

SECTION 40 75 76

TOTAL ORGANIC CARBON ANALYZERS

PART 1 **General**

1.01 **SUMMARY**

- A. Requirements for a Total Organic Carbon (TOC) analyzer that shall determine the TOC content of an aqueous sample. The analyzer shall be suitable for the analysis of water in all stages of industrial and municipal waste water facilities, as well as surface water monitoring. The analyzer shall be equipped with an automatic, self-cleaning sample filtration system for solids greater than 200 microns and shall be capable of performing either TOC or Total Carbon (TC) measurements, operating in one of the following maximum measurement ranges: 600, 2400, 6000, or 12,000mg/l. The system shall be capable of sample dilution factors of 20:1, (full scale range of 240,000 mg/l), with an optional heated salt trap and replaceable furnace for applications with high salt loads.
- B. Related Sections.
 - 1. Control and Information Systems Scope and General Requirements.
 - 2. Power Instruments, General.

1.02 **SUBMITTAL**

- A. Furnish complete Product Data, Shop Drawings, Test Reports, Operating Manuals, Record Drawings, Manufacturer's certifications, Manufacturer's Field Reports
- B. Product Data:
 - 1. Dimensional Drawings.
 - 2. Materials of Construction.
 - 3. Measurement accuracy.
 - 4. Range and range ability.
 - 5. Enclosure Rating.
 - 6. Classification Rating.
 - 7. Power.
 - 8. Output options.

1.03 **QUALITY ASSURANCE**

- A. Manufacture instruments facilities certified to the quality standards of ISO Standard 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing.

1.04 **DELIVERY, STORAGE, AND HANDLING**

- A. Store all instruments in a dedicated structure with space conditioning to meet the recommended storage requirements provided by the Manufacturer.

- B. Any instruments that are not stored in strict conformance with the manufacturer's recommendation shall be replaced.

1.05 PROJECT OR SITE CONDITIONS

- A. Provide instruments suitable for the installed site conditions including but not limited to material compatibility, site altitude, process and ambient temperature, and humidity conditions.

1.06 CALIBRATION AND WARRANTY

- A. The manufacturer's warranty does not cover normal wear and tear, damage to the sensor due to improper storage or handling, or any other mode of failure or reduced analyzer life that is not a direct consequence of a manufacturing defect.
- B. The analyzer shall have standard one year warranty from date of shipment and if the analyzer is commissioned by a factory certified technician, the warranty is extended to three years from the date of shipment.
- C. The analyzer shall be capable of performing programmed automatic cleaning, adjustment, and calibration. These programs shall be capable of manual, automatic, or remote activation. Liquid adjustment is two-point, using known concentrations of organic carbon standard. Liquid calibration is single point and shall be used as a check to verify correct operation. Cleaning programs shall use clean water for the Pre-Filter, Stripping and Separation Chamber.

1.07 MAINTENANCE

- A. Provide all parts, materials, fluids, etc. necessary for maintenance and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.
- B. It is acceptable to require routine maintenance on a regular basis to keep the system operating efficiently.
 - 1. 7-Day (Weekly) Maintenance.
 - a. Visual inspection of gas and liquid flow.
 - b. Check sample conditioning system.
 - 2. 30-Day (Monthly) Maintenance.
 - a. Replenish TIC removal reagent and calibration standards.
 - b. Check feed rate of pumps.
 - c. Inspect combustion furnace and salt trap.
 - d. Perform automatic clean and verify operation.
 - e. Perform automatic calibrate (adjustment) and verify operation.
 - 3. 90-Day (Quarterly) Maintenance.
 - a. Clean strip and separation chamber.
 - b. Replace glass beads in DIN filter.
 - c. Calibrate pH sensor.
 - d. Replace pump hoses.
 - e. For salt content 1g/ or higher, replace acid filter, replace catalyst and clean combustion chamber.
- C. It shall be acceptable to make routine adjustments according to the application's specific needs.

- D. The analyzer shall include two instruction manuals, spare tubing and fittings, key for front and rear door, safety glasses and gloves, and maintenance kits for the combustion chamber, acid filter, and stripping chamber.

1.08 LIFECYCLE MANAGEMENT

- A. Instrument documentation, like original calibration certificates, manuals and product status information shall be accessed via a web enabled system with a license. The instrument-specific information shall be accessed via its serial number. When services are provided by an authorized service provider the services information like subsequent field calibrations shall be archived and accessible via this web enabled system.

PART 2 Products

2.01 SYSTEMS/ASSEMBLIES

- A. Manufacturer
 - 1. Endress+Hauser, CA72TOC Total Organic Carbon Analyzer.
- B. Performance criteria
 - 1. Measurement Range (Model dependent):
 - a. 0.25 to 600 mg/L TOC or
 - b. 1 to 2,400 mg/L TOC or
 - c. 2.5 to 6,000 mg/L TOC or
 - d. 5 to 12,000 mg/L TOC
 - 2. Limit of detection (LOD): 0.75% of full scale
 - 3. Limit of quantitation (LOQ): 2.5% of full scale
 - 4. Short-term drift: 0.5%/day
 - 5. Repeatability for 20 % of full scale: 0.4%
 - 6. Limit of resolution for 20 % of full scale (LDC): 1.1%
 - 7. Systematic measured error for 20 % of full scale (BIAS): 0.4%
 - 8. Repeatability for 80 % of full scale: 1.6%
 - 9. Limit of resolution for 80 % of full scale(LDC): 4.6%
 - 10. Systematic measured error for 80 % of full scale (BIAS): 2.4%
- C. Certifications
 - 1. CE marked.
- D. Environmental
 - 1. Process temperature: 0 to 40 °C (32 to 104 °F).
 - 2. Ambient temperature: 5 to 35 °C (41 to 95 °F).
 - 3. Operating humidity: 10 to 90%, con-condensing.

4. Ingress protection: IP54.

2.02 MANUFACTURED UNITS

- A. The analyzer shall determine TOC or TC using thermal catalytic combustion with subsequent NDIR detection of the produced CO₂. The system shall work with two interconnected circuits, liquid and gas. In the liquid circuit, the filtered sample shall be pumped into the analyzer where it can be diluted in case of high salt loads or extreme high TOC values. For TOC analysis, the sample shall be acidified and sparged with CO₂ free air to remove inorganic carbon. This shall be pH controlled and have efficiency of 95% or greater. (For TC analysis, this step will be bypassed.) The sample will then be transported to a DIN rotational slit filter to remove particles greater than 2 microns, then injected via a programmable pump into the combustion furnace operating at 820 °C and combust the liquid sample completely to CO₂ gas which shall then be conveyed with CO₂ free air to a heated salt trap (Optional), acid scrubber, and moisture removal before it is measured using Non-Dispersive Infra-red analysis. The resulting CO₂ measurement is then displayed as TOC. The injection pump shall then reverse and flush the old sample from the system (liquid phase), while CO₂ free air is circulated in the furnace, and NDIR (gas phase). Therefore, a new baseline of CO₂ free air shall be established before the next analysis.
- B. The analyzer shall measure TOC or TC using a double batch analysis method. After TIC removal and DIN filtration, the sample shall be dosed into the combustion chamber via a programmable pump. The unit shall employ pressure sensors to measure each drop of liquid injected into the combustion furnace, and thus verify the correct volume.
- C. The analyzer shall employ an optional heated salt trap for liquids with dissolved salt concentrations greater than 1 g/l. The heated salt trap shall be accessible from the front of the analyzer and shall be easily removed and cleaned without shut down of the system.
- D. Liquid sample shall be pumped to the analyzer and filtered by an on board pre-filter to 500 microns for flow rates of 260-1000 gal/hr., and 100 microns for flow rates of 26-260 gal/hr. The filter system shall have an automatic back-flush for cleaning, controlled by the analyzer.
- E. The analyzer shall have as a standard feature a replaceable combustion furnace. The unit shall have a stand and holder for heating, and shall not require the use of special tools for installation.
- F. The analyzer shall monitor the temperature of the combustion furnace with temperature sensors. The system shall alarm when temperature is high or low compared to the set point. The analyzer will shut down the combustion chamber and sample pumps, the analyzer shall give a fault alarm, and restart automatically when the condition is corrected.
- G. The analyzer shall be housed in an IP54 enclosure, capable of mounting on a table, wall, or stand, and shall house the analysis section and operator interface separately.
- H. For analysis, the analyzer shall include up to five pumps. There shall be dedicated pumps to:

1. Bring the sample into the analyzer.
 2. Dose acid for TIC removal.
 3. Remove acidified TIC from the system.
 4. Injection of programmed sample volume into the combustion furnace.
 5. Dilution for high salt loads and extreme TOC loads.
- I. The analyzer shall include a manual sample valve to interrupt operation in order to perform measurements on manually collected grab samples. The analyzer shall not require any changes to the plumbing to analyze grab samples.
- J. The analyzer shall avoid excess acid dosing for TIC (Total Inorganic Carbon) removal, as well as TIC carryover into the furnace by use pH controlled acid addition. TIC removal efficiency shall be 95% or greater. The pH controlled TIC removal shall operate at pH 2.5. The analyzer shall detect malfunctions in the pH system with deviations of pH +/- 2.5 pH from set point.
- K. Inputs:
1. The analyzer shall include as a standard feature, 8 signal inputs, 24 VDC, maximum load 500 ohms. These inputs shall activate Analyzer Adjustment, Analyzer calibration, Cleaning of the Pre-Filter, Stripping and Separation Chamber.
- L. Outputs:
1. The analyzer shall include, as a standard feature, four binary alarm relays.
 - a. Relay 1 is a dedicated malfunction alarm and shall activate on any combination of the following conditions: loss of liquid sample flow, loss of loss of carrier gas, liquid leak detected, over range, unit currently in calibration, unit currently cleaning, unit offline, dilution active, alarm inhibited, analog output inhibited, calibration/cleaning inhibited, reagents low warning, IR fault, power failure, adjustment/calibration fault, combustion furnace temperature high or low, loss of pH control, loss of water pressure, malfunction of Peltier Cooler, unstable dosing of sample.
 - b. Relay 2 shall be dedicated to limit detection of TOC or TC value.
 - c. Relay 3 shall be dedicated for analyzer standby.
 - d. Relay 4 shall be dedicated for Operating Control.
 2. The analyzer shall include as a standard feature a scalable, user-selectable 0-20 mA or 4-20 mA analog output. The analog output shall be able to be programmed to output zero or the last measured value in the event that a Clean, Calibration, or Inhibit Analog Signal cycle is activated.
 3. As a standard option, an RS232 interface shall be available for data output.
- M. Power requirements shall be 115 V and 230V (50/60 Hz).
- N. The analyzer shall include one 5 liter polyethylene bottle for the required acid (to remove TIC) and two 2 liter polyethylene bottles for calibration standards. The unit

shall include all necessary tubing and connectors for reagents, sample flow, standards, and cleaning solution.

- O. The analyzer shall detect each drop of sample as it is pumped into the combustion furnace. When unstable dosing occurs, the analyzer shall activate a fault alarm and give the information on the display.
- P. The analyzer shall include a pressure sensor to detect loss of clean water supply for flushing and dilution. If the minimum permissible pressure of 1.5 mbar is not achieved, then the analyzer will shut down the combustion chamber and sample pumps and give a fault alarm. The analyzer shall restart automatically once this error is cleared.
- Q. The analyzer shall measure and detect loss or increase of pressure in the gas circuit by means of a pressure sensor. The sensor shall provide a signal to the analyzer should there be a loss of gas flow for more than 10 seconds, at which time the analyzer will shut down the pumps and the combustion chamber. The signal from the pressure sensor shall provide a fault condition to be reported on the analyzer display and on the maintenance alarm.
- R. The analyzer shall include a leak detection system. The leak detection system shall consist of a conductance sensor placed in a drip tray. The drip tray shall cover the bottom surface area of the analyzer so that if a leak occurs, liquid will collect in the drip tray and the sensor will detect its presence. A fault alarm shall be activated in the event of a leak.
- S. The system shall detect changes in the cooling value of the Peltier Cooler for +/- 3 C., as well as malfunction for the IR Bench. In the event of a malfunction, the analyzer will shut down the combustion chamber and sampler pumps, give a fault alarm, and will restart automatically once the error is cleared.

2.03 ACCESSORIES

- A. The analyzer shall include as an option an air purification system. This option eliminates the need for replacement of cylinders of carrier gas (CO₂-free air) and the changing of tubing or connections, thus minimizing maintenance and consumable costs. The purification system will require 90 PSI house air or a compressor for operation.
- B. Reagents for operation of the analyzer including: stripper reagent; parent solution.
- C. Furnace power conditioning station for 230 VAC or 120 VAC.
- D. Furnace, both for units with and without heated salt trap, to be available as replacement.
- E. Optional heated salt trap to be available as a replacement for maintenance purposes.

2.04 SOURCE QUALITY CONTROL & CALIBRATION

- A. Any standards and cleaning solutions will be supplied with MSDS data sheets.

2.05 SAFETY

- A. All electrical equipment shall meet the requirements of ANSI/NFPA 70, National Electric Code latest addition.

- B. All devices shall be suitable for operation in a non-hazardous area.

PART 3 Execution

3.01 EXAMINATION

- A. Examine the complete set of plans, the process fluids, pressures, and temperatures and furnish instruments that are compatible with installed process condition.
- B. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

3.02 INSTALLATION

- A. Contractor will install the analyzer in strict accordance with the manufacturer's instructions and recommendation.
- B. The standard one-year warranty against manufacturing defects shall be extendable to three-years on covered equipment if paid start-up service is accomplished on that covered equipment by an authorized service provider.
- C. Coordinate the installation with all trades to ensure that the mechanical system has all necessary appurtenances for proper installation of instruments.
 - 1. General contractor
 - 2. Electrical or Instrumentation contractor
 - 3. Factory trained authorized service provider or representative
 - 4. Site (owner/operator) personnel
 - 5. Engineer

3.03 FIELD QUALITY CONTROL

- A. Each instrument shall be tested before commissioning and the ENGINEER shall witness the interface capability in the PLC control system and associated registers.
 - 1. Each instrument shall provide direct programming capability through the PLC
 - 2. Each instrument shall be supported with a device profile permitting direct integration in the PLC.
- B. The ENGINEER shall witness all instrument verifications in the field.
- C. Manufacturers Field Services are available for start-up and commissioning by a manufacturer authorized service provider – the warranty against manufacturing defects is three years.
 - 1. Manufacturer field service representative shall verify installation of all installed sensors, cables and transmitters.
 - 2. Manufacturer representative shall notify the ENGINEER in writing of any problems or discrepancies and proposed solutions.
 - 3. Manufacturer representative shall generate a configuration report for each sensor installation following commissioning.

3.04 ADJUSTING

- A. Verify factory calibration of all instruments in accordance with the manufacturer's instructions.

3.05 PROTECTION

- A. All instruments shall be fully protected after installation and before commissioning. Replace any instruments damaged before commissioning.
 - 1. The ENGINEER shall be the sole party responsible for determining the corrective measures.