

**Title: Standard Operating Procedure for Measurement of Total Hydrocarbon Using a Flame Ionization Detection**

Procedure No: SOP-020

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1. INTRODUCTION AND SCOPE

To obtain timely data for the purpose of air quality assessment, air quality trend reporting, and to meet the requirements for inclusion of the data in provincial and national air quality databases, a continuous method of analyzing Total Hydrocarbon (THC) concentrations in ambient air is used. This method is capable of measurement updates at a rate of once every five minutes or faster. Readings from instruments of this method enables the calculation of hourly averaged concentrations of THC. Commercially available THC analyzers are used in the method.

This method is applicable to the measurement of THC concentrations in ambient air in the range of 0.1 parts per million (ppm) to 50.0 parts per million (ppm).

This method adheres to the requirements of the current Air Monitoring Directive (AMD) 1989. In some cases the limits and specifications exceed the requirements of the current AMD. It should be considered that the current and any future amendments or drafts of the AMD will be used as the benchmark for requirements and criteria for ambient air monitoring practices conducted in the Province of Alberta. Information used to write this procedure was also taken from sources identified in the reference section.

2. PRINCIPLE OF THE METHOD

Two models of the THC analyzer are described in this method; see section 4.0 for models. The detection principle is the same for both analyzers, however, there are specific operating differences for each instrument.

THC analyzers use a flame ionization detector (FID) to measure organic gases and vapors. Flame ionization is a well-known technology that has been used in laboratories and industry for many years. Flame ionization detectors are highly sensitive; they provide a wide linear range and efficient detection of organic compounds. A FID operates by ionizing organic compounds in the sample stream using the energy of a hydrogen flame. The hydrogen flame oxidizes organic compounds to generate carbon dioxide and water. In the process, ions are formed in an electrical field that is generated between a polarized jet where the hydrogen flame burns, and a cylindrical collector electrode, which surrounds the jet. Sample gas is mixed with the hydrogen inside the FID at the base of the jet. An external source of air provides the necessary oxygen for the combustion of fuel at the jet. Due to the voltage difference between the jet and collector, negatively charged ions formed in the flame migrate to the collector. When the ions arrive at the collector, a small ion current is created. This current, which can be as

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small as 1×10^{-12} amps, is proportional to the concentration of carbon atoms in the sample. Unlike some other ionization detectors, the FID responds to almost all organic compounds, including methane. Because the signal is produced primarily by the ions formed during the oxidation of carbon-hydrogen bonds, the strength of the response is directly related to the molar concentration of the organic compound and the number of carbon atoms per molecule. The current signal generated at the FID's collector electrode is carried through a shielded cable that runs to an electrometer and amplifier circuit. The electrometer circuit converts the current to a voltage that is amplified and, in Thermo Instruments analyzers, then digitized by a voltage to frequency (V/F) converter.

3. MEASUREMENT RANGE AND SENSITIVITY

The THC analyzers used in this method are commercially available models. The measurement range is user selectable at ranges between 0 to 10,000 parts per million by volume (ppm). The typical range selection used in Alberta is 0 to 20 ppm for THC.

The detection limit of the analyzer is specified by the manufacturer. Generally it is at the 0.05 ppm as methane (CH₄).

4. EQUIPMENT AND APPARATUS

The following are available commercial analyzers suitable for used in this method and are currently in use in the AENV network:

- Thermo Environmental Instruments (TEI) Model 51CLT THC Analyzer
- Bendix Model 8201 Total Hydrocarbon Analyzer

This list does not exclude the use of other equipment that has received the USEPA Reference and Equivalent Method designation.

5. INTERFERENCES

The FID will detect any carbon based compounds in the sample stream this is the objective of the method, and therefore no interferences.

Particulate matter may interfere with analyzer response. This problem is normally eliminated by using a particle filter of 2.0µm pore size made of inert material, such as Teflon, at the sample inlet of the instrument.

---THIS DOCUMENT MUST NOT BE PHOTOCOPIED---

Additional copies are available from the Air Monitoring Manager or designate



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6. PRECISION AND ACCURACY

The measurement precision is generally considered to be the “repeatability of the measurement”. Precision of the data output by the analyzer is established by the manufacturer, but confirmed during daily span checks and monthly calibrations.

The accuracy of the sensor is generally considered the “deviation from true”. This means how close it is to what it should be. The benchmark of “what it should be” is provided by the Alberta Environment Audit Program staff and the use of high quality standards such as available from the National Institute of Standards and Technology (NIST). As with precision, accuracy is confirmed by the daily and monthly calibration checks. Refer to the sections identified above for further information on accuracy relating to calibration and audit procedures.

7. SITE REQUIREMENTS

Site location for THC monitoring should be determined according to the intended application of the monitoring data. Detailed requirements for selection of sites for monitoring ambient THC can be found in the Air Monitoring Directive

8. INSTALLATION REQUIREMENTS

All the installation requirements are specified by the manufacturer in the installation procedures of the manual. General requirements listed below must also be followed. Considerations for siting requirements can be found in the reference listed in section 7.0 above.

- 8.1 The ¼ inch outside diameter (1/8 or 3/16 inch inside diameter) connection tubing from the manifold to the analyzer inlet must be made of Teflon or equivalent material for chemical inertness. Plastic tubing can be used but is more susceptible to cracking due to aging so not preferred.
- 8.2 A Teflon or glass fibre particulate filter with a pore size of no larger than 5.0µm must be placed in the sampling line before the air sample enters the detection cell and is recommended to be located as close as possible to the inlet manifold. The holder for such filter can be made of Teflon, aluminum, stainless steel or delrin.

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- 8.3 A data acquisition system (DAS) should be connected to the analyzer to record or download the signal output from the analyzer. For connection to record analog voltage signals, the DAS system should be set to match the voltage range of the analyzer output. Generally this is 1V or 10V full scale for conversion to engineering units.
- 8.4 The monitoring station temperature should be controlled within the range of 15 to 30°C. It is important to note that the analyzer will operate properly at any temperature within this range; however, the stability of the station temperature is most important.
- 8.5 Within the vicinity of the station all products containing solvents and other sources of hydrocarbon must be avoided.
- 8.6 Refer to setup and setup instructions table for H₂S & TRS analyzers for information on selecting settings for AENV operations.
- 8.7 The analyzer has the capability to output specific alarms or a general alarm via a contact closure. These outputs are connected to the digital input section of the DAS. See the DAS operations manual for instructions on configuring these channels.

9. OPERATIONAL REQUIREMENTS

The following activities must be performed when operating a continuous THC analyzer in Alberta. All operational activities conducted at any ambient monitoring station, must be documented in the station logbook, and/or station checklists. This allows other operators to access a history of the station if the regular technician is not available. The following documentation must be available to the operators on site: operational and maintenance manual(s), quality system documentation including set up instructions, and check lists, and station site documentation.

9.1 Set Up

Range Set – the typical range used for monitoring THC is 0 to 20 or 0 to 50ppm. This is done as soon as the analyzer is powered up after installation. Refer to the operations manual for instructions on this procedure. Setup configuration is recorded and kept with the instrument.

9.2 Daily Requirements

Zero/Span Check – a zero/span cycle is required every day to verify the analyzer's performance. This involves diverting the sample flow of the analyzer so that the analyzer

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subsequently samples zero air for the zero cycle and air with a known amount of CH₄ in air or CH₄ and C₃H₈ in air for the span cycle. The zero source is typically provided by a zero air system consisting of a compressor, air dryer and a high temperature oxidizer for removal of hydrocarbons or a cylinder of Zero Air, and span by a cylinder of CH₄ in air or CH₄ and C₃H₈ in air in the appropriate range. This cycle is normally controlled by the DAS in the station, as it also flags the collected data as calibration and not sample data. The DAS is programmed to close contacts that are connected to the zero and span contacts on the analyzer. It is recommended to perform the zero check cycle last to reduce the time required for the instrument to return to ambient readings

Refer to the analyzer manual for more information.

9.3 Analyzer Test Parameters

The analyzer monitors and displays test functions in order for the operator to monitor the performance of specific systems within the analyzer. These test parameters should be monitored on a weekly basis and recorded on a site/instrument check list. A variety of support gasses are also required for the operation of these analyzers – specific!!. Pressures of these cylinders should be monitored routinely so that cylinders are changed before they run empty. A good “rule of thumb” is to change the cylinders once they drop below 500 psi.

9.4 Inlet Filter Change

The sample inlet filter is typically replaced when the monthly multipoint calibration is being done. This should not occur until the as-found points have been completed to rule out any interference. Filters are changed out monthly before each calibration. Use forceps to handle the filter element.

9.4 Analyzer Maintenance

Preventative maintenance tasks should be completed on the analyzer on a periodic basis. These tasks are outlined in the operations manual. A strict regiment of these tasks should be adhered to as they are intended to prevent occurrence of problem. Any maintenance must be recorded in the station logbook and a record kept with the instrument documentation.

9.5 Multipoint Calibration

Multipoint calibrations are conducted on the THC analyzer to verify precision, accuracy and linearity of the instrument. This procedure must be completed after the analyzer has been installed following at least a 24 hour warm up period, after any repairs or

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maintenance has taken place which may affect the performance of the instrument and monthly to comply with Alberta Environment regulations. Calibration procedures specific to the THC analyzer are found in section 10 of this document.

9.6 Analyzer Audit

THC analyzers operating in Alberta are required to undergo an on-site audit once per year. This audit involves the Alberta Environment Audit Program staff visiting the site with the NIST traceable standards to verify the accuracy and linearity of the instrument.

10. CALIBRATION

The calibration procedure for THC analyzers is similar to calibration of other continuous ambient air analyzers. This procedure, found in SOP #11 "Dilution Calibrations" involves generating a known amount of methane and propane $\text{CH}_4/\text{C}_3\text{H}_8$ in combination in air, which is introduced to the analyzer to verify its performance. There are certain specifics to the THC calibration that are identified in this section.

- 10.1 Calibration Equipment – THC analyzers are typically calibrated using the dilution method.
- 10.2 Referring to the calibration procedure, calculate the slope and intercept of the 4 data points against the calibrator values using linear regression analysis. The acceptance criteria are slope of 1.0 ± 0.1 and intercept of $\pm 3\%$ full scale and a coefficient of correlation (CC) > 0.998 .
- 10.3 Analyzer is adjusted for zero reading and for a reading of 1:1 at the highest scale point in the calibration. Slope and intercept corrections are not performed.
- 10.4 A zero/span check cycle is run through the DAS following the calibration to verify the span values and to pick up and zero offset.

11. APPLICABLE DOCUMENTS

- **EM-020a** Thermo Environmental Instruments (TEI) Model 51CLT THC Analyzer Operating Manual
- **EM-020b** Bendix Model 8201 Total Hydrocarbon Analyzer operating manual
- **SOP11** Dilution Calibrations

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12. LITERATURE REFERENCES*None***13. REVISION HISTORY**

Revision 1.0; Add sections 8.5, 8.6, 8.7

14. APPROVAL

Approved by: Harry Benders
Title: Air Monitoring Manager

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