ABB MEASUREMENT & ANALYTICS

Total Organic Carbon (TOC) Measurement

Solutions with Flame Ionization Detection

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ABB Analytical possesses decades of experience in solutions for Total Organic Carbon (TOC) measurement. The FID portfolio based on both Advance Optima and EasyLine Series. Providing solutions for any purposes.

Simplicity is key for many diverse applications in different industry segments and areas: From applications in general purpose to hazardous areas.

Protecting environment with type tested equipment in emissions monitoring and save operation in hazardous area ABB Analytical offers the right FID analyzer portfolio: Fidas24.

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Sources of VOCs and their impact Industry and Environment

Sources of Volatile Organic Carbon compounds (VOC) are diverse. In general VOCs have an environmental impact. Ground level emissions of VOC, e.g., react with NOx in presents of sun light and form ground level Ozone (O_3) which has a significant impact on the health status of people.

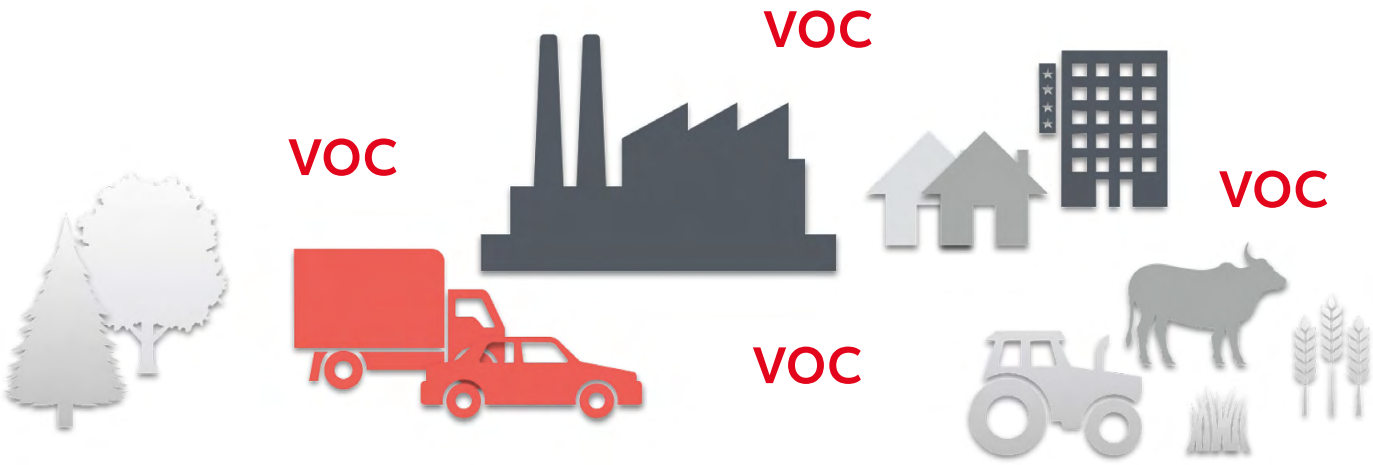
VOC basically include hydrocarbons (aliphatics and aromatics (benzene, toluene)), alcohols, aldehydes and ketones. The most important class in terms of emissions are hydrocarbons, especially CH_4 and C_2-compounds.

Concentrations of VOCs are greatest in large cities and industrial areas, as traffic is by far the most significant anthropogenic source, along with solvent emissions from industries. Other anthrop ogenic sources of VOC, particularly for methane, are cattle breeding, land farming, burning of biomass, wastewater treatment, landfill and natural gas during production and processing.

This leads to an average value of about 1.8 ppm CH4 in the atmosphere. As diverse as the sources of organic compounds are, so are the applications. The most important application is emissions monitoring (CEM), regulated by directives and regulations. Others are process control, product quality and ground-level monitoring. Flame Ionization is still the method of choice, to measure VOCs as Total Organic Carbon*).

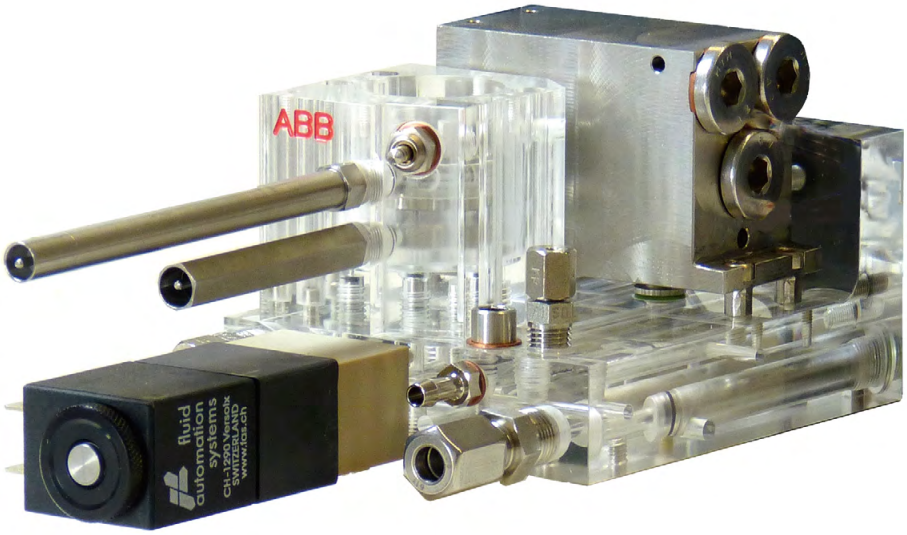
ABB's product portfolio offers solutions for a wide range of applications, from standard, mobile, NMHC (Non-Methane-Hydrocarbon) and hazardous applications.

*) or Total Hydro Carbon (THC)



How to measure VOC? Fidas24
Flame Ionization Detection – Benefits

The Flame Ionization Detector is designed to detect VOCs in air or other background gases. The sample gas is burned in a H_2 flame which burns between two electrodes. Organic ions are formed. They increase the conductivity between the electrodes and are proportional to the Carbonconcentration.



Detector design and principle
The detector is made of stainless steel. An air aspirator (injector pump) is driven by pressurized air producing a vacuum. The sample gas is drawn into the combustion chamber where the hydrogen flame burns, and ionization takes place.

Aspirator pump's benefits
- No membrane sample pump is needed
- Only very little maintenance compared to a membrane pump
- No pulsing flows (i.e., pump vibrations)
- No moving parts – No wear and tear
- No need for condensate drain

Technical features and their benefits
The heated Fidas24 design with a heated sample gas connection (180°C), prevents the formation of cold-spots and avoids condensation, and separate disposal of condensate is not required.

Due to the heated chamber, no corrosion can happen. Especially in case of halogenated VOCs (e.g., CH_3Cl). These components will form HCl in the hydrogen flame, which in case of condensation might cause corrosion.

All solenoid valves are installed directly on the analyzer's module. No combustion gas and air control valves, and calibration gas valves are required.

In total all these features make operation and start-up easy to handle.

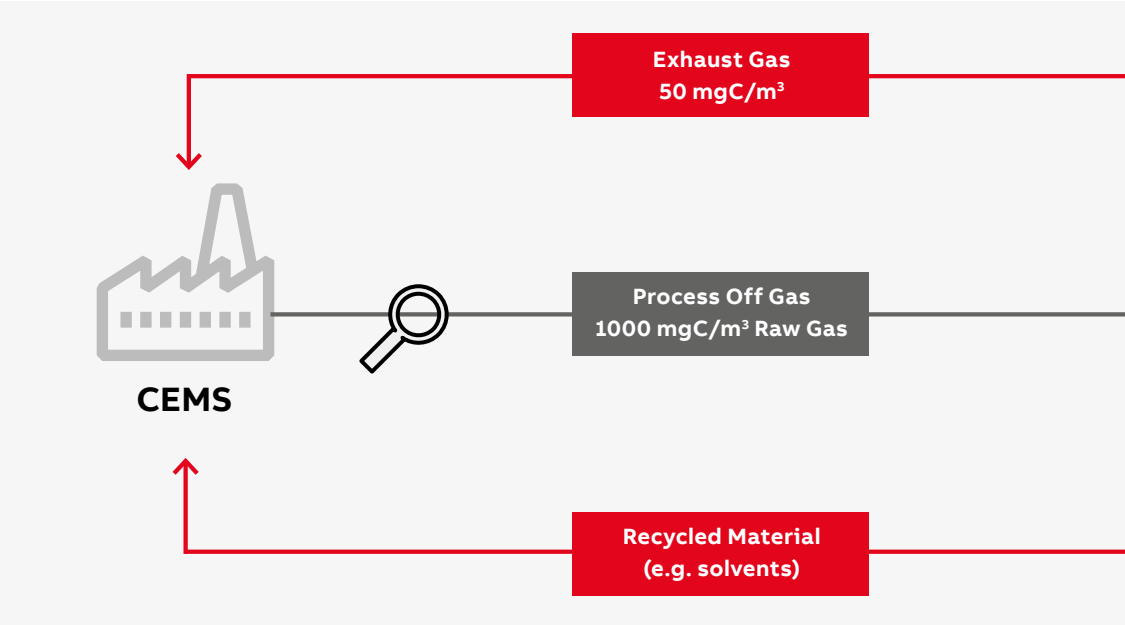
Process gas
Process efficiency monitoring

The FID principle is used in different areas with different purposes. Emission monitoring in waste, power, cement and automotive are the major markets. But applications can also be found in process, quality and safety measurement.

TOC measurement
Depending on the VOC's load in the process off gas, different methods of air pollutions control to remove the VOCs are available (A-H).

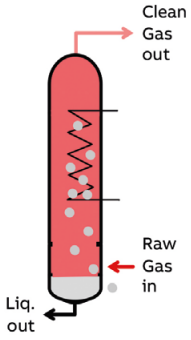
TOC measurement with an FID can be used to determine the efficiency of each process.

Many of these applications are installed in hazardous areas and require explosion proof solutions – available for Advanced Optima AO2040-Fidas24 Ex.

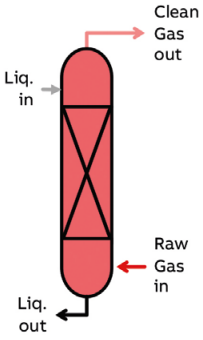


Examples for VOC absorption, recycle and abatement Systems (A-H):

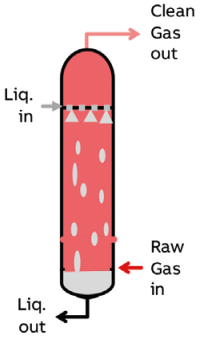
A
Condensation



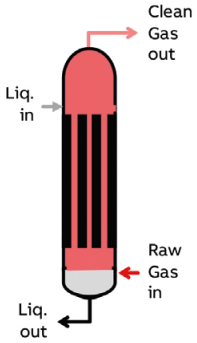
B
Column with packing



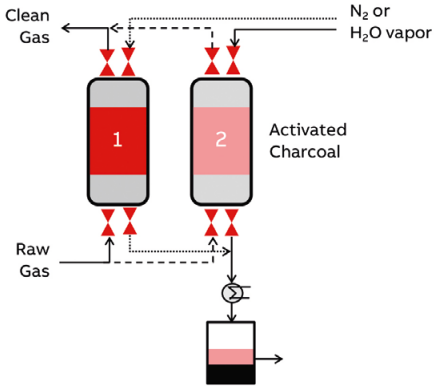
C
Spray scrubber



D
Fall-film-absorber

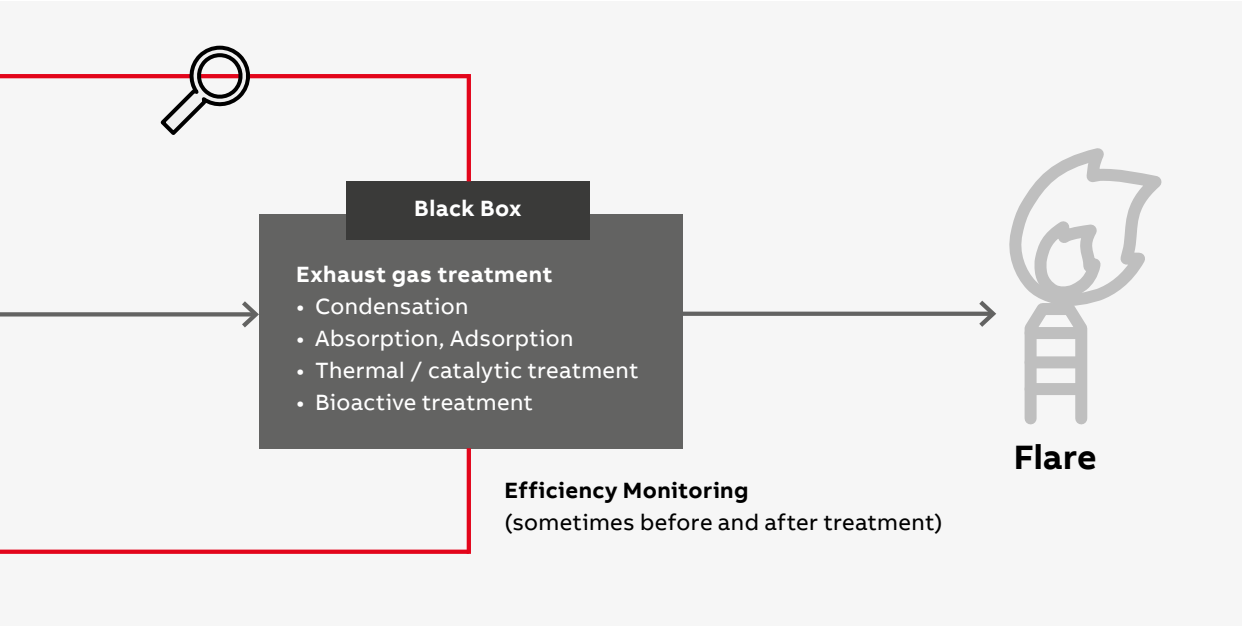


E
Fixed bed adsorber



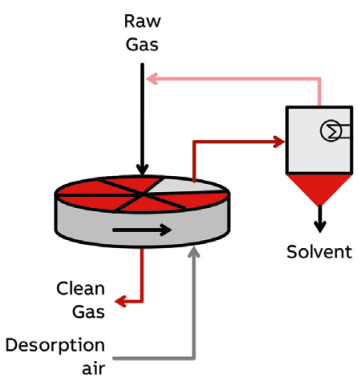
Exhaust gas treatment
Emission monitoring

Recovery or abatement of VOCs from industrial processes or any other procedures using or releasing VOC might require a physical or chemical method to remove, reuse or discard VOCs. TOC measurement might be required to monitor the efficiency or meet environmental standards.

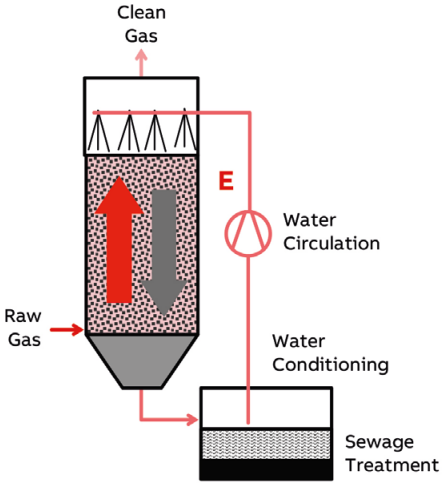


The method chosen depends on the VOC load in the off gas. If VOC concentration reaches vol% levels condensation is the method of choice. Highest efficiency is achieved with thermal or catalytic combustion. But all pollution control systems might require a TOC measurement from lower ranges to higher levels but must not exceed the lower explosive limits.

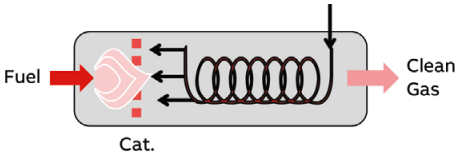
F
Adsorption wheel at paint-spray lines



G
Biological Treatment



H
Thermal- or catalytic post-combustion

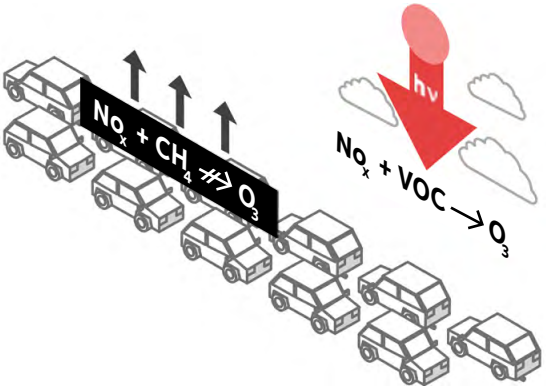


Further applications
Environment, health, safety, mobility

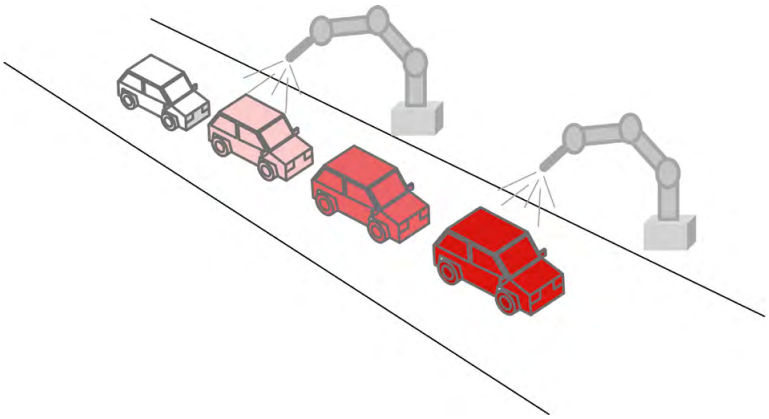
NMHC Measurement
VOCs cause the formation of ground level ozone, due to photochemical reactions with NOx. Methane does not contribute to the formation of noxious ozone near the ground (troposphere). If measured separately it sometimes does not need to be included in the TOC emissions:

$$NMHC = THC - CH_4$$

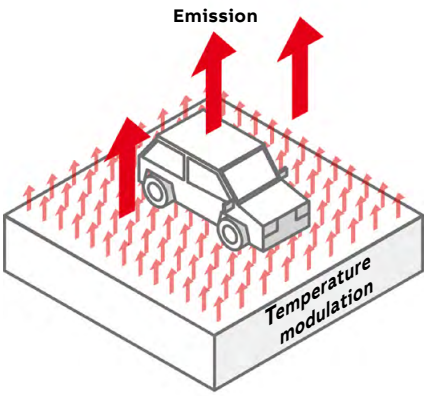
However, CH_4 has a higher global warming effect than CO_2 and might be required by some regulations for this reason.

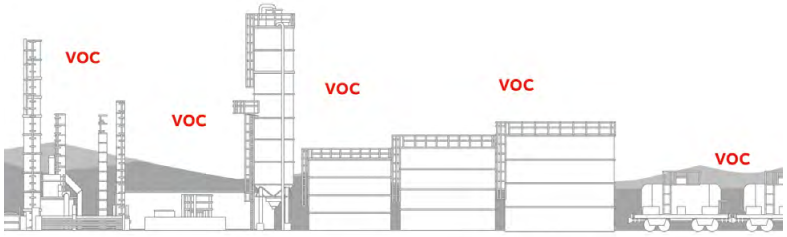


Painting lines, paint spray booths
Despite todays reduced VOC limits, in the exhaust of painting lines, paint spray booths or dryer systems of those processes, TOC measurement is a legal requirement. These applications can also be found in furniture manufacturing, or any other industry where surfaces are treated, coated or painted for decoration or protection.



SHED Test
Sealed Housing for Evaporative Emission Determination Test
Evaporation test chambers are used to determine the fuel and non-fuel emission rates from vehicles. Non-fuel VOC's source coming from interior equipment (car dashboard, side carpeting, etc.)

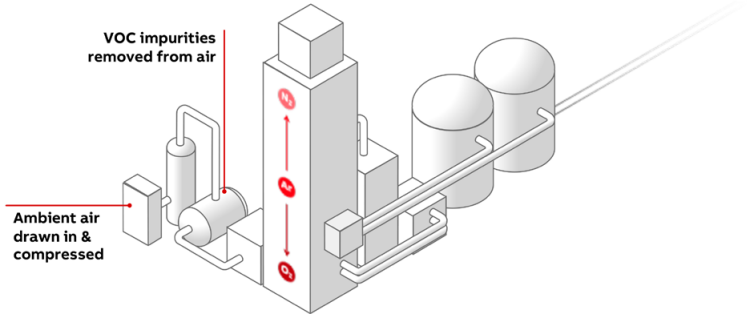




Mobile measurement
In some applications instrument air is not available or easy to handle, like mobile ground level monitoring close to refineries or other industrial facilities, exhaust gas monitoring from car engines, while driving, or any other air hygienic profile measurement, for scientific or health reasons.
For these cases, an internal pump can be applied.

Measure VOC in O_2
Avoid dangerous surprises

Traces of VOC enrich in the air separation process and react with liquid Oxygen (LOX) vigorously. Air separation units are typically found at refineries or chemical plants. Ambient air around these facilities contains more HC as usual air does. HCs are filtered of prior air is fed to the separation unit. The efficiency can be monitored with Fidas24.



Specific hazards of each HC
The VOCs typically occur are methane, ethane, ethylene and acetylene. The most critical are ethylene and acetylene. Acetylene for instance has a low solubility in LOX. If it enters the cold box it will concentrate in LOX and precipitate as a solid. Solid acetylene is relatively unstable and requires little energy to ignite.

Reactive impurities concentrate in Oxygen
VOCs have boiling points above that from oxygen. They concentrate in oxygen rich fluids found at the bottom of columns and reflux condensers. When VOC is concentrated to the lower explosive limit, reaction with O_2 can occur. The LEL of VOC in GOX expressed as CH_4 equivalents is between 5% and 10%.

Air separation units with pre-cleaner
They remove all acetylene and other HC so that it does not enter the cold box. Propylene – the fourth component of interest – is a hazardous substance as well. However, it is removed easily in the pre-cleaner unit. In the purification process molecular sieves, alumina or silica gel are used as an absorbent.

Good reasons for TOC measurement with FID

Conclusions
Flame ionization is a unique measuring method that allows fast and reliable information to be obtained about the VOC content in the sample gas. Especially when only a sum status is required, i.e. the individual components are not important, this method is unsurpassed (fast quality or purity check). Think about the effort involved in a gas chromatographic analysis. This involves time and cost. Sometimes a fast and continuous response on measuring values is mandatory (safety or quality), but an exact value is of minor importance. By using the NMHC variant, the methane can be measured separately and provides more information about the remaining (more reactive) VOCs without a full GC analysis. With Fidas24 ABB offers a solution for a wide range of applications.

Benefits
Fidas24 is available in the Advance Optima (AO2000) and EasyLine (EL3000) product series and can be employed in a vast number of applications, measuring hydrocarbons from low ppm levels up to 15 Vol% CH_4 from general purpose to hazardous area Zone 1.

The heated analyzer can be directly connected to a heated sample line avoiding cold spots at any point in the sample gas path. Hydrocarbons with dew point <180°C can be detected.

Fidas24 can be integrated in an analyzer system with other measuring principles, should measurement of other components be required.

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ABB Measurement & Analytics

For your local ABB contact, visit:
www.abb.com/contacts

For more product information, visit:
www.abb.com/measurement

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