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WBEA – Standard Operating Procedure			
SOP Title		Procedures for operating continuous Total Hydrocarbon (THC) analyzers	
SOP Number		WBEA-ANA-004-THC	
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Implementation date		February 19, 2013	
Revision History			
Revision #	Date	Description	Author



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Introduction and Background

This document is intended to be used as a reference for use in the calibration, maintenance and operation of continuous analysis of the Total Hydrocarbons (THC) in ambient air. The proper utilization of this procedure in conjunction with the operators manual will conform to the current Alberta Air Monitoring Directive (AMD) and enable the data to be included in provincial and national air quality data bases

Principle of the Method

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 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 then digitized by a voltage to frequency (V/F) converter.

Differences are notable for THC analyzers in the method of sampling as they each require a pressurized sample supply to the FID. Because the mass of the sample under pressure has a great effect on sensitivity the sample pressure must be tightly regulated and controlled. The sampling methods for the analyzers in use within the WBEA network are described on the next page.

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TEI Model 51 CLT and iLT

The Model 51 analyzer utilizes a heated internal pump to draw sample in and pressurize it into the FID. The analyzer also uses zero air supply pressure to back regulate and control the sample pressure. The use of 1/16th inch stainless steel sample lines restrict the vacuum and thus pressurization of the sample below control limits of the air supply and electronic regulator. The menu permits user setting of the sample pressure. Refer to the manual for specifics to the type of Thermo analyzer used. This analyzer does have an auto relight function if normal FID operations are interrupted.

Rosemount Model 400A

The Rosemount Model 400A total hydrocarbon analyzer also uses a flame ionization detector (FID) to provide quantitative analysis of ambient levels of total hydrocarbon (THC). The 400A functions in the same way as the TEI 51CLT, but does not offer method or control of sample pressurization. An external pump with proper Teflon lining and regulation system must be setup in order to operate this analyzer. Refer to the manual for specifics to the Rosemount model 400A. This analyzer does not have an auto relight function if normal FID operations are interrupted. The operator may be required to manually relight in the event of FID operation interruption.

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 within the WBEA network is 0 to 25 ppm for THC specific analyzers.


The detection limit of the analyzer is specified by the manufacturer and specific settings applied to the analyzer when placed in the field. This is also governed by the noise level of the output signal, whether analog or digital. Two times the noise level is generally accepted as the lower detectable limit (LDL); generally it is at the 0.05 ppm as methane (CH₄). The health of the analyzer is important as poor health = higher noise = higher LDL.

Equipment and Apparatus

THC analyzers in use are all AMD compliant monitors including TEI and Rosemount analyzers.

The design of the analyzer requires the use of support gases. WBEA network analyzers are integrated with hydrogen for fuel and a zero air source (generator) for FID supply air, and sample pressure control zero air if required. All cylinders utilized for the network are rated Ultra High Purity (UHP) hydrogen.

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Refer to the respective operating manuals for specifics regarding setup and settings of the support gases as required.

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 5.0µm pore size made of inert material, such as Teflon, at the sample inlet of the instrument.

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 span and monthly calibration checks.


Site Requirements

All THC analyzers are housed in a temperature controlled ambient air monitoring shelter in a standard instrument rack. Sample air is brought into the shelter using a glass sample inlet system and made available to the THC analyzer. The station is sited according to appendix A-2, Station Site Criteria section of the AMD. Site location for THC monitoring should be determined according to the intended application of the monitoring data.

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:

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- The ¼ inch outside diameter connection tubing from the manifold to the analyzer inlet must be made of Teflon or equivalent material for chemical inertness.
- A Teflon 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 cells and is recommended to be located as close as possible to the inlet manifold. The holder for such filter must also be made of Teflon, stainless steel or Delrin.
- 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 system should be set to match the voltage range of the analyzer output. In the WBEA network the standard is 5V full scale and is scaled to convert the output signal to the concentration range outlined in section 3. For serial or LAN connection there must be a station router in place and configurations made to the analyzer settings, the router, and the data logger. See the DAS operations manual for instructions on configuring these channels.
- 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.
- Range Set – the typical range used for monitoring THC is 0 to 25 ppm. This is done as soon as the analyzer is powered up after installation. Refer to the operations manual for instructions on this procedure.

Operational and Maintenance Requirements

The following activities must be performed when operating a continuous THC analyzer in the WBEA network. All operational activities conducted at any ambient monitoring station must be documented in the Doc-It system. 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 and station site documentation.

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 subsequently samples zero air for the zero cycle and air with a known amount of CH₄ and C₃H₈ in air for the span cycle. These two sources are provided by the in-situ calibration system. A zero air point of dilution air only is generated through a saved sequence in the calibrator, and span is generated by a saved calibration point in the calibrator, typically the high point of the routine multipoint calibration sequence. This cycle is controlled by the data system in the station, as it also flags the collected data as calibration and not sample data. Refer to the analyzer manual for more information.

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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 recorded digitally via DAS collection or documented on calibration reports. Hydrogen is required as a support gas for the operation of these analyzers. Pressures of the hydrogen cylinders should be monitored routinely so that cylinders are changed before they run empty. It is necessary for continuous data and the proper maintenance of THC analyzers to change the cylinders once they drop below 500 psi. The data systems within the WBEA network monitor and alarm for support system conditions when they are below required levels.

Inlet Filter Change

The sample inlet filter is typically replaced when the monthly multipoint calibration is being done. The filter change is completed after the as found points have been completed and before the multipoint calibration is carried out. This is done to establish a reference prior to the removal of the filter.

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 fix a problem before it happens. Any maintenance must be recorded in the Doc-It system. This is also recorded in the instrument log that accompanies each instrument.

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, prior to removal, and monthly to comply with Alberta Environment regulations. This procedure is also completed before and after any major maintenance to confirm the precision and accuracy after repairs. The calibration standard for the WBEA network utilizes a blend of methane and propane for calculation of a THC response.

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.

Calibration Requirement

The calibration procedure for THC analyzers is similar to calibration of other continuous ambient air analyzers. This procedure involves generating a known amount of methane CH₄ or methane and
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propane CH₄/C₃H₈ 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. As THC analyzers are calibrating using the dilution method, please see WBEA SOP-OPS-002.

- Three upscale points must be used, spaced approximately 15%, 30% and 60% of full scale as well as minimum of a single zero point from a separate zero air source.
- Methane equivalency for propane must be converted in for THC calculated concentration. The equivalency multiplying factor is 2.75.
- Calibration results must be graphed as indicated concentrations (C_i) versus calculated concentrations (C_c) from which the slope of the graph, the intercept and final correction coefficient are calculated.
- The acceptance criteria are slope of 1.0, ±0.05, and intercept of ±3% full scale and a coefficient of correlation (CC) >0.995.
- 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.
- A recorded trace of the instrument, response over time is required to demonstrate stability and accuracy.

Data Collection and Management

The analog output of the THC analyzers is typically wired to the analog input channels of the station Campbell's Scientific CR3000 data logger. This data recorded at 5 minute intervals and is then polled remotely via cellular modem. Alternatively the data can be polled digitally via the serial or Ethernet port, and can be accompanied by the diagnostic or meta-data information.

Reference Documents

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