
Solid biofuels — Determination of self-heating of pelletized biofuels —

Part 2: Basket heating tests

*Biocombustibles solides — Détermination de l'auto-échauffement des
granulés de biocombustibles —*

Partie 2: Essais utilisant la méthode du point de croisement

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Contents

Page

Foreword	iv
Introduction	v
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Symbols	3
5 Basket heating tests	3
6 Tests for product classification	4
6.1 UN classification	4
6.1.1 General	4
6.1.2 Test method for self-heating substances — UN MTC Test N.4	4
6.1.3 Classification criteria — GHS	5
6.2 Classification criteria — IMO	5
6.3 Applicability of UN MTC Test N.4 for pelletized biofuels	5
7 Tests for determination of reaction kinetics	6
7.1 General	6
7.2 Isoperibolic test methods	6
7.2.1 General	6
7.2.2 Test procedure	7
7.2.3 Determination of reaction kinetics	7
7.2.4 Applicability for pelletized biofuels	7
7.3 Crossing-point method	8
7.3.1 General	8
7.3.2 Test procedure	8
7.3.3 Determination of reaction kinetics	9
7.3.4 Applicability for pelletized biofuels	9
7.4 Adiabatic hot storage tests	10
7.4.1 General	10
7.4.2 Test procedure	10
7.4.3 Determination of reaction kinetics	11
7.4.4 Applicability for pelletized biofuels	12
8 Sample handling	12
8.1 General	12
8.2 Sampling	12
8.3 Sample transport and storage	13
8.4 Sample preparation	13
8.5 Sample disposal	13
9 Test report	13
Annex A (informative) Example of calculating kinetic parameters from crossing-point method tests	15
Annex B (informative) Use of data for calculations of critical conditions in storages	18
Bibliography	23

Foreword

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A list of all parts in the ISO 20049 series can be found on the ISO website.

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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.

Heat can be generated in solid biofuel by exothermic biological, chemical and physical processes. Biological processes include the metabolism of fungus and bacteria and occur at lower temperatures; the oxidation of wood constituents increases with temperature and dominates at higher temperatures; the heat production from biological and chemical processes leads to transport of moisture in the bulk material, with associated sorption and condensation of water, which both are exothermic processes. In, for example, a heap of stored forest fuel or a heap of moist wood chips, all of these processes can be present and contribute to heat production.

Solid biofuels such as wood pellets, however, are intrinsically sterile^[6] due to the conditions during manufacturing (exposure to severe heat during drying, fragmentation during hammermilling and pressure during extrusion) but can attract microbes if becoming wet during handling and storage resulting in metabolism and generation of heat. Leakage of water into a storage of wood pellets can also lead to the physical processes mentioned above. Non-compressed wood like feedstock and chips typically have a fauna of microbes which under certain circumstances will result in heating. All the processes mentioned above contribute to what is called self-heating although oxidation is likely to be one of the main contributing factors in the temperature range under which most biofuels are stored. The heat build-up can be significant in large bulk stores as the heat conduction in the material is low. Under certain conditions the heat generation can lead to thermal runaway and spontaneous ignition.

The potential for self-heating seems to vary considerably for different types of solid biofuel pellets. The raw material used, and the properties of these raw materials have proven to influence the propensity for self-heating of the produced wood pellets. However, the production process (e.g. the drying process) also influences the potential for self-heating. It is therefore important to be able to identify solid biofuel pellets with high heat generation potential to avoid fires in stored materials.

Two intrinsically different types of tests methods can be used to estimate the potential of self-heating:

- a) in the isothermal calorimetry method described in ISO 20049-1, the heat flow generated from the test portion is measured directly;
- b) in the basket heating tests described in this document, the temperature of the test portion is being monitored and the critical ambient temperature (CAT), where the temperature of the test portion just does not increase significantly due to self-heating, is used for indirect assessment of self-heating.

These two methods are applied at different analysis temperature regimes. The operating temperature for an isothermal calorimeter is normally in the range 5 °C to 90 °C whereas basket heating tests are conducted at higher analysis (oven) temperatures. For basket heating tests with wood pellets, the CAT is found for a 1 l sample portion in the range 150 °C to 200 °C.

NOTE 1 The two types of test methods referred to above do not measure heat production from physical processes such as transport of moisture.

NOTE 2 It is likely that oxidation reactions taking place in the low respective high temperature regimes for solid biofuel pellets are of different character and thus have different reaction rates and heat production rates. In such a case, extrapolation of the data from a high temperature test series can lead to non-conservative results and might not be applicable without taking the low temperature reactions into account. In the general case of two reactions with different activation energies, the high activation energy is “frozen out” at low temperatures and the low activation energy reaction is “swamped” at higher temperatures^[7].