TECHNICAL SPECIFICATION

ISO/TS 20048-1

First edition
2020-03

Solid biofuels — Determination of off-gassing and oxygen depletion characteristics —

Part 1:
Laboratory method for the determination of off-gassing and oxygen depletion using closed containers

Reference number
ISO/TS 20048-1:2020(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 238, *Solid biofuels*.

A list of all parts in the ISO 20048 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

There is a continuous global growth in production, storage, handling, bulk transport and use of solid biofuels especially in the form of pelletized biofuels.

The specific physical and chemical characteristics of solid biofuels, their handling and storage can lead to a risk of fire and/or explosion, as well as health risks such as intoxication due to exposure to carbon-monoxide, asphyxiation due to oxygen depletion or allergic reactions.

Emission from pellets or biomass stored in enclosed space represents a significant health risk due to exposure to carbon-monoxide (CO) and oxygen depletion. It is important to be able to assess the risk by quantifying the emission of CO in combination with oxygen level. This document describes a method for estimating the propensity of a particular quality of pellets or biomass to emit CO, CO_2, CH_4 as well as the depletion of oxygen within the stored environment. In a confined space, the gas composition can result in a toxic as well as explosive atmosphere.

Biomass species, age of the material as well as the ambient temperature impacts the dynamics of the gas emissions. Unless the level of CO and oxygen levels are well understood in an operating environment, there are inherent risk for workers, which have implications for liability.

This document specifies the methodology for measuring the emission and depletion factor and emission and depletion rate of off-gassing in combination with oxygen depletion for permanent gases emitted in an enclosed storage for biomass.

NOTE A method to be used in preliminary screening of CO for operational planning is currently under development within ISO/TC 238/WG 7. Stage at the time of publication ISO/CD 20048-2:2018.

The method described in this document uses highly sensitive gas chromatography to be able to identify the spectrum of gases and their relative concentration to predict the potential for unhealthy conditions during indoor storage of biomass. The sensitivity for detection of gas species and concentrations is only limited by the sensitivity of the chromatographic instrument. The method allows for estimation of emission and depletion factor and emission and depletion rate for each gas species of biomass at different storage temperatures.

The gas instrument analysis part of the method also allows for identification of gas species and determination of concentrations of gases sampled in open storage spaces for occupational hygiene purposes (Annex C).

Solid biofuels — Determination of off-gassing and oxygen depletion characteristics —

Part 1: Laboratory method for the determination of off-gassing and oxygen depletion using closed containers

1 Scope

This document defines a method for determination of off-gassing (permanent gases) and oxygen depletion from woody as well as non-woody biomass, including densified materials such as pellets and briquettes, as well as non-densified materials such as chips. The method is also applicable for thermally treated materials, including torrefied and carbonized materials.

The emission and depletion factor and emission and depletion rate for various gas species emitted from sample within a closed test container is determined by means of gas chromatography.

The emission and depletion factor and emission and depletion rate provide guidance for ventilation requirements to keep gas concentrations below Permissible Exposure Levels (PEL) in spaces where workers can be exposed to the enclosed atmosphere.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 16559, *Solid biofuels — Terminology, definitions and descriptions*

ISO 18135, *Solid biofuels — Sampling*

ISO 14780, *Solid biofuels — Sample preparation*

ISO 17827-2, *Solid biofuels — Determination of particle size distribution for uncompressed fuels — Part 2: Vibrating screen method using sieves with aperture of 3,15 mm and below*

ISO 17828, *Solid biofuels — Determination of bulk density*

ISO 18134-1, *Solid biofuels — Determination of moisture content — Oven dry method — Part 1: Total moisture — Reference method*

ISO 18134-2, *Solid biofuels — Determination of moisture content — Oven dry method — Part 2: Total moisture — Simplified method*

ISO 18846, *Solid biofuels — Determination of fines content in quantities of pellets*

ISO 18847, *Solid biofuels — Determination of particle density of pellets and briquettes*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 16559 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
emission factor
concentration in percent of a gas species relative to other gases in a volume and expressed in gram per kilogram of the substance emitting at a given temperature

3.2
depletion factor
concentration in percent of a gas species relative to other gases in a volume and expressed in gram per kilogram of the substance depleting at a given temperature

3.3
emission rate
concentration in percent of a gas species relative to other gases in a volume and expressed in gram per kilogram per day of the substance emitting at a given temperature

3.4
depletion rate
concentration in percent of a gas species relative to other gases in a volume and expressed in gram per kilogram per day of the substance depleting at a given temperature

3.5
ppmv
parts per million on volume basis

3.6
gas chromatograph
GC
instrument used in analytical chemistry for separating and analysing compounds that can be vapourized without decomposition

3.7
Permissible Exposure Level
PEL
regulatory limit on the amount or concentration of a substance in the air

Note 1 to entry: This is usually based on an eight-hour time weighted average, but some are based on short-term exposure limits.

4 Principle

One or more test container(s) sealed with an air-tight lid and partly filled with biomass test sample are placed in oven with controlled temperature such as 20 °C, 30 °C, 40 °C or 50 °C. Gas samples are drawn by means of a syringe through the sampling port of the container(s) and the relative concentration of gas species is quantified by means of a gas chromatograph. The concentration is converted from a volume fraction in % relative to other gases in the test container and expressed as emission and depletion factor in gram per kilogram of biomass at a given temperature. The emission and depletion rate are expressed as gram of gas species per kilogram of biomass per day at a given temperature.

A method for converting emission and depletion factor (ppmv) concentration and calculating the number of air exchanges in a space with controlled ventilation is provided in Annex B.

5 Apparatus

5.1 General

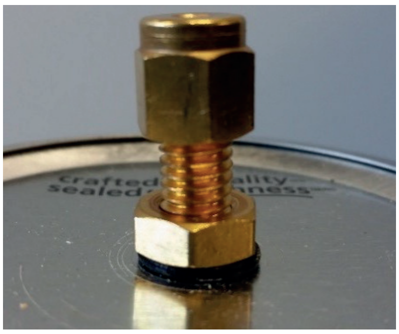
All equipment holding biomass samples and gas samples extracted during the determination shall be free of any contaminants, well ventilated and dry before the off-gassing test starts.

NOTE Containers and fittings can be dried overnight at low temperature around 30 °C.

5.2 Test containers

The test container(s) shall preferably be made of glass, not plastic, due to the risk of contaminating gases from plastic materials at higher temperatures. Since the containers shall only be filled to 75 % with biomass to be tested, it is an advantage to be able to see the level of biomass from the outside. Figure 1 a) to 1 c) show photos of the test container with sampling port and Figure 2 shows a schematic of the test container and sampling port.

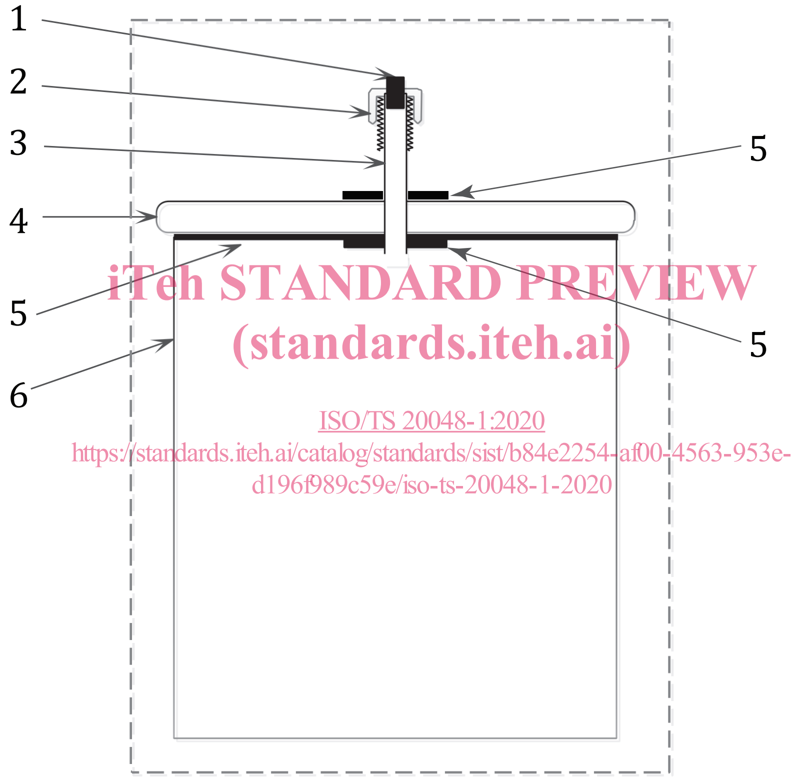
a) Test container of glass with sampling port



b) Sampling port, from the side

c) Sampling port, from above

Figure 1 — Example of test container of glass with sampling port



Key

1 septum
2 nipple
3 sampling port
4 container lid
5 air-tight seal
6 test container

Figure 2 — Schematic of test container with sampling port

The headspace in an enclosed container shall contain sufficient oxygen to sustain oxidation of test sample to reach a peak (plateau) and allow determination of the emission and depletion factor[1][2]. The 25 % headspace of enclosed air volume under roof in a typical large-scale storage facility such as a silo when fully loaded is typical and is therefore selected for this test method.

The seal between the lid and the container as well as the sampling port nipple (septum) shall be made of polytetrafluoroethylene (PTFE) or neoprene, which are non-reactive materials at the temperatures recommended for the off-gassing tests. Gas samples shall be drawn using a syringe (see 5.3) piercing through the septum.

The effective gas volume in a test container can be expressed in accordance with Formula (1).

$$V = V_h + V_v = 0{,}25 \times V_c + V_v \quad (1)$$

where

- V is the effective gas volume in test container when filled with biomass;
- V_h $= 0{,}25 \times V_c$ is the selected headspace volume;
- V_v is the volume of void between the biomass particles;
- V_c is the volume of empty test container.

EXAMPLE

The effective gas volume (V) for a test container with a volume of 3 500 ml (V_c) loaded to 75 % with wood pellets and with a volume of void of 50 % can be calculated as follows:

V = 0,25 × 3 500 [ml]+0,75 × 3 500 [ml] × 0,5 = 3 500 [ml] × 0,625 = 2 188 ml

Guidance for selecting container size in relation to gas sample size required by the GC for a selected gas depletion volume is provided in 7.3.

5.3 Gas sampler

A gas-tight GC syringe shall be used for drawing gas test samples through septum in the container sampling port nipple. It is recommended that the capacity of the syringe be at least 3 times the volume of the sampling tube and sampling loop of the GC or as recommended by the manufacturer of the GC (see 5.5). The syringe shall have a scale with a resolution of 1 ml and a valve to secure the sample after drawing. It is best to use needles that have a hole on the side rather than the tip to prevent silicone or neoprene material blocking the hole while sampling.

The gas sample is injected directly from the sampler syringe into the GC sample port.

5.4 Ovens

The temperature within the test containers shall be controlled by placing the containers in ovens automatically controlling the temperature in the range of 20 °C to 50 °C ± 1 °C. A separate oven is required for each temperature selected for testing. The ovens shall be able to hold the size of containers required to achieve the necessary accuracy of the off-gassing determination.

Since temperature of biomass under test has a propensity to self-generate heat[4] at testing temperatures above 40 °C, particularly if the moisture in the material is high, a thermocouple should be placed inside the material in one of the containers. A thermocouple in the centre of the test volume will help monitoring the uniformity of the temperature.

5.5 Gas chromatograph (GC) analyser

The detection limit for each gas species and related concentrations is determined by the type of column in the GC. The manufacturer of the GC should be consulted. GC with thermal conductivity detector (TCD) shall be used to detect and quantify permanent gases and light hydrocarbons. Packed and capillary