromium-50mm	NO ₃ -N (2)	Nitrate N(NO ₂ -N≦0.015mg/L)		
Cr ⁶⁺ (D)	Hexavalent Chromium (Low)	NO ₃ -N (3)	Nitrate N(NO ₂ -N≦1.5mg/L)		
Cr6+(WAK)	Hexavalent Chromium (WAK)	Pb	Lead		
Cr ^T	Total Chromium	Phenol	Phenol		
Cu	Copper	PO ₄	Phosphate		
F	Fluoride (Free)	PO ₄ (D)	Phosphate (Enzyme)		
Fe	Iron	PO ₄ -P	Phosphate Phosphorus		
Fe (D)	Iron (Low)	PO ₄ -P(D)	Phosphate P(Enzyme)		
FOR	Formaldehyde	S	Sulfde		
H ₂ O ₂	Hydrogen Peroxide	TH	Total Hardness		
Mn	Manganese	Turbid (FTU)	Turbidity (Formazin)		
NH ₄	Ammonium	Turbid (PS)	Turbidity (Polystyrene)		
NH ₄ -N	Ammonium Nitrogen	Zn (D)	Zinc (Low)		
Ni	Nickol				



Analytical Solutions for Industrial Process Water





Inorganic lons and Organic Acids

Inorganic anions and organic acids are incorporated into process water and can be detrimental to process efficiency. Various contaminants can cause corrosion of plumbing or can poison expensive catalysts used during processing.

Shimadzu's Prominence Ion Chromatograph allows for rugged, repeatable IC analyses for process- and wastewater. Its patent-pending electrolytic suppressor design features a folded flowpath for maximized suppression efficiency. The Prominence IC is also small, up to 4% narrower than similar instruments. The performance of the Prominence IC has been evaluated for the requirements of common EPA methods, such as Method 300 and 300.1 for analysis of anions in water to help with assessment of process water and permitting for discharge.

Ion Chromatograph Prominence IC

The Prominence IC features:

- Unique suppressor design minimizes size and internal volume while maximizing internal surface area for small size and minimal peak broadening.
- Completely inert flowpath ensures no leaching or corrosion when using caustic eluents, which maximizes column and suppressor lifespan.
- Narrow, forced-air column oven offers superior thermal stability up to 85° C
- High-speed autosampling that provides repeatable, reliable injections.
- Measures only 16.5 inches wide, optimizing valuable laboratory bench space.







The Prominence Ion Chromatograph features a slim, spacesaving design that uses up to 47% less bench space than comparable IC instruments.

Inorganic lons and Organic Acids





Elemental and Metals Analysis

Because of the high solubility of many metal compounds in aqueous solution, coupled with their potential toxicity, metal-rich process water must be treated to meet concentration requirements in discharge permits.

Shimadzu offers a slate of instruments for elemental analysis of process water, including atomic absorption (AA), inductively coupled plasma optical emission spectrometry (ICP-OES), and ICP mass spectrometry (ICP-MS). The performance of these instruments have been evaluated in accordance to approved methods for compliance monitoring (e.g., EPA 200.7, 200.8 and 200.9).

	EPA 200.7 (ICP-OES)	EPA 200.8 (ICP-MS)	EPA 200.9 (AA)
Aluminum	•	•	•
Antimony	•	•	•
Arsenic	•	•	•
Barium	•	•	
Beryllium	•	•	•
Boron	•		
Cadmium	•	•	•
Calcium	•		
Cerium	•		
Chromium	•	•	•
Cobalt	•	•	•
Copper	•	•	•
Iron	•		•
Lead	•	•	•
Lithium	•		
Magnesium	•		
Manganese	•	•	•

	EPA 200.7 (ICP-OES)	EPA 200.8 (ICP-MS)	EPA 200.9 (AA)
Mercury	•	•	
Molybdenum	•	•	
Nickel	•	•	•
Phosphorus	•		
Potassium	•		
Selenium	•	•	•
Silicon	•		
Silver	•	•	•
Sodium	•		
Strontium	•		
Thallium	•	•	•
Thorium		•	
Tin	•		•
Titanium	•		
Uranium		•	
Vanadium	•	•	
Zinc	•	•	

Comparison table of common analytical methods and target elements.



Elemental and Metals Analysis

Atomic Absorption Spectroscopy AA-7000 Series

The AA-7000 series is an affordable, robust solution for elemental analysis. It can be configured for flame or graphite furnace analysis, depending on analyte concentration.

- An automated, six-lamp carousel for multi-element analysis
- Optional integrated graphite furnace for determination of low concentration analytes
- Carousel-style autosampler for sampling, dilution, and pretreatment
- Redundant interlock features to ensure safe operation

ICP Optical Emission Spectroscopy ICP-9800 Series

The ICP-9800 series optical emission spectrometer offers reliable, robust elemental analysis of waters. It is well-suited for analysis of waters, brines, and emulsions. It offers:

- A vacuum-purged optical bench to minimize gas usage
- Easy configuration for axial and radial viewing with simultaneous detection of all wavelengths and elements
- A vertically-oriented torch that minimizes carryover and contamination
- The industry's lowest argon consumption at 11 liters per minute during analysis using the mini torch

ICP Mass Spectrometry ICPMS-2030

The ICPMS-2030 is Shimadzu's flagship instrument for elemental analysis. It enables the highest sensitivity, into the parts-per-trillion range for many analytes. It also features:

- The industry's lowest argon consumption at 11 liters per minute during analysis using the mini torch
- An integrated helium-based collision cell for efficient removal of polyatomic interferences
- Simplified hardware for easy routine maintenance with minimal tools







Volatile and Semi-volatile Organic Compounds

Volatile and semi-volatile organic compounds (VOCs and SVOCs) can be incorporated into industrial water streams. Many VOCs and SVOCs demonstrate negative health effects and are major components of air pollution, particularly around industrial facilities. Gas chromatography with mass spectrometry (GC-MS) is a powerful tool that enables fast, targeted analyses for VOCs and SVOCs in water and air, for example, analysis of purgeable organic compounds using EPA Method 624.

Shimadzu offers a comprehensive EPA Method 624/8260 package that includes standards, columns, sample vials and other consumable items, method conditions, and documentation to achieve and maintain the quality assurance criteria outlined in EPA method 624 and 8260.

Gas Chromatograph-Mass Spectrometer GCMS-QP2020 NX

The GCMS-QP2020 NX is Shimadzu's versatile single-quadrupole GCMS, capable of reliable, routine analysis of water samples.

- High-performance ion source and ion optics for maximum sensitivity and ion transport
- High-efficiency turbomolecular pump to exhaust any carrier gas, including helium, hydrogen, nitrogen, and argon
- Scan speeds of up to 20,000 µ/sec across all masses using patented Advance Scanning Speed Protocol™ functionality





Total Ion Chromatogram (TIC) for 50 $\mu\text{g/L}$ compounds for EPA Method 624.1.



Surrogate standard recoveries for EPA Method 624 over a 12 hour period.

PFAS, Trace Organics, and other Emerging Contaminants

Monitoring the occurrence of Per- and Polyfluoroalkyl substances (PFAS) as well as other emerging contaminants in industrial wastewater is becoming a routine application to respond to regulatory and public demand. LC-MS is the gold standard technique for this purpose because of its high sensitivity and selectivity.

Liquid Chromatograph-Mass Spectrometer LCMS-8050

Shimadzu's LCMS-8050 is ideal for industrial and process water applications, combining high speed and sensitivity with a robust, heated inlet capable of handling difficult matrices. It features:

- High sensitivity with a heated ESI probe for efficient desolvation and ionization
- Rapid polarity switching, capable of switching between positive and negative in 5 msec
- Fast scanning across the mass range, capable of sweeping 30,000 u/sec





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Data Processing and **Informatics**

Through its LabSolutions CS/DB platform, Shimadzu offers as simple way in which to access your laboratory's data and control its instrumentation. Networking instruments into a centralized server allows for remote access from other networked devices, including PCs and tablets. It is even functional with third party instrument vendors so that your entire laboratory operated under a unified software platform.

- Access data and control instruments from remote devices not directly connected to the instrument
- Complete data integrity and security to comply with rigorous standards
- Compatible with various instruments and vendors to ensure total laboratory control





Shimadzu Corporation

www.shimadzu.com/an/

Shimadzu Scientific Instruments

7102 Riverwood Drive, Columbia, Maryland 21046, U.S.A. Phone: 800-477-1227/410-381-1227. Fax: 410-381-1222

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