Stationary source emissions - Determination of total volatile organic compounds (TVOCs) in waste gases from non-combustion processes - Non-dispersive infrared analyser equipped with catalytic converter (ISO 13199:2012)

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Stationary source emissions - Determination of total volatile organic compounds (TVOCs) in waste gases from non-combustion processes - Non-dispersive infrared analyser equipped with catalytic converter (ISO 13199:2012)

Émissions de sources fixes - Détermination des composés organiques volatils totaux (COVT) dans les effluents gazeux des processus sans combustion - Analyseur à infrarouge non dispersif équipé d'un convertisseur catalytique (ISO 13199:2012)

Emissionen aus stationären Quellen - Bestimmung der Summe der flüchtigen organischen Verbindungen (TVOCs) in Abgasen, die nicht aus Verbrennungsprozessen stammen - Nicht-dispersives Infrarot-Messgerät mit Konverter (ISO 13199:2012)

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Foreword

This document (EN ISO 13199:2012) has been prepared by Technical Committee ISO/TC 146 "Air quality" in collaboration with Technical Committee CEN/TC 264 “Air quality” the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 2013, and conflicting national standards shall be withdrawn at the latest by April 2013.

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Endorsement notice

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Introduction

Volatile organic compounds (VOCs) play significant roles in atmospheric chemistry, especially the formation of photochemical oxidants and/or ozone (O_3) and suspended particulate matter (SPM), which are known to have negative impacts on human health and biological systems. There are many areas of the world where their atmospheric concentrations are close to or above the level of the WHO guidelines for environmental standards in each nation. It is therefore strongly required in many nations to reduce the emission of VOC from various anthropogenic sources.

In order to manage VOC emission from stationary emission sources, it is essential for enterprises to evaluate the quantity of VOCs emitted from their facilities where organic solvents as well as other chemicals are used for industrial processes like painting, printing, cleaning, and degreasing.

A technique for continuously and precisely measuring the concentration of total VOCs (TVOCs) in waste gases emitted from ducts to atmosphere, which is easy to operate and to maintain, is very helpful for both governments and enterprises to control and reduce VOC emissions. This measurement method, based on the use of an NDIR analyser equipped with a catalytic converter for oxidation of TVOCs to CO_2, has some advantages compared to measurement methods using flame ionization detection (FID) and FID–GC (flame ionization detection–gas chromatography), namely:

a) high-safety operation is possible, since no flame and no hydrogen are used;

b) response factors of individual VOCs are not different from each other;

c) no interference due to oxygen is observed.

Note, however, that this method is not applicable to waste gas from combustion processes.

Stationary source emissions — Determination of total volatile organic compounds (TVOCs) in waste gases from non-combustion processes — Non-dispersive infrared analyser equipped with catalytic converter

1 Scope

This International Standard specifies the principle, the essential performance criteria and quality assurance/quality control (QA/QC) procedures of an automatic method for measuring total volatile organic compound (TVOC) content in waste gases of stationary sources, using a non-dispersive infrared absorption (NDIR) analyser equipped with a catalytic converter which oxidizes VOC to carbon dioxide.

This method is suitable for the measurement of TVOC emissions from non-combustion processes. This method allows continuous monitoring with permanently installed measuring systems, as well as intermittent measurements of TVOC emissions.

The method has been tested on field operation for painting and printing processes, where TVOC concentrations in the waste gases were from about 70 mg/m^3 to 600 mg/m^3.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 9169:2006, *Air quality — Definition and determination of performance characteristics of an automatic measuring system*

ISO 14956, *Air quality — Evaluation of the suitability of a measurement procedure by comparison with a required measurement uncertainty*

ISO 20988, *Air quality — Guidelines for estimating measurement uncertainty*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
automatic measuring system
AMS
measuring system interacting with the waste gas under investigation, returning an output signal proportional to the physical unit of the measurand in unattended operation

NOTE 1 Adapted from ISO 9169:2006, 2.1.2.

NOTE 2 In the sense of this document, an AMS is a system that can be attached to a duct to continuously or intermittently measure and record TVOC mass concentrations passing through the duct.

3.2
analyser
analytical part in an extractive or *in situ* AMS

[ISO 12039:2001,[3] 3.3]

3.3
calibration of an automatic measuring system
procedure for establishing the statistical relationship between values of the measurand indicated by the automatic measuring system and the corresponding values given by an independent method of measurement implemented simultaneously at the same measuring point

3.4
interference
negative or positive effect upon the response of the measuring system, due to a component of the sample that is not the measurand

3.5
interferent
interfering substance
substance present in the air mass under investigation, other than the measurand, that affects the response

[ISO 9169:2006, 2.1.12]

3.6
lack of fit
systematic deviation, within the range of application, between the accepted value of a reference material applied to the measuring system and the corresponding result of measurement produced by the measuring system

[ISO 9169:2006, 2.2.9]

3.7
mass concentration
concentration of a substance in a waste gas expressed as mass per volume

NOTE 1 Adapted from ISO 12039:2001,[3] 3.10.

NOTE 2 Mass concentration is often expressed in milligrams per cubic metre (mg/m^3).

3.8
measurand
particular quantity subject to measurement

[ISO/IEC Guide 98-3:2008,[4] B.2.9]

EXAMPLE The TVOC mass concentration (mg/m^3) in waste gas.

3.9
performance characteristic
one of the quantities assigned to equipment in order to define its performance

NOTE Performance characteristics can be described by values, tolerances or ranges.

3.10
period of unattended operation
maximum interval of time for which the performance characteristics remain within a predefined range without external servicing, e.g. refill, adjustment

[ISO 9169:2006, 2.2.11]

NOTE The period of unattended operation is often called maintenance interval.

3.11
residence time
time period for the sampled gas to be transported from the inlet of the probe to the inlet of the measurement cell

3.12
response time

time interval between the instant when a stimulus is subjected to a specified abrupt change and the instant when the response reaches and remains within specified limits around its final stable value, determined as the sum of the lag time and the rise time in the rising mode, and the sum of the lag time and the fall time in the falling mode

[ISO 9169:2006, 2.2.4]

3.13
span gas

gas or gas mixture used to adjust and check a specific point on a calibration curve

NOTE Adapted from ISO 12039:2001,[3] 3.4.1.

EXAMPLE Normally a mixture of propane and air is used.

3.14
span point

value of the output quantity (measured signal) of the automatic measuring ssytem for the purpose of calibration, adjustment, etc. that represents a correct measured value generated by reference material

3.15
standard uncertainty

uncertainty of the result of measurement expressed as a standard deviation

[ISO/IEC Guide 98-3:2008,[4] 2.3.1]

NOTE The standard uncertainty of a result of measurement is an estimate of the standard deviation of the population of all possible results of measurement which can be obtained by means of the same method of measurement for the measurand exhibiting a unique value.

3.16
total volatile organic compounds
TVOCs

by convention, total organic compounds present with a partial pressure below their saturated vapour pressure at ambient air pressure and temperature

NOTE Measured TVOC values (mass concentration or volume concentration) are usually referred to carbon.

3.17
uncertainty (of measurement)

parameter, associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the measurand

[ISO/IEC Guide 98-3:2008,[4] 2.2.3]

3.18
zero gas

gas or gas mixture used to establish the zero point on a calibration curve within a given concentration range

[ISO 12039:2001,[3] 3.4.2]

3.19
zero point

specified value of the output quantity (measured signal) of the AMS and which, in the absence of the measured component, represents the zero crossing of the calibration line

4 Symbols and abbreviated terms

γ	TVOC mass concentration

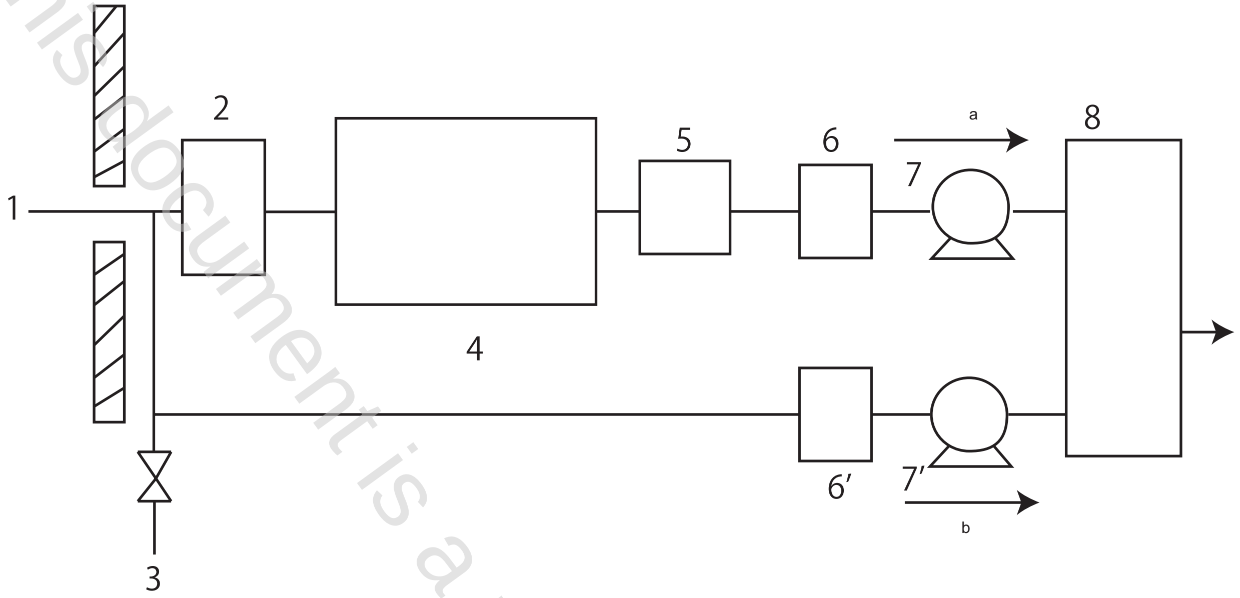
$\bar{\gamma}$	grand mean of measured TVOC mass concentration
φ	TVOC volume fraction (= 10^{-6})
e_i	residual (lack of fit) at level i
k	coverage factor
M_C	molar mass of carbon (= 12 g/mol)
n	number of measurements
s_j	standard deviation of level j
$s_{r,j}$	standard deviation of repeatability
$s_{R,j}$	standard deviation of reproducibility
u	standard uncertainty of TVOC mass concentration
$u(\gamma_\mathrm{TVOC})$	combined uncertainty of TVOC mass concentration
$U(\gamma_\mathrm{TVOC})$	expanded uncertainty of mass concentration
V_m	molar volume (22,4 l/mol)
$C_{V,r}$	coefficient of variation of repeatability
$C_{V,R}$	coefficient of variation of reproducibility
$C_{V,u}$	coefficient of variation of the standard uncertainty
$\bar{x}$	average of the measured values x_i
x_i	ith measured value
$\bar{x}_i$	average of the measured value at level i
$\hat{x}_i$	value estimated by the regression line at level i
AMS	automatic measuring system
NDIR	non-dispersive infrared absorption
QA	quality assurance
QC	quality control

5 Principle

5.1 Method of measurement

The measuring system consists of a sample conditioning system and the NDIR analyser for measuring CO_2 equipped with the converter for oxidation of TVOCs to CO_2 as shown in Figure 1. A portion of sample gas (gas A) passes through the converter (and the moisture removal system), and goes into the NDIR analyser, while another portion of sample gas (gas B) passes through (the moisture removal system), and goes into the NDIR analyser. The difference in the CO_2 concentration between gas A and gas B is equal to the concentration of CO_2 which comes from TVOCs.

The converter consists of oxidation catalyst such as platinum metal which is heated to around 450 °C for complete oxidation of TVOCs to CO_2. To avoid possible damage to the NDIR analyser due to halogens such as chlorine and/or chloride produced when halogenated organic compounds are oxidized, a halogen scrubber containing adsorbent is placed after the converter. Figure 1 shows an example of the measuring system including an NDIR analyser plus converter.



Key

1	sampling probe, heated (if necessary)	5	halogen scrubber
2	particle filter (heated, if necessary)	6, 6′	moisture removal system
3	zero and span gas inlet	7, 7′	pump
4	converter	8	NDIR analyser
a	Gas A.	b	Gas B.

Figure 1 — Diagram of the measuring system (example)

Sampling is the process of extracting a small portion which is truly representative of the composition of the main gas stream from a large quantity of waste gas.

A partial flow of the waste gas is directly fed into the NDIR analyser containing the catalytic converter via the sampling probe, the particle filter and the sampling line. The sampling device, including the filter to remove fine particles that could affect the NDIR analyser, is heated to avoid sample condensation, if necessary.

The sampling device shall:

a) be made of a material that is chemically and physically inert to the constituents of the waste gas under analysis;

NOTE Stainless steel, polytetrafluoroethylene or polypropylenefluoride are well-proven construction materials.

b) be designed to ensure a sample residence time less than 60 s — with long sampling lines or high flow resistance, the use of an external pump with bypass is recommended;

c) have a filtering device upstream of the sampling line to trap all particles liable to impair the operation of the apparatus;

d) have an inlet for applying zero and span gases at close to the entry nozzle of the sampling probe, upstream of the filter.