INTERNATIONAL STANDARD

ISO 17225-1

First edition
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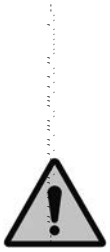
Solid biofuels — Fuel specifications and classes —

Part 1: General requirements

Biocombustibles solides — Classes et spécifications des combustibles —

Partie 1: Exigences générales

Reference number
ISO 17225-1:2014(E)



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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 on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 238, *Solid biofuels*.

ISO 17225 consists of the following parts, under the general title *Solid biofuels — Fuel specifications and classes*:

— *Part 1: General requirements*

— *Part 2: Graded wood pellets*

— *Part 3: Graded wood briquettes*

— *Part 4: Graded wood chips*

— *Part 5: Graded firewood*

— *Part 6: Graded non-woody pellets*

— *Part 7: Graded non-woody briquettes*

Introduction

The objective of the ISO 17225 series is to provide unambiguous and clear classification principles for solid biofuels and to serve as a tool to enable efficient trading of biofuels and to enable good understanding between seller and buyer as well as a tool for communication with equipment manufacturers. It will also facilitate authority permission procedures and reporting.

The ISO 17225 series is made for all stakeholders.

Solid biomass covers organic, non-fossil material of biological origin which may be used as fuel for heat and electrical generation.

Figure 1 describes the bioenergy utilization chain from sources of biomass, to biofuel production to final use of bioenergy. Although biomass can be used for energy generation it has many other primary uses (non-fuels) as a raw material for construction, furniture, packaging, paper products, etc.

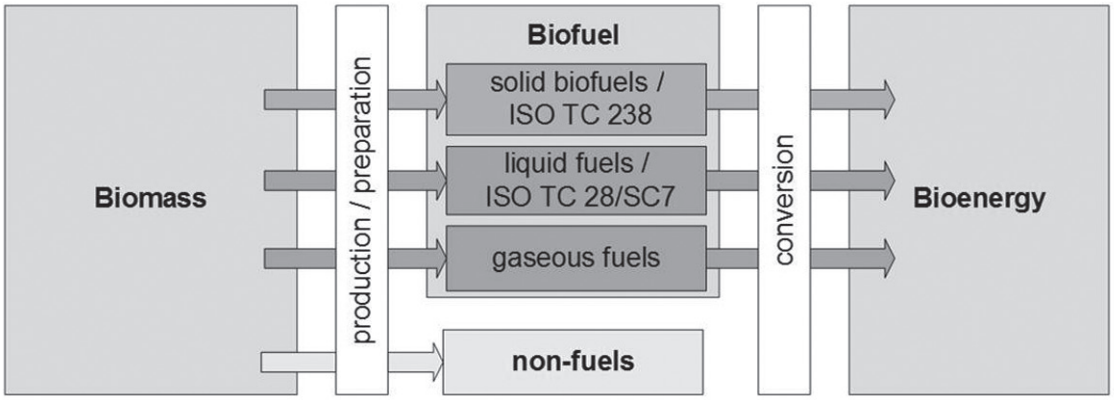


Figure 1 — ISO TC 238 within the biomass — Biofuel — Bioenergy field

The classifications given in this International Standard are provided with the objective of using biomass as a solid biofuel and therefore do not deal with all other uses.

Although these product standards may be obtained separately, they require a general understanding of the standards based on and supporting ISO 17225-1. It is recommended to obtain and use ISO 17225-1 in conjunction with these standards.

In these product standards, graded means that solid biofuel is used either in commercial applications, such as in households and small commercial and public sector buildings or industrial applications, which demand the use of fuels with specified quality (properties) expressed by quality classes like A1, A2 or B.

Solid biofuels — Fuel specifications and classes —

Part 1: General requirements

1 Scope

This part of ISO 17225 determines the fuel quality classes and specifications for solid biofuels of raw and processed materials originating from

a) forestry and arboriculture;

b) agriculture and horticulture;

c) aquaculture.

Chemically treated material may not include halogenated organic compounds or heavy metals at levels higher than those in typical virgin material values (see Annex B) or higher than typical values of the country of origin.

NOTE Raw and processed material includes woody, herbaceous, fruit, aquatic biomass and biodegradable waste originating from above sectors.

2 Normative references

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

NOTE ISO standards describing methods for analysis of fuel properties listed in the Bibliography, will become normative references when they are published.

ISO 16559, *Solid biofuels — Terminology, definitions and descriptions*[1)]

ISO 16948, *Solid biofuels — Determination of total content of carbon, hydrogen and nitrogen*[2)]

ISO 16967, *Solid biofuels — Determination of major elements*[3)]

ISO 16968, *Solid biofuels — Determination of minor elements*[4)]

ISO 16993, *Solid biofuels — Conversion of analytical results from one basis to another*[5)]

ISO 16994, *Solid biofuels — Determination of total content of sulfur and chlorine*[6)]

ISO 17828, *Solid biofuels — Determination of bulk density*[7)]

1) To be published.

2) To be published.

3) To be published.

4) To be published.

5) To be published.

6) To be published.

7) To be published.

ISO 17829, *Solid biofuels — Determination of length and diameter for pellets*[8)]

ISO 17831-1, *Solid biofuels — Determination of mechanical durability of pellets and briquettes — Part 1: Pellets*[9)]

ISO 17831-2, *Solid biofuels — Determination of mechanical durability of pellets and briquettes — Part 2: Briquettes*[10)]

ISO 18122, *Solid biofuels — Determination of ash content*[11)]

ISO 18123, *Solid biofuels — Determination of the content of volatile matter*[12)]

ISO 18134-1, *Solid biofuels — Determination of moisture content — Oven dry method — Part 1: Total moisture — Reference method*[13)]

ISO 18134-2, *Solid biofuels — Determination of moisture content — Oven dry method — Part 2: Total moisture — Simplified method*[14)]

3 Terms and definitions

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

3.1
chemical treatment
any treatment with chemicals other than air, water or heat

Note 1 to entry: Examples of chemical treatments are listed in informative Annex C.

3.2
commercial application
facility that utilize solid biofuel burning appliances or equipment that have similar fuel requirements as residential appliances

Note 1 to entry: Commercial applications should not be confused with industrial applications, which can utilize a much wider array of materials and have vastly different fuel requirements.

8) To be published.

9) To be published.

10) To be published.

11) To be published.

12) To be published.

13) To be published.

14) To be published.

4 Symbols and abbreviated terms

The symbols and abbreviated terms used in this part of ISO 17225 comply with the SI system of units as far as possible.

d	dry (dry basis)
daf	dry, ash-free
ar	as received
w-%	weight-percentage
A	Designation for ash content on dry basis A_d [w-%]
BD	Designation for bulk density as received [kg/m^3]
C	Designation for fixed carbon on dry basis C_f [w-%]
D	Designation for diameter as received, D [mm]
DE	Designation for particle density as received [g/cm^3]
DU	Designation for mechanical durability as received [w-%]
E	Designation for energy density as received, E_{ar} [MJ/m^3 or kWh/m^3 loose or stacked volume] (amount of energy/volume unit)
F	Designation for amount of fines as received [w-%]
L	Designation for length as received L [mm]
M	Designation for moisture content as received on wet basis, M_{ar} [w-%]
P	Designation for particle size distribution on analysis moisture basis
$q_{V,gr,\,d}$	Gross calorific value at constant volume on dry basis [MJ/kg or kWh/kg]
$q_{p,\mathrm{net,d}}$	Net calorific value at constant pressure on dry basis [MJ/kg or kWh/kg]
Q	Designation for net calorific value as received, $q_{p,\mathrm{net,ar}}$ [MJ/kg or kWh/kg or MWh/t] at constant pressure
U	Designation for moisture content as received on dry basis U_{ar} [w-%]
VM	Designation for volatile matter on dry basis [w-%]

NOTE 1 Fixed carbon (%) is calculated by the following: 100 - [moisture (w-%) + ash (w-%)+volatile matter (w-%)]. All percentages are on the same moisture base.

NOTE 2 1 MJ/kg equals 0,277 8 kWh/kg (1 kWh/kg equals 1 MWh/t and 1 MWh/t is 3,6 MJ/kg). 1 g/cm^3 equals 1 kg/dm^3. 1 mg/kg equals 0,000 1 % or 1 ppm.

NOTE 3 Designation symbols are used in combination with a number to specify property levels in Tables 3 to 16. For designation of chemical properties, chemical symbols such as S (sulfur), Cl (chlorine), and N (nitrogen) are used and the property class is added at the end of the symbol.

5 Principle

Solid biofuels are specified by:

a) origin and source, Clause 6;

b) major traded forms and properties, Clause 7.

For specification of origin and source, see Table 1. For major traded forms, see Table 2.

For specification of properties see Tables 3 to 15. The major traded forms of solid biofuels are covered by Tables 3 to 15. Table 16 is a general master table to be used for a specification of solid biofuels not covered by Tables 3 to 15.

Tables 3 to 16 list the normative properties, which shall be specified and informative properties, which are voluntary. Normative properties vary depending on both origin and traded form.

EXAMPLE OF SPECIFICATION

Origin: Logging residues (1.1.4)

Traded form: Wood chips

Properties: Dimensions P45, Moisture M40, Ash A1.5

In the case of wood chips (Table 5) the properties of dimensions, moisture and ash are normative in the specification. Other properties are informative.

Product standards for graded solid biofuels are given in other parts of this ISO series.

6 Classification of origin and sources of solid biofuels

6.1 General

The classification is based on the biofuel origin and source. In the hierarchical classification system (Table 1) the main origin-based solid biofuel groups are:

a) woody biomass;

b) herbaceous biomass;

c) fruit biomass;

d) aquatic biomass;

e) blends and mixtures.

Woody biomass is biomass from trees, bushes and shrubs.

Herbaceous biomass is from plants that have a non-woody stem and which die back at the end of the growing season. It includes grains and their by-products such as cereals.

Fruit biomass is biomass from those parts of a plant which are from or hold seeds.

Aquatic biomass is from so called hydrophytic plants or hydrophytes, which are plants that have adapted to living in or on aquatic environments.

If appropriate, also the actual species (e.g. spruce, wheat) of biomass should be stated.

The term “Blends and mixtures” in Table 1 refers to material of various origin within the given box in the classification table and appears on four levels. Blends are intentionally mixed biofuels, whereas mixtures are unintentionally mixed biofuels. The origin of the blend and mixture shall be described using Table 1.

If a solid biofuel blend or mixture contains chemically treated material it shall be stated.

The second level of classification in Table 1 describes fuels from different sources within the main groups, primarily stating whether the biomass is a virgin material, a by-product or a residue from the industry.

Groups in Table 1 are further divided into third and fourth level sub-groups. The purpose of Table 1 is to allow the possibility to differentiate and specify biofuel material based on origin with as much detail as needed. With the help of typical values from informative Annex B information on physical and chemical properties can be deduced.

Examples for classification according to Table 1:

a) Whole trees without roots from birch (1.1.1.1);

b) Blend of broad-leaf and coniferous whole trees without roots (1.1.1.1, 1.1.1.2);

c) Oil palm stem (1.1.3.3);

d) Logging residues (1.1.4);

e) Oil palm branches (1.1.4.1);

f) Logging residues from spruce stands (1.1.4.2);

g) Sawdust from broad-leaf (1.2.1.1);

h) Plywood from coniferous (1.2.1.2);

i) Plywood residues (1.2.2.1);

j) Grinding dust from furniture industry (1.2.2.1);

k) Lignin (1.2.2.4);

l) Construction wood (1.3.1.1);

m) Pallets (1.3.2.1);

n) Straw from wheat, barley, oat, rye (2.1.1.2);

o) Rice husk (2.1.1.4);

p) Reed canary grass (2.1.2.1);

q) Bamboo (2.1.2.5);

r) Grains or seeds crops from food processing industry (2.2.1.1);

s) Palm kernel or palm shell (3.1.2.3);

t) Oil palm fruit bunch (3.2.1.2);

u) Olive residues from olive pressing (3.2.2.4);

v) Kelp (4.3.2.4);

w) Blend; 80w-% sawdust from coniferous (1.2.1.2) and 20w-% reed canary grass (2.1.2.1);

x) Mixture; whole trees without roots from birch (1.1.1.1), whole trees without roots from spruce (1.1.1.2);

y) Blend; 99w-% sawdust (1.2.1), 1w-% glued wood (glue content of whole mass 0,1w-%) (1.2.2).

Table 1 — Classification of origin and sources of solid biofuels

1. Woody biomass	1.1 Forest, plantation and other virgin wood	1.1.1 Whole trees without roots	1.1.1.1 Broad-leaf 1.1.1.2 Coniferous 1.1.1.3 Short rotation coppice 1.1.1.4 Bushes 1.1.1.5 Blends and mixtures
		1.1.2 Whole trees with roots	1.1.2.1 Broad-leaf 1.1.2.2 Coniferous 1.1.2.3 Short rotation coppice 1.1.2.4 Bushes 1.1.2.5 Blends and mixtures
		1.1.3 Stemwood	1.1.3.1 Broad-leaf with bark 1.1.3.2 Coniferous with bark 1.1.3.3 Broad-leaf without bark 1.1.3.4 Coniferous without bark 1.1.3.5 Blends and mixtures
		1.1.4 Logging residues	1.1.4.1 Fresh/Green, Broad-leaf (including leaves) 1.1.4.2 Fresh/Green, Coniferous (including needles) 1.1.4.3 Stored, Broad-leaf 1.1.4.4 Stored, Coniferous 1.1.4.5 Blends and mixtures
		1.1.5 Stumps/roots	1.1.5.1 Broad-leaf 1.1.5.2 Coniferous 1.1.5.3 Short rotation coppice 1.1.5.4 Bushes 1.1.5.5 Blends and mixtures
		1.1.6 Bark (from forestry operations)	
		1.1.7 Segregated wood from gardens, parks, roadside maintenance, vineyards, fruit orchards and driftwood from freshwater	
		1.1.8 Blends and mixtures	
	1.2 By-products and residues from wood processing industry	1.2.1 Chemically untreated wood by-products and residues	1.2.1.1 Broad-leaf with bark 1.2.1.2 Coniferous with bark 1.2.1.3 Broad-leaf without bark 1.2.1.4 Coniferous without bark 1.2.1.5 Bark (from industry operations)
		1.2.2 Chemically treated wood by-products, residues, fibres and wood constituents	1.2.2.1 Without bark 1.2.2.2 With bark 1.2.2.3 Bark (from industry operations) 1.2.2.4 Fibres and wood constituents
		1.2.3 Blends and mixtures	
	1.3 Used wood	1.3.1 Chemically untreated used wood	1.3.1.1 Without bark 1.3.1.2 With bark 1.3.1.3 Bark
		1.3.2 Chemically treated used wood	1.3.2.1 Without bark 1.3.2.2 With bark 1.3.2.3 Bark
		1.3.3 Blends and mixtures	
	1.4 Blends and mixtures		

Table 1 *(continued)*

2. Herbaceous biomass	2.1 Herbaceous biomass from agriculture and horticulture	2.1.1 Cereal crops	2.1.1.1 Whole plant 2.1.1.2 Straw parts 2.1.1.3 Grains or seeds 2.1.1.4 Husks or shells 2.1.1.5 Blends and mixtures
		2.1.2 Grasses	2.1.2.1 Whole plant 2.1.2.2 Straw parts 2.1.2.3 Seeds 2.1.2.4 Shells 2.1.2.5 Bamboo 2.1.2.6 Blends and mixtures
		2.1.3 Oil seed crops	2.1.3.1 Whole plant 2.1.3.2 Stalks and leaves 2.1.3.3 Seeds 2.1.3.4 Husks or shells 2.1.3.5 Blends and mixtures
		2.1.4 Root crops	2.1.4.1 Whole plant 2.1.4.2 Stalks and leaves 2.1.4.3 Root 2.1.4.4 Blends and mixtures
		2.1.5 Legume crops	2.1.5.1 Whole plant 2.1.5.2 Stalks and leaves 2.1.5.3 Fruit 2.1.5.4 Pods 2.1.5.5 Blends and mixtures
		2.1.6 Flowers	2.1.6.1 Whole plant 2.1.6.2 Stalks and leaves 2.1.6.3 Seeds 2.1.6.4 Blends and mixtures
		2.1.7 Segregated herbaceous biomass from gardens, parks, roadside maintenance, vineyards and fruit orchards	
		2.1.8 Blends and mixtures	
	2.2 By-products and residues from food and herbaceous processing industry	2.2.1 Chemically untreated herbaceous residues	2.2.1.1 Cereal crops and grasses 2.2.1.2 Oil seed crops 2.2.1.3 Root crops 2.2.1.4 Legume crops 2.2.1.5 Flowers 2.2.1.6 Blends and mixtures
		2.2.2 Chemically treated herbaceous residues	2.2.2.1 Cereal crops and grasses 2.2.2.2 Oil seed crops 2.2.2.3 Root crops 2.2.2.4 Legume crops 2.2.2.5 Flowers 2.2.2.6 Blends and mixtures
		2.2.3 Blends and mixtures	
	2.3 Blends and mixtures		

Table 1 *(continued)*

3. Fruit biomass	3.1 Orchard and horticulture fruit	3.1.1 Berries	3.1.1.1 Whole berries 3.1.1.2 Flesh 3.1.1.3 Seeds 3.1.1.4 Blends and mixtures
		3.1.2 Stone/kernel fruits	3.1.2.1 Whole fruit 3.1.2.2 Flesh 3.1.2.3 Stone/kernel/fruit fibre 3.1.2.4 Blends and mixtures
		3.1.3 Nuts and acorns	3.1.3.1 Whole nuts 3.1.3.2 Shells/husks 3.1.3.3 Kernels 3.1.3.4 Blends and mixtures
		3.1.4 Blends and mixtures	
	3.2 By-products and residues from food and fruit processing industry	3.2.1 Chemically untreated fruit residues	3.2.1.1 Berries 3.2.1.2 Stone/kernel fruits/fruit fibre 3.2.1.3 Nuts and acorns 3.2.1.4 Crude olive cake 3.2.1.5 Blends and mixtures
		3.2.2 Chemically treated fruit residues	3.2.2.1 Berries 3.2.2.2 Stone/kernel fruits 3.2.2.3 Nuts and acorns 3.2.2.4 Exhausted olive cake 3.2.2.5 Blends and mixtures
		3.2.3 Blends and mixtures	
	3.3 Blends and mixtures		
4. Aquatic biomass	4.1 Algae	4.1.1 Micro algae (latin name to be stated)	
		4.1.2 Macro algae (latin name to be stated)	
		4.1.3 Blends and mixtures	
	4.2 Water hyacinth		
	4.3 Lake and sea weed	4.3.1 Lake weed (latin name to be stated)	
		4.3.2 Sea weed	4.3.2.1 Blue sea weed (latin name to be stated) 4.3.2.2 Green sea weed (latin name to be stated) 4.3.2.3 Blue-green sea weed (latin name to be stated) 4.3.2.4 Brown sea weed (latin name to be stated) 4.3.2.5 Red sea weed (latin name to be stated)
		4.3.3 Blends and mixtures	
	4.4 Reeds	4.4.1 Common reed	
		4.4.2 Other reed	
		4.4.3 Blends and mixtures	
	4.5 Blends and mixtures		
5 Blends and mixtures	5.1 Blends		
	5.2 Mixtures		

NOTE 1 If appropriate, also the actual species (e.g. spruce, wheat) of biomass may be stated according to EN 13556, *Round and sawn timber — Nomenclature of timbers used in Europe*.[1]

NOTE 2 Driftwood from saltwater is not recommended as a fuel.

NOTE 3 Group 5 “Blends and mixtures” include blends and mixtures from the main origin-based solid biofuel groups 1 to 4.

6.2 Woody biomass

6.2.1 Forest, plantation and other virgin wood

Forest, plantation and other virgin wood in this group may only have been subjected to size reduction, debarking, drying or wetting. Forest, plantation and other virgin wood includes wood from forests, parks, gardens, plantations and from short rotation forests and coppice.

6.2.2 By-products and residues from wood processing industry

Wood by-products and wood residues from industrial production are classified in this group. These biofuels can be chemically untreated (for example residues from debarking, sawing or size reduction, shaping, pressing) or chemically treated wood residues from wood processing and the production of panels and furniture (glued, painted, coated, lacquered or otherwise treated wood), as long as they do not contain heavy metals or halogenated organic compounds as a result of treatment with wood preservatives or coating.

6.2.3 Used wood

This group includes post consumer/post society wood waste; natural or merely mechanically processed wood, contaminated only to an insignificant extent during use by substances that are not normally found in wood in its natural state (for example pallets, transport cases, boxes, wood packages, cable reels, construction wood). With respect to treatment the same criteria apply as with respect to “wood processing industry by-products and residues”, i.e. the used wood shall not contain heavy metals more than in virgin wood, or halogenated organic compounds as a result of treatment with wood preservatives or coating.

6.2.4 Blends and mixtures

This refers to blends and mixtures of woody biomass in the groups 1.1 to 1.3 in Table 1. The mixing can be either intentional (blends) or unintentional (mixtures).

6.3 Herbaceous biomass

6.3.1 Herbaceous biomass from agriculture and horticulture

Material, which comes directly from the field, perhaps after a storage period, and may only have been subject to size reduction and drying is included here. It covers herbaceous material from agricultural and horticultural fields and from gardens and parks.

6.3.2 By-products and residues from food and herbaceous processing industry

This refers to any herbaceous biomass material that is left over after industrial handling and treatment.

Examples are residues from the production of sugar from sugar beets, barley malt residues from beer production and raw vegetable residues from food processing industry.

6.3.3 Blends and mixtures

This refers to blends and mixtures of herbaceous biomass in the groups 2.1 to 2.2 in Table 1. The mixing can be either intentional (blends) or unintentional (mixtures).

6.4 Fruit biomass

6.4.1 Orchard and horticulture fruit

Fruit from trees, bushes and fruit from herbs (e.g. tomatoes and grapes) are classified in this group.

6.4.2 By-products and residues from food and fruit processing industry

This refers to a fruit biomass material that is left over after industrial handling and treatment.

Examples are pressing residues from olive oil or apple juice production and processed (e.g. heated, steamed, cooked, etc.) vegetable residues from food processing industry.

6.4.3 Blends and mixtures

This refers to blends and mixtures of fruit biomass in the groups 3.1 to 3.2 in Table 1. The mixing can be either intentional (blends) or unintentional (mixtures).

6.5 Aquatic biomass

Aquatic biomasses are divided in to the following main species: algae, water hyacinth, lake and sea weed.

6.6 Biomass blends and mixtures

These include blends and mixtures of different biomasses mentioned above under 6.2 to 6.5. The mixing can be either intentional (blends) or unintentional (mixtures).

7 Specification of solid biofuels based on traded forms and properties

7.1 Traded forms of solid biofuels

Solid biofuels are traded in many different sizes and shapes. The size and shape influence the handling of the fuel as well as its combustion properties. Biofuels may be delivered e.g. in the forms shown in Table 2.

Table 2 — Major traded forms and raw materials of solid biofuels

Fuel name	Typical particle size	Common preparation method
Whole tree (Table 16)	> 500 mm	No preparation or delimbed
Wood chips (Table 5)	5 mm to 100 mm	Cutting with sharp tools
Hog fuel (Table 5)	Varying	Crushing with blunt tools
Stemwood/roundwood (Table 6)	> 100 cm	Cutting with sharp tools
Logwood (Table 6)	50 cm to 100 cm	Cutting with sharp tools
Firewood (Table 6)	5 cm to 100 cm	Cutting with sharp tools
Slabs and offcuts (Table 6 or 16)	Varying	Cutting with sharp tools
Bark (Table 9)	Varying	Debarking residue from trees (shredded or unshredded)
Bundle (Table 16)	Varying	Lengthwise oriented and bound
Fuel powder (Table 16)	< 1 mm	Milling
Sawdust (Table 7)	1 mm to 5 mm	Cutting with sharp tools
Shavings (Table 8)	1 mm to 30mm	Planing with sharp tools
Briquettes (Table 3)	Ø > 25 mm	Mechanical compression
Pellets (Table 4)	Ø ≤ 25 mm	Mechanical compression
Bales (Table 10) Small square bales Big square bales Round bales	 0,1 m^3 3,7 m^3 2,1 m^3	 Compressed and bound to squares Compressed and bound to squares Compressed and bound to cylinders
Chopped straw or energy grass (Table 16)	10 mm to 200 mm	Chopped during harvesting or before combustion

Table 2 *(continued)*

Fuel name	Typical particle size	Common preparation method
Grain (Table 11, Table 13) or seed (Table 12, Table 13)	Varying	No preparation or drying except for process operations necessary for storage for cereal grain
Fruit stones or kernel (Table 12)	5 mm to 15 mm	No preparation or pressing and extraction by chemicals.
Fibre cake (Table 16)	Varying	Prepared from fibrous waste by dewatering
Charcoal (Table 14)	Varying	Charcoal is prepared by the destructive distillation and pyrolysis of biomass.
Thermally treated biomass (Table 15)	Varying	Mild pre-treatment of biomass at a temperature between 200 and 300 °C for a short time period (e.g. 60 min).

NOTE 1 Also other forms may be used.

NOTE 2 The definitions from different traded forms are in accordance with ISO 16559.

Figures in the informative Annex A describe the particle size differences between different wood fuels and also the difference between wood chips and hog fuel.

7.2 Specification of properties of solid biofuels

The International Standards listed in Clause 2 shall be used for the sampling and determination of properties of solid biofuels. The additional parts of ISO 17225 (e.g. ISO 17225-2, ISO 17225-3, etc.) have been developed to describe graded solid biofuel products. These International product Standards are recommended for smaller scale appliances, such as used in households and small commercial and public sector applications. Pellets, briquettes, wood chips and firewood (log wood) are traded forms commonly used for small-scale applications. ISO 17225-2 also include specifications for graded industrial pellets.

For a specification of a solid biofuel, the denominations given in Tables 3 to 16 are normative and informative properties. In Tables 3 to 15 solid biofuels are defined by property classes.

When specifying a class within a property, the average numerical value from the whole lot or defined portion from the lot (e.g. shipload, truckload or bag) shall determine which class shall be used. For an example in Table 5, the ash class A3.0 (≤3 %) means that the ash content shall not be higher than 3,0 % to belong to this class. For all properties the lowest possible class shall be stated, except for bulk density, particle density and mechanical durability where the highest possible class shall be stated. Only one class shall be specified.

EXAMPLE A fuel with a moisture content of 17 w-% should be categorized as M20 and not M10 or M30.

A general master table (Table 16) shall be used for solid biofuels not covered by Tables 3 to 15.

If data for chemical or physical properties are available, further analysis may not be required.

To ensure resources are used appropriately and the declaration is accurate, use the most appropriate measure below:

a) using previous measured values or obtained by experience of same raw material (see Annex B);

b) calculation of properties, e.g. by using typical values and considering documented specific values;

c) carrying out of analysis:

   1) with simplified methods if available;

   2) with reference methods.

The responsibility of the producer or supplier to provide correct and accurate information is exactly the same whether laboratory analysis is performed or not. Typical values do not negate the producer or supplier from providing accurate and reliable information.

Conversion of a value on a dry basis (*d*) to a dry, ash free basis (*daf*) or to as received basis (*ar*) is given in ISO 16993.

NOTE 1 Typical values for some physical and chemical properties of biofuels are listed in Annex B. These can be used as an indication of the properties when needed, however, they may not be used for the limitation of the fuel parameters.

NOTE 2 It is important to carry out laboratory analysis, if raw material basis is changed.

NOTE 3 For Tables 3 to 16: only chemically treated biomass that are included in the scope, should be considered, i.e. wood waste which can contain halogenated organic compounds or heavy metals more than virgin wood as a result of treatment with wood preservatives or coating, are not included. Examples of chemical treatment are mentioned in Annex C.

NOTE 4 For Tables 3 to 16 is stated that the net calorific value should be specified on as received basis. The net calorific value will vary depending on the actual moisture content in the fuel. The value given in a specification is thus valid only for the actual connected moisture content. The net calorific value as received ($q_{p,\mathrm{net,ar}}$, designation Q) can be calculated using both the net calorific value on a dry basis ($q_{p,\mathrm{net,d}}$) and the moisture content (see Annex D).

Table 3 — Specification of properties for briquettes

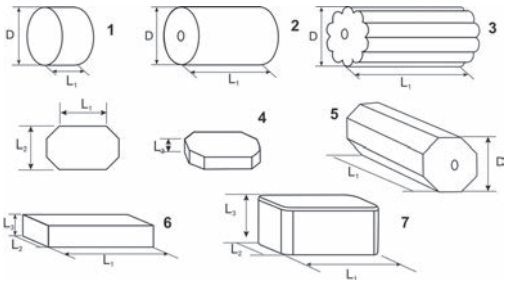
Master table			
Normative	**Origin**: According to 6.1 and Table 1		Woody biomass (1); Herbaceous biomass (2); Fruit biomass (3); Aquatic biomass (4); Blends and mixtures (5).
	Traded Form (see Table 2)		Briquette
	Dimensions (mm)		
	Diameter (*D*) and **Length** (*L*)		
	Diameter, height, width and length to be stated L_1 length, L_2 width, L_3 height Specify shape according to Figure 2 e.g. 1 or 2, etc.		 *L* Length *D* Diameter **Figure 2 — Examples of briquettes**
	Moisture, M (w-% as received) ISO 18134-1, ISO 18134-2		
	M10	≤ 10 %	
	M12	≤ 12 %	
	M15	≤ 15 %	
	Ash, A (w-% of dry basis) ISO 18122		
	A0.5	≤ 0,5 %	
	A0.7	≤ 0,7 %	
	A1.0	≤ 1,0 %	
	A1.5	≤ 1,5 %	
	A2.0	≤ 2,0 %	
	A3.0	≤ 3,0 %	
	A5.0	≤ 5,0 %	
	A7.0	≤ 7,0 %	
	A10.0	≤ 10,0 %	
	A10.0+	> 10,0 % (maximum value to be stated)	
	Particle density, DE (g/cm^3 as received) ISO 18847		
	DE0.8	≥ 0,8 g/cm^3	
	DE0.9	≥ 0,9 g/cm^3	
	DE1.0	≥ 1,0 g/cm^3	
	DE1.1	≥ 1,1 g/cm^3	
	DE1.2+	> 1,2 g/cm^3 (maximum value to be stated)	
	Additives [a] (w-% of pressing mass)		Type and content of pressing aids, slagging inhibitors or any other additives have to be stated
	Net calorific value, Q (MJ/kg or kWh/kg as received) ISO 18125		Minimum value to be stated [b]

Table 3 *(continued)*

Master table			
Normative/ Informative	**Mechanical durability, DU** (w-% of briquettes after testing) ISO 17831-2		
	DU95.0	≥ 95,0 %	Informative:
	DU90.0	≥ 90,0 %	only if traded in bulk
	DU90.0-	< 90,0 % (minimum value to be stated)	
	Nitrogen, N (w-% of dry basis) ISO 16948		
	N0.2	≤ 0,2 %	Normative:
	N0.3	≤ 0,3 %	Chemically treated biomass (1.2.2; 1.3.2; 2.2.2; 3.2.2)
	N0.5	≤ 0,5 %	Informative:
	N0.7	≤ 0,7 %	All fuels that are not chemically treated (see the exceptions above)
	N1.0	≤ 1,0 %	
	N1.5	≤ 1,5 %	
	N2.0	≤ 2,0 %	
	N3.0	≤ 3,0 %	
	N3.0+	> 3,0 % (maximum value to be stated)	
	Sulfur, S (w-% of dry basis) ISO 16994		
	S0.02	≤ 0,02 %	Normative:
	S0.03	≤ 0,03 %	Chemically treated biomass (1.2.2; 1.3.2; 2.2.2; 3.2.2) or if sulfur containing additives have been used.
	S0.04	≤ 0,04 %	Informative:
	S0.05	≤ 0,05 %	All fuels that are not chemically treated (see the exceptions above)
	S0.08	≤ 0,08 %	
	S0.10	≤ 0,10 %	
	S0.20	≤ 0,20 %	
	S0.20+	> 0,20 % (maximum value to be stated)	
	Chlorine, Cl (w-% of dry basis) ISO 16994		
	Cl0.01	≤ 0,01 %	Normative:
	Cl0.02	≤ 0,02 %	Chemically treated biomass (1.2.2; 1.3.2; 2.2.2; 3.2.2)
	Cl0.03	≤ 0,03 %	Informative:
	Cl0.07	≤ 0,07 %	All fuels that are not chemically treated (see the exceptions above)
	Cl0.10	≤ 0,10 %	
	Cl0.20	≤ 0,20 %	
	Cl0.30	≤ 0,30 %	
	Cl0.30+	> 0,30 % (maximum value to be stated)	
	Fixed carbon, C [c] (w-% of dry basis)		
	Minimum value to be stated		Normative only for thermally treated biomass briquettes
	Volatile matter, VM (w-% of dry basis) ISO 18123		
	Maximum value to be stated		Normative only for thermally treated biomass briquettes
Informative	**Ash melting behaviour** [d] (°C) CEN/TS 15370–1 [4]		Should be stated

[a] The maximum amount of additive is 20 w-% of pressing mass. Type stated as chemical substance (e.g. starch, corn flour, potato flour, vegetable oil, lignin). If amount is greater, then raw material for briquette is blend.

[b] Minimum value for torrefied or other thermally treated biomass briquettes are usually ≥ 18 MJ/kg.

[c] Fixed carbon (%) is calculated by the following: 100 – [moisture (w-%) + ash (w-%) + volatile matter (w-%)]. All percentages are on the same moisture basis.

[d] Special attention should be paid to the ash melting behaviour for some biomass fuels, for example eucalyptus, poplar, short rotation coppice, straw, miscanthus and olive stone. It is recommended that all characteristic temperatures (shrinkage starting temperature (SST), deformation temperature (DT), hemisphere temperature (HT) and flow temperature (FT)) in oxidizing conditions should be stated.

NOTE 5 Thermally treated biomass briquettes (e.g. torrefied briquettes) are also included in Table 3.

Table 4 — Specification of properties for pellets

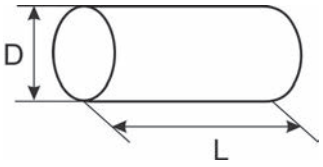
Master table			
Normative	**Origin:** According to 6.1 and Table 1		Woody biomass (1); Herbaceous biomass (2); Fruit biomass (3); Aquatic biomass (4); Blends and mixtures (5).
	Traded Form (see Table 2)		Pellets
	Dimensions (mm) ISO 17829		
	Diameter (*D*) and **Length** (*L*) [a]		
	D06 D08 D10 D12 D25	6 mm ± 1,0 mm and 3,15 mm < L ≤ 40 mm 8 mm ± 1,0 mm and 3,15 mm < L ≤ 40 mm 10 mm ± 1,0 mm and 3,15 mm < L ≤ 40 mm 12 mm ± 1,0 mm and 3,15 mm < L ≤ 50 mm 25 mm ± 1,0 mm, and 10 mm < L ≤ 50 mm	 **Figure 3 — Dimensions (mm)**
	Moisture, M (w-% as received) ISO 18134-1, ISO 18134-2		
	M05 M08 M10 M12 M15	≤ 5 % ≤ 8 % ≤ 10 % ≤ 12 % ≤ 15 %	
	Ash, A (w-% of dry basis) ISO 18122		
	A0.5 A0.7 A1.0 A1.2 A1.5 A2.0 A3.0 A4.0 A5.0 A6.0 A7.0 A8.0 A10.0 A10.0+	≤ 0,5 % ≤ 0,7 % ≤ 1,0 % ≤ 1,2 % ≤ 1,5 % ≤ 2,0 % ≤ 3,0 % ≤ 4,0 % ≤ 5,0 % ≤ 6,0 % ≤ 7,0 % ≤ 8,0 % ≤ 10,0 % > 10.0 % (maximum value to be stated)	

Table 4 *(continued)*

Master table			
	Mechanical durability, DU (w-% of pellets after testing) ISO 17831-1		
	DU97.5	≥ 97,5 %	
	DU96.5	≥ 96,5 %	
	DU95.0	≥ 95,0 %	
	DU95.0-	< 95,0 % (minimum value to be stated)	
	Amount of fines, F (w-%, < 3,15 mm) after production when loaded or packed, ISO 18846		
	F1.0	≤ 1,0 %	
	F2.0	≤ 2,0 %	
	F3.0	≤ 3,0 %	
	F4.0	≤ 4,0 %	
	F5.0	≤ 5,0 %	
	F6.0	≤ 6,0 %	
	F6.0+	> 6,0 % (maximum value to be stated)	
	Additives (w-% of pressing mass) [b]		Type and content of pressing aids, slagging inhibitors or any other additives have to be stated
	Bulk density (BD) (kg/m^3 as received) ISO 17828		
	BD550	≥ 550 kg/m^3	
	BD580	≥ 580 kg/m^3	
	BD600	≥ 600 kg/m^3	
	BD625	≥ 625 kg/m^3	
	BD650	≥ 650 kg/m^3	
	BD700	≥ 700 kg/m^3	
	BD750	≥ 750 kg/m^3	
	BD800+	> 800 kg/m^3 (minimum value to be stated)	
	Net calorific value, Q (MJ/kg or kWh/kg as received) ISO 18125		Minimum value to be stated [c]

Table 4 *(continued)*

Master table			
Normative/ Informative	**Nitrogen, N** (w-% of dry basis) ISO 16948		
	N0.2	≤ 0,2 %	Normative:
	N0.3	≤ 0,3 %	Chemically treated biomass (1.2.2; 1.3.2; 2.2.2; 3.2.2)
	N0.5	≤ 0,5 %	Informative:
	N0.6	≤ 0,6 %	All fuels that are not chemically treated (see the exceptions above)
	N0.7	≤ 0,7 %	
	N1.0	≤ 1,0 %	
	N1.5	≤ 1,5 %	
	N2.0	≤ 2,0 %	
	N3.0	≤ 3,0 %	
	N3.0+	> 3,0 % (maximum value to be stated)	
	Sulfur, S (w-% of dry basis) ISO 16994		
	S0.02	≤ 0,02 %	Normative:
	S0.03	≤ 0,03 %	Chemically treated biomass (1.2.2; 1.3.2; 2.2.2; 3.2.2) or if sulfur containing additives have been used.
	S0.04	≤ 0,04 %	Informative:
	S0.05	≤ 0,05 %	All fuels that are not chemically treated (see the exceptions above)
	S0.08	≤ 0,08 %	
	S0.10	≤ 0,10 %	
	S0.20	≤ 0,20 %	
	S0.20+	> 0,20 % (maximum value to be stated)	
	Chlorine, Cl (w-% of dry basis) ISO 16994		
	Cl0.01	≤ 0,01 %	Normative:
	Cl0.02	≤ 0,02 %	Chemically treated biomass (1.2.2; 1.3.2; 2.2.2; 3.2.2)
	Cl0.03	≤ 0,03 %	Informative:
	Cl0.05	≤ 0,05 %	All fuels that are not chemically treated (see the exceptions above)
	Cl0.07	≤ 0,07 %	
	Cl0.10	≤ 0,10 %	
	Cl0.20	≤ 0,20 %	
	Cl0.30	≤ 0,30 %	
	Cl0.30+	> 0,30 % (maximum value to be stated)	
	Fixed carbon, C [d] (w-% of dry basis)		
	Minimum value to be stated		Normative only for thermally treated biomass pellets
	Volatile matter, VM (w-% of dry basis) ISO 18123		
	Maximum value to be stated		Normative only for thermally treated biomass pellets
	Particle size distribution of disintegrated pellets (w-% of dry basis) ISO 17830		Values to be stated of pellets for industrial use

Table 4 *(continued)*

Master table		
Informative	**Ash melting behaviour** [e] (°C) CEN/TS 15370–1 [4]	Should be stated

[a] Amount of pellets longer than 40 mm (or 50 mm) can be 5 w-%. Maximum length for classes *D*06, *D*08 and *D*10 shall be ≤ 45 mm. Pellets are longer than 3,15 mm, if they stay on a round hole-sieve of 3,15 mm.

[b] The maximum amount of additive is 20 w-% of pressing mass. Type stated (e.g. starch, corn flour, potato flour, vegetable oil, lignin). If amount is greater, then raw material for pellet is blend.

[c] Minimum value for torrefied or other thermally treated biomass pellets are usual ≥ 18 MJ/kg.

[d] Fixed carbon (%) is calculated by the following: 100 – [moisture (w-%) + ash (w-%) + volatile matter (w-%)]. All percentage are on the same moisture basis.

[e] Special attention should be paid to the ash melting behaviour for some biomass fuels, for example eucalyptus, poplar, short rotation coppice, straw, miscanthus and olive stone. It is recommended that all characteristic temperatures (shrinkage starting temperature (SST), deformation temperature (DT), hemisphere temperature (HT) and flow temperature (FT)) in oxidizing conditions should be stated. Pre-ashing temperature other than 550 °C should be stated.

NOTE 6 Thermally treated biomass pellets (e.g. torrefied pellets) are also included in Table 4.

Table 5 — Specification of properties for wood chips and hog fuel

Master table					
Normative	**Origin**: According to 6.1 and Table 1.			Woody biomass (1)	
	Traded Form			Wood chips or hog fuel [a]	
	Dimensions (mm) ISO 17827-1				
	Main fraction [b] (minimum 60 w-%), mm		Coarse fraction, w-% (length of particle, mm)	Max. length of particles [c], mm	Max. cross sectional area of the coarse fraction [d], cm^2
	P16S	3,15 mm < *P* ≤ 16 mm	≤ 6 % > 31,5 mm	≤ 45 mm	≤ 2 cm^2
	P16	3,15 mm < *P* ≤ 16 mm	≤ 6 % > 31,5 mm	≤ 150 mm	
	P31S	3,15 mm < *P* ≤ 31,5 mm	≤ 6 % > 45 mm	≤ 150 mm	≤ 4 cm^2
	P31	3,15 mm < *P* ≤ 31,5 mm	≤ 6 % > 45 mm	≤ 200 mm	
	P45S	3,15 mm < *P* ≤ 45 mm	≤ 10 % > 63 mm	≤ 200 mm	≤ 6 cm^2
	P45	3,15 mm < *P* ≤ 45 mm	≤ 10 % > 63 mm	≤ 350 mm	
	P63	3,15 mm < *P* ≤ 63 mm	≤ 10 % > 100 mm	≤ 350 mm	
	P100	3,15 mm < *P* ≤ 100 mm	≤ 10 % > 150mm	≤ 350 mm	
	P200	3,15 mm < *P* ≤ 200 mm	≤ 10 % > 250mm	≤ 400 mm	
	P300	3,15 mm < *P* ≤ 300 mm	to be specified	to be specified	
	Fine fraction, F (<3,15 mm w-%), ISO 17827-1				
	F05	≤ 5 %			
	F10	≤ 10 %			
	F15	≤ 15 %			
	F20	≤ 20 %			
	F25	≤ 25 %			
	F30	≤ 30 %			
	F30+	> 30 (maximum value to be stated)			
	Moisture, M [e] (w-% as received) ISO 18134-1, ISO 18134-2				
	M10	≤ 10 %			
	M15	≤ 15 %			
	M20	≤ 20 %			
	M25	≤ 25 %			
	M30	≤ 30 %			
	M35	≤ 35 %			
	M40	≤ 40 %			
	M45	≤ 45 %			
	M50	≤ 50 %			
	M55	≤ 55 %			
	M55+	> 55 % (maximum value to be stated)			

Table 5 *(continued)*

Master table			
	Ash, A (w-% of dry basis) ISO 18122		
	A0.5	≤ 0,5 %	
	A0.7	≤ 0,7 %	
	A1.0	≤ 1,0 %	
	A1.5	≤ 1,5 %	
	A2.0	≤ 2,0 %	
	A3.0	≤ 3,0 %	
	A5.0	≤ 5,0 %	
	A7.0	≤ 7,0 %	
	A10.0	≤ 10,0 %	
	A10.0+	> 10,0 % (maximum value to be stated)	
Normative/ Informative	**Nitrogen, N** (w-% of dry basis) ISO 16948		
	N0.2	≤ 0,2 %	Normative:
	N0.3	≤ 0,3 %	Chemically treated biomass (1.2.2; 1.3.2)
	N0.5	≤ 0,5 %	Informative:
	N1.0	≤ 1,0 %	All fuels that are not chemically treated (see the exceptions above)
	N1.5	≤ 1,5 %	
	N2.0	≤ 2,0 %	
	N3.0	≤ 3,0 %	
	N3.0+	> 3,0 % (maximum value to be stated)	
	Sulfur, S (w-% of dry basis) ISO 16994		
	S0.02	≤ 0,02 %	Normative:
	S0.03	≤ 0,03 %	Chemically treated biomass (1.2.2; 1.3.2)
	S0.04	≤ 0,04 %	Informative:
	S0.05	≤ 0,05 %	All fuels that are not chemically treated (see the exceptions above)
	S0.08	≤ 0,08 %	
	S0.10	≤ 0,10 %	
	S0.10+	> 0,10 % (maximum value to be stated)	
	Chlorine, Cl (w-% of dry basis) ISO 16994		
	Cl0.02	≤ 0,02 %	Normative:
	Cl0.03	≤ 0,03 %	Chemically treated biomass (1.2.2, 1.3.2)
	Cl0.05	≤ 0,05 %	Informative:
	Cl0.07	≤ 0,07 %	All fuels that are not chemically treated (see the exceptions above)
	Cl0.10	≤ 0,10 %	
	Cl0.10+	> 0,10 % (maximum value to be stated)	

Table 5 *(continued)*

Master table			
Informative	**Net calorific value, Q** (MJ/kg or kWh/kg as received) or **energy density, E** (MJ/ m^3 or kWh/m^3 loose) ISO 18125		Minimum value to be stated
	Bulk density (BD) (kg/m^3 as received) ISO 17828		
	BD150	≥ 150	Recommended to be stated if traded on a volume basis
	BD200	≥ 200	
	BD250	≥ 250	
	BD300	≥ 300	
	BD350	≥ 350	
	BD400	≥ 400	
	BD450+	> 450 (minimum value to be stated)	
	Ash melting behaviour [f] (°C) CEN/TS 15370–1 [4]		Should be stated

[a] For the production of hog fuel or chip sometimes the raw material used has a high content of stones e.g. stumps/roots or wood from gardens/parks. It is recommended to determine and specify the maximum content of these stones in w-% since the declaration of the ash content alone may not provide sufficient information to describe the impacts of a hog fuel batch on feeding and combustion processes. The content of stones is determined by hand sorting of the fraction > 3,15 mm and weighing the stones. A suitable large sample has to be used for the determination, see ISO 18135. Small stones, sand and soil which pass the 3,15 mm sieve contribute to the ash content but not to the content of stones.

[b] The numerical values (P-class) for dimension refer to the particle sizes (at least 60 w-%) passing through the mentioned round hole sieve size (ISO 17827-1). Use S classes for wood chips and hog fuel for residential and small scale commercial applications. Lowest possible property class to be stated.

[c] Length and cross sectional area only have to be determined for those particles, which are to be found in the coarse fraction.

Maximum 2 pieces of about 10 l sample may exceed the maximum length, if the cross sectional area is < 0,5 cm^2.

[d] For measuring the cross sectional area it is recommended to use a transparent set square, place the particle orthogonally behind the set square and estimate the maximum cross sectional area of this particle with the help of the cm^2-pattern.

[e] Lowest possible property class to be stated. Certain boilers require minimum moisture content, which should be stated.

[f] Special attention should be paid to the ash melting behaviour for some biomass fuels, for example eucalyptus, poplar, short rotation coppice. It is recommended that all characteristic temperatures (shrinkage starting temperature (SST), deformation temperature (DT, hemisphere temperature (HT) and flow temperature (FT)) in oxidizing conditions should be stated.

Table 6 — Specification of properties for log wood, firewood

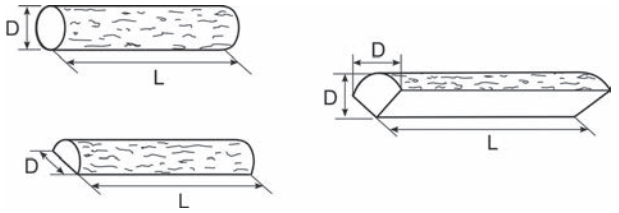
Master table			
Normative	**Origin**: According to 6.1 and Table 1.		Woody biomass (1.1 or 1.2.1) Wood species to be stated
	Traded Form		Stem wood/round wood, Log wood, firewood
	Dimensions (cm)		
	Length (*L*) (maximum length of a single piece), cm [a]		
	L20-	< 20 cm	 *L* Length *D* Diameter **Figure 4 — Examples**
	L20	20 cm ± 2 cm	
	L25	25 cm ± 2 cm	
	L30	30 cm ± 2 cm	
	L33	33 cm ± 2 cm	
	L40	40 cm ± 2 cm	
	L50	50 cm ± 4 cm	
	L100	100 cm ± 5 cm	
	L100+	> 100 cm (maximum value has to be stated)	
	Diameter (*D*) (maximum diameter of a single piece), cm [a]		
	D2-	< 2 cm ignition wood (kindling)	
	D5	2 cm ≤ *D* ≤ 5 cm	
	D10	5 cm ≤ *D* ≤ 10 cm	
	D15	10 cm ≤ *D* ≤ 15 cm	
	D20	10 cm ≤ *D* ≤ 20 cm	
	D25	10 cm ≤ *D* ≤ 25 cm	
	D35	20 cm ≤ *D* ≤ 35 cm	
	D35+	> 35 cm (maximum value to be stated)	
	Moisture, M (w-% as received) [b] ISO 18134-1, ISO 18134-2		
	M10	≤ 10%	
	M15	≤ 15%	
	M20	≤ 20%	
	M25	≤ 25%	
	M30	≤ 30%	
	M35	≤ 35%	
	M40	≤ 40%	
	M45	≤ 45%	
	M55	≤ 55%	
	M55+	> 55% (maximum value to be stated)	
	Volume, m³ stacked or loose **or weight, kg** as received		To be stated which unit is used when retailed (m^3 stacked or m^3 loose, kg) and/or packaged log woods weight.

Table 6 *(continued)*

Master table			
Informative	**Moisture content, U** (w-% of dry basis) [b]		
	U10	≤ 10%	
	U11	≤ 11%	
	U15	≤ 15%	
	U20	≤ 20%	
	U25	≤ 25%	
	U30	≤ 30%	
	U50	≤ 50%	
	U100	≤ 100%	
	U100+	> 100% (maximum value to be stated)	
	Energy density, E [C] (MJ/m^3 or kWh/m^3 stacked or loose) or **Net calorific value, Q** (MJ/kg or kWh/kg as received) ISO 18125		Recommended to be specified when retailed.
	Proportion of split volume (% of pieces)		No split (= mainly round wood) ≥ 90% ≥ 50%
	The cut-off surface		To be stated if the cut-off surface of log wood is even and smooth [d] or ends of log wood is uneven
	Decay and mould		No visible decay or mould ≤ 5% of pieces If significant amount (more than 10% of pieces) of decay or mould exists it should be stated.
	Drying		Recommended to be stated, if firewood is dried by natural seasoning by ambient air or artificially by hot air.

[a] 85% of the firewood should be kept in specified diameter property class. It is allowed to have 15% firewood shorter than requested length including the limit value.

[b] M (w-%) on wet basis and U (w-%) on dry basis. Moisture content should not be less 12 w-% on wet basis (M) or 13,64 w-% on dry basis (U) for oven-ready firewood. The lowest possible moisture content class to be stated. Calculation from M to U or from U to M is presented in informative Annex E.

[c] The energy density may be calculated according to Annex D on the basis of the bulk density and the net calorific value of the dry fuel. Example: For a firewood with a net calorific value on dry basis, E of 5,3 kWh/kg and an actual moisture content M_{ar} of 15 w-%, the net calorific value on as received basis E_{ar} is 4,43 kWh/kg. For a bulk density BD of 410 kg/stacked m^3, the energy density E_{ar} is 1 800 kWh/stacked m^3.

[d] Use of chainsaw or circular saw is considered to be smooth and even.

Table 7 — Specification of properties for sawdust

Master table			
Normative	**Origin**: According to 6.1 and Table 1.		Woody biomass (1)
	Traded Form		Sawdust
	Moisture, M (w-% as received) [a] ISO 18134-1, ISO 18134-2		
	M10	≤ 10 %	
	M15	≤ 15 %	
	M20	≤ 20 %	
	M25	≤ 25 %	
	M30	≤ 30 %	
	M35	≤ 35 %	
	M45	≤ 45 %	
	M50	≤ 50 %	
	M55	≤ 55 %	
	M60	≤ 60 %	
	M65	≤ 65 %	
	M65+	> 65 % (maximum value to be stated)	
	Ash, A (w-% of dry basis) ISO 18122		
	A0.5	≤ 0,5 %	
	A0.7	≤ 0,7 %	
	A1.0	≤ 1,0 %	
	A1.5	≤ 1,5 %	
	A2.0	≤ 2,0 %	
	A3.0	≤ 3,0 %	
	A5.0	≤ 5,0 %	
	A7.0	≤ 7,0 %	
	A10.0	≤ 10,0 %	
	A10.0+	> 10,0 % (maximum value to be stated)	
	Net calorific value, Q (MJ/kg or kWh/kg as received) or **energy density, E** (MJ/m^3 or kWh/m^3 loose) ISO 18125		Minimum value to be stated
Normative/ Informative	**Nitrogen, N** (w-% of dry basis) ISO 16948		
	N0.2	≤ 0,2 %	Normative:
	N0.3	≤ 0,3 %	Chemically treated biomass (1.2.2; 1.3.2)
	N0.5	≤ 0,5 %	Informative:
	N1.0	≤ 1,0 %	All fuels that are not chemically treated (see the exceptions above)
	N2.0	≤ 2,0 %	
	N3.0	≤ 3,0 %	
	N3.0+	> 3,0 % (maximum value to be stated)	
	Chlorine, Cl (weight of dry basis, w-%) ISO 16994		
	Cl0.01	≤ 0,01 %	Normative:
	Cl0.02	≤ 0,02 %	Chemically treated biomass (1.2.2; 1.3.2)
	Cl0.03	≤ 0,03 %	Informative:
	Cl0.07	≤ 0,07 %	All fuels that are not chemically treated (see the exceptions above)
	Cl0.10	≤ 0,10 %	
	Cl0.10+	> 0,10 % (maximum value to be stated)	

Table 7 *(continued)*

Master table			
Informative	**Bulk density (BD)** (kg/m³ as received) ISO 17828		
	BD100	≥ 100 kg/m³	Recommended to be stated if traded by volume basis
	BD150	≥ 150 kg/m³	
	BD200	≥ 200 kg/m³	
	BD250	≥ 250 kg/m³	
	BD300	≥ 300 kg/m³	
	BD350	≥ 350 kg/m³	
	BD400 +	> 400 kg/m³ (minimum value to be stated)	
	Ash melting behaviour [b] (°C) CEN/TS 15370–1 [4]		Should be stated
	Sieving		Sieving and the screen size of the sieve should be stated

[a] Lowest possible property class to be stated. Certain boilers require minimum moisture content, which should to be stated.

[b] It is recommended that all characteristic temperatures (shrinkage starting temperature (SST), deformation temperature (DT), hemisphere temperature (HT) and flow temperature (FT)) in oxidizing conditions should be stated.

NOTE 7 Particle size of sawdust is considered to be homogenous. Particle size distribution may be specified if requested.

Table 8 — Specification of properties for shavings

Master table			
Normative	**Origin**: According to 6.1 and Table 1.		Woody biomass (1)
	Traded Form		Shavings
	Moisture, M (w-% as received) ISO 18134-1, ISO 18134-2		
	M10	≤ 10 %	
	M15	≤ 15 %	
	M20	≤ 20 %	
	M30	≤ 30 %	
	M30+	> 30 % (maximum value to be stated)	
	Ash, A (w-% of dry basis) ISO 18122		
	A0.5	≤ 0,5 %	
	A0.7	≤ 0,7 %	
	A1.0	≤ 1,0 %	
	A1.5	≤ 1,5 %	
	A2.0	≤ 2,0 %	
	A3.0	≤ 3,0 %	
	A5.0	≤ 5,0 %	
	A7.0	≤ 7,0 %	
	A10.0	≤ 10,0 %	
	A10.0+	> 10,0 % (maximum value to be stated)	
	Net calorific value, Q (MJ/kg or kWh/kg as received) or **energy density, E** (MJ/m³ or kWh/m³ loose) ISO 18125		Minimum value to be stated

Table 8 *(continued)*

Master table			
Normative/ Informative	**Nitrogen, N** (w-% of dry basis) ISO 16948		
	N0.2	≤ 0,2 %	Normative:
	N0.3	≤ 0,3 %	Chemically treated biomass (1.2.2; 1.3.2)
	N0.5	≤ 0,5 %	Informative:
	N1.0	≤ 1,0 %	All fuels that are not chemically treated (see the exceptions above)
	N2.0	≤ 2,0 %	
	N3.0	≤ 3,0 %	
	N3.0+	> 3,0 % (maximum value to be stated)	
	Chlorine, Cl (weight of dry basis, w-%) ISO 16994		
	Cl0.01	≤ 0,01 %	Normative:
	Cl0.02	≤ 0,02 %	Chemically treated biomass (1.2.2; 1.3.2)
	Cl0.03	≤ 0,03 %	Informative:
	Cl0.07	≤ 0,07 %	All fuels that are not chemically treated (see the exceptions above)
	Cl0.10	≤ 0,10 %	
	Cl0.10+	> 0,10 % (maximum value to be stated)	
Informative	**Bulk density (BD)** (kg/m^3 as received) ISO 17828		
	BD100	≥ 100 kg/m^3	Recommended to be stated if traded by volume basis
	BD150	≥ 150 kg/m^3	
	BD200	≥ 200 kg/m^3	
	BD250	≥ 250 kg/m^3	
	BD300	≥ 300 kg/m^3	
	BD350+	> 350 kg/m^3 (minimum value to be stated)	
	Ash melting behaviour [a] (°C) CEN/TS 15370–1 [4]		Should be stated
	Sieving		Sieving and the screen size of the sieve should be stated
[a] It is recommended that all characteristic temperatures (shrinkage starting temperature (SST), deformation temperature (DT), hemisphere temperature (HT) and flow temperature (FT)) in oxidizing conditions should be stated.			

NOTE 8 Particle sizes of shavings are considered to be homogenous. Particle size distribution may be specified if requested.

Table 9 — Specification of properties for bark

Master table			
Normative	**Origin**: According to 6.1 and Table 1.		Woody biomass (1.1.6, 1.2.1.5, 1.2.2.3, 1.3.1.3, 1.3.2.3)
	Traded Form:		Bark
	Dimensions (mm) ISO 17827-1		
		Nominal top size, mm [a]	Coarse fraction, max. length of a particle, mm < 5 w-%
	P16	$P \leq 16$ mm	> 45 mm, all < 100 mm
	P45	$P \leq 45$ mm	> 63 mm
	P63	$P \leq 63$ mm	> 100 mm
	P100	$P \leq 100$ mm	> 150 mm
	P200	$P \leq 200$ mm	> 350 mm
	Moisture, M (w-% as received) [b] ISO 18134-1, ISO 18134-2		
	M20	≤ 20 %	
	M25	≤ 25 %	
	M30	≤ 30 %	
	M35	≤ 35 %	
	M40	≤ 40 %	
	M45	≤ 45 %	
	M50	≤ 50 %	
	M55	≤ 55 %	
	M60	≤ 60 %	
	M65	≤ 65 %	
	M65+	> 65 % (maximum value to be stated)	
	Ash, A (w-% of dry basis) ISO 18122		
	A1.0	≤ 1,0 %	
	A1.5	≤ 1,5 %	
	A2.0	≤ 2,0 %	
	A3.0	≤ 3,0 %	
	A5.0	≤ 5,0 %	
	A7.0	≤ 7,0 %	
	A10.0	≤ 10,0 %	
	A10.0+	> 10,0 % (maximum value to be stated)	
	Shredding		To be stated if bark is shredded or not into pieces
	Net calorific value, Q (MJ/kg or kWh/kg as received) or **energy density, E** (MJ/m^3 or kWh/m^3 loose) ISO 18125		Minimum value to be stated
Normative/ Informative	**Nitrogen, N** (w-% of dry basis) ISO 16948		
	N0.5	≤ 0,5 %	Normative:
	N1.0	≤ 1,0 %	Chemically treated biomass (1.2.2; 1.3.2)
	N2.0	≤ 2,0 %	Informative:
	N3.0	≤ 3,0 %	All fuels that are not chemically treated (see the exceptions above)
	N3.0+	> 3,0 % (maximum value to be stated)	
	Chlorine, Cl (w-% of dry basis) ISO 16994		
	Cl0.02	≤ 0,02 %	Normative:
	Cl0.03	≤ 0,03 %	Chemically treated biomass (1.2.2; 1.3.2)
	Cl0.07	≤ 0,07 %	Informative:
	Cl0.10	≤ 0,10 %	All fuels that are not chemically treated (see the exceptions above)
	Cl0.10+	> 0,10 % (maximum value to be stated)	

Table 9 *(continued)*

Master table			
Informative	**Bulk density (BD)** (kg/m^3 as received) ISO 17828		
	BD250	≥ 250 kg/m^3	Recommended to be stated if traded on a volume basis
	BD300	≥ 300 kg/m^3	
	BD350	≥ 350 kg/m^3	
	BD400	≥ 400 kg/m^3	
	BD450	≥ 450 kg/m^3	
	Ash melting behaviour [c] (°C) CEN/TS 15370–1 [4]		Should be stated

[a] The numerical values (P-class) for dimension refer to the particle sizes (at least 95 % by mass) passing through the mentioned round hole sieve size (ISO 17827-1). If a sample fulfils the criteria of more than one class attach it to the lowest possible class.

[b] Lowest possible property class to be stated. Certain boilers require minimum moisture content, which should to be stated.

[c] It is recommended that all characteristic temperatures (shrinkage starting temperature (SST), deformation temperature (DT), hemisphere temperature (HT) and flow temperature (FT)) in oxidizing conditions should be stated.

Table 10 — Specification of properties for bales of straw, reed canary grass and Miscanthus

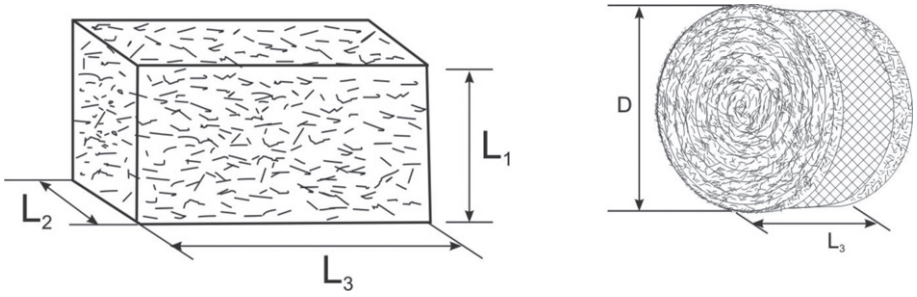
Master table				
Normative	**Origin:** According to 6.1 and Table 1.	2.1.1.2 Cereal crop straw, 2.1.2.1 Whole plant (Reed canary grass and Miscanthus), 2.1.2.2 Grass straw, 2.1.3.2 Oil seed crops stalks and leaves		
	Traded Form	Round bale and square bale		
				
	L_1 Height D Diameter L_2 Width L_3 Length			
	Figure 5 — Dimensions (m)			
	Round bale	Diameter (D)	Length (L_3)	
	D1	1,2 m – 1,5 m	1,2 m	
	D2	1,6 m – 1,8 m	1,5 m	
	Square bale	Height (L_1)	Width (L_2)	Length (L_3)
	P1	≤ 0,35 m	≤ 0,4 m	≤ 0,5 m
	P2	≤ 0,9 m	≤ 1,2 m	1,5 m – 2,8 m
	P3	≤ 1,3 m	≤ 1,2 m	1,0 m – 3,0 m
	P3+	> 3 m (maximum values to stated)		
	Bale density, BD (kg/m^3 as received) ISO 17828			
	BD100	≥ 100 kg/m^3		
	BD120	≥ 120 kg/m^3		
	BD160	≥ 160 kg/m^3		
	BD180	≥ 180 kg/m^3		
	BD220	≥ 220 kg/m^3		
	BD240+	≥ 240 kg/m^3 (minimum value to be stated)		
	Moisture, M (w-% as received) ISO 18134-1, ISO 18134-2			
	M10	≤ 10 %		
	M15	≤ 15 %		
	M20	≤ 20 %		
	M25	≤ 25 %		
	M30	≤ 30 %		
	M30+	> 30 % (maximum value to be stated)		

Table 10 *(continued)*

Master table			
	Ash, A (w-% of dry basis) ISO 18122		
	A4.0	≤ 4 %	
	A5.0	≤ 5 %	
	A6.0	≤ 6 %	
	A7.0	≤ 7 %	
	A8.0	≤ 8 %	
	A10.0	≤ 10 %	
	A10.0+	> 10 % (maximum value to be stated)	
	Chlorine, Cl (w-% of dry basis) ISO 16994		
	Cl0.01	≤ 0,01 %	
	Cl0.02	≤ 0,02 %	
	Cl0.03	≤ 0,03 %	
	Cl0.07	≤ 0,07 %	
	Cl0.10	≤ 0,10 %	
	Cl0.10+	> 0.10 % (maximum value to be stated)	
	Species of biomass		Has to be stated (Example: spring harvested reed canary grass (*Phalaris arundinacea L.*) or Miscanthus (*Miscanthus Giganteus*))
	Net calorific value, Q (MJ/kg or kWh/kg as received) or **energy density, E** (MJ/m^3 or kWh/m^3 loose) ISO 18125		Minimum value to be stated
Informative	**Production method**		It is recommended to declare production methods that influence the size of the straw particles in the bale. That is for instance whether the crop has been trashed by rotation or oscillation or whether it has been chopped. Harvested as a whole plant for Reed canary grass and Miscanthus.
	Binding type of bales		Tying material recommended to be specified (net binding, plastic line).
	Ash melting behaviour [a] (°C) CEN/TS 15370–1 [4]		Should be stated
[a] It is recommended that all characteristic temperatures (shrinkage starting temperature (SST), deformation temperature (DT), hemisphere temperature (HT) and flow temperature (FT)) in oxidizing conditions should be stated.			

Table 11 — Specification of properties for energy grain

Master table			
Normative	**Origin**:According to 6.1 and Table 1		Herbaceous biomass (2.1.1.3)
	Traded Form		Grain (species to be stated e.g. wheat)
	Dimensions (mm), Diameter (*D*) (5 w-% may have diameter over the class) ISO 17827-1, ISO 17827-2		
	D05	1 mm ≤ *D* ≤ 5 mm	
	D10	3,15 mm ≤ *D* ≤ 10 mm	
	Moisture, M (w-% as received) ISO 18134-1, ISO 18134-2		
	M10	≤ 10 %	
	M15	≤ 15 %	
	Ash, A (w-% of dry basis) ISO 18122		
	A2.0	≤ 2,0 %	
	A3.0	≤ 3,0 %	
	A5.0	≤ 5,0 %	
	A5.0+	> 5,0 % (maximum value to be stated)	
	Net calorific value, Q (MJ/kg or kWh/kg as received) ISO 18125		Minimum value to be stated
	Nitrogen, N (w-% of dry basis) ISO 16948		
	N2.0	≤ 2,0 %	
	N2.0+	> 2,0 % (maximum value to be stated)	
	Sulfur, S (w-% of dry basis) ISO 16994		
	S0.20	≤ 0,20 %	
	S0.20+	> 0,20 % (maximum value to be stated)	
	Chlorine, Cl (w-% of dry basis) ISO 16994		
	Cl0.05	≤ 0,05 %	
	Cl0.10	≤ 0,10 %	
	Cl0.15	≤ 0,15 %	
	Cl0.15+	> 0,15 % (maximum value to be stated)	
Informative	**Amount of fines, F** (w-%, < 1 mm for *D* 05 and w-%, < 3,15 mm for *D* 10) ISO 17827-1		
	F1.0	≤ 1,0 %	
	F1.0+	> 1,0 % (without additive)	
	Bulk density (BD) (kg/m^3 as received) ISO 17828		
	BD350	≥ 350 kg/m^3	
	BD450	≥ 450 kg/m^3	
	BD550	≥ 550 kg/m^3	
	BD600	≥ 600 kg/m^3	
	BD650+	> 650 kg/m^3 (minimum value to be stated)	
	Ash melting behaviour [a] (°C) CEN/TS 15370–1 [4]		Should be stated
[a] It is recommended that all characteristic temperatures (shrinkage starting temperature (SST), deformation temperature (DT), hemisphere temperature (HT) and flow temperature (FT)) in oxidizing conditions should be stated.			

NOTE 9 When using cereal grain materials for combustion special attention should be paid to risk of corrosion in small- and medium-scale boilers and flue gas system. Be aware that different types and varieties of grains, grown under different conditions and soil type, may have a fuel ash composition, i.e. high content of P, K, that will capture chlorine (K will form K-phosphates instead of KCl) in the ash that will result in high hydrochloric emissions.

Table 12 — Specification of properties for olive residues

Master table			
Normative	**Origin**: According to 6.1 and Table 1		Fruit biomass (3.2.1.2, 3.2.1.4,3.2.2.2,3.2.2.4)
	Traded Form		Grain or seed, kernel
	Dimensions (mm)		
	Diameter (*D*) [a]		
	D 03	1 mm ≤ *D* ≤ 3,15 mm	
	D 05	1 mm ≤ *D* ≤ 5 mm	
	D 10	1 mm ≤ *D* ≤ 10 mm	
	D 10+	> 10 mm (maximum value to be stated)	
	Moisture, M (w-% as received) ISO 18134-1, ISO 18134-2		
	M10	≤ 10 %	
	M15	≤ 15 %	
	Ash, A (w-% of dry basis) ISO 18122		
	A1.5	≤ 1,5 %	
	A2.0	≤ 2,0	
	A3.0	≤ 3,0	
	A5.0	≤ 5,0 %	
	A7.0	≤ 7,0 %	
	A10.0	≤ 10,0 %	
	A10.0+	> 10,0 % (maximum value to be stated)	
	Additives (w-%)		Type and amount of additive to be stated
	Net calorific value, Q [b] (MJ/kg or kWh/kg as received) ISO 18125		Minimum value to be stated
	Nitrogen, N (w-% of dry basis) ISO 16948		
	N1.0	≤ 1,0 %	
	N1.5	≤ 1,5 %	
	N2.0	≤ 2,0 %	
	N3.0	≤ 3,0 %	
	N3.0+	> 3,0 % (maximum value to be stated)	
Informative	**Amount of fines, F** (w-%, < 1 mm) ISO 17827-1		
	F1.0	≤ 1,0 %	
	F1.0+	> 1,0 % (without additive)	
	Bulk density (BD) as received (kg/m^3 loose) ISO 17828		Recommended to be stated if traded on a volume basis
	Chlorine, Cl (w-% of dry basis) ISO 16994		
	Cl 0.10	≤ 0,10 %	
	Cl 0.15	≤ 0,15 %	
	Cl0.15+	> 0,15 % (maximum value to be stated)	
	Sulfur, S (w-% of dry basis) ISO 16994		
	S0.15	≤ 0,15 %	
	S0.20	≤ 0,20 %	
	S0.20+	> 0,20 % (maximum value to be stated)	
	Ash melting behaviour [c] (°C) CEN/TS 15370–1 [4]		Should be stated

[a] 5 w-% may have diameter over the class.

[b] Additives can reduce net calorific value.

[c] It is recommended that all characteristic temperatures (shrinkage starting temperature (SST), deformation temperature (DT), hemisphere temperature (HT) and flow temperature (FT)) in oxidizing conditions should be stated.

Table 13 — Specification of properties for fruit seeds

Master table			
Normative	**Origin**: According to 6.1 and Table 1		Fruit biomass (3.1.1.3, 3.1.3, 3.2.1.2, 3.2.1.3, 3.2.2.2, 3.2.2.3)
	Traded Form		Fruit seed or kernel
	Dimensions (mm) ISO 17827-1, ISO 17827-1, ISO 17827-2		
	Diameter (*D*) (5 w-% may have diameter over the class)		
	D 03	1 mm ≤ *D* ≤ 3,15 mm	
	D 05	1 mm ≤ *D* ≤ 5 mm	
	D 10	1 mm ≤ *D* ≤ 10 mm	
	D 10+	*D* > 10 mm (maximum value to be stated)	
	Moisture, M (w-% as received) ISO 18134-1, ISO 18134-2		
	M10	M ≤ 10 %	
	M15	M ≤ 15 %	
	Ash, A (w-% of dry basis) ISO 18122		
	A1.5	≤ 1,5 %	
	A2.0	≤ 2,0	
	A3.0	≤ 3,0	
	A5.0	≤ 5,0 %	
	A7.0	≤ 7,0 %	
	A10.0	≤ 10,0 %	
	A10.0+	> 10,0 % (maximum value to be stated)	
	Additives (w-%)		Type and amount of additive to be stated
	Net calorific value, Q [a] (MJ/kg or kWh/kg as received), ISO 18125		Minimum value to be stated
	Nitrogen, N (w-% of dry basis) ISO 16948		
	N1.0	≤ 1,0 %	
	N1.5	≤ 1,5 %	
	N_2.0	≤ 2,0 %	
	N3.0	≤ 3,0 %	
	N3.0+	> 3,0 % (maximum value to be stated)	
Informative	**Amount of fines, F** (w-%, < 1 mm) ISO 17827-1		
	F1.0	≤ 1,0 %	
	F1.0+	> 1,0 %	
	Bulk density (BD) (kg/m^3 as received) ISO 17828		Recommended to be stated if traded on a volume basis
	Chlorine, Cl (w-% of dry basis) ISO 16994		
	Cl 0.10	≤ 0,10 %	
	Cl 0.15	≤ 0,15 %	
	Cl 0.15+	> 0,15 % (maximum value to be stated)	
	Sulfur, S (w-% of dry basis) ISO 16994		
	S0.15	≤ 0,15 %	
	S0.20	≤ 0,20 %	
	S0.20+	> 0,20 % (maximum value to be stated)	
	Ash melting behaviour [b] (°C) CEN/TS 15370–1 [4]		Should be stated

[a] Additives can reduce net calorific value.

[b] It is recommended that all characteristic temperatures (shrinkage starting temperature (SST), deformation temperature (DT), hemisphere temperature (HT) and flow temperature (FT)) in oxidizing conditions should be stated.

NOTE 10 Fruit seeds include kernels, nuts and acorns.

Table 14 — Specification of properties for charcoals

Master table				
Normative	**Origin**: According to 6.1 and Table 1		Woody biomass (1.1 and 1.2.1); Fruit biomass (3)	
	Traded Form (see Table 2)		Charcoal	
	Dimensions (mm)			
		Main fraction (minimum 75 w-%), mm	Fines fraction, w-% (<10 mm)	Coarse fraction, (w-%), max. length of particle, mm
	P150	16 mm ≤ *P* ≤ 150 mm	≤ 7 %	≤ 10 % > 100 mm, and all < 150mm
	Moisture, M (w-% as received) ISO 18134-1, ISO 18134-2			
	M8	≤ 8 %		
	M10	≤ 10 %		
	Ash, A (w-% of dry basis) ISO 18122			
	A5.0	≤ 5,0 %		
	A8.0	≤ 8,0 %		
	A8.0+	> 8,0 % (maximum value to be stated)		
	Fixed carbon, C [a] (w-% of dry basis)			
	C60	≥ 60 %		
	C75	≥ 75 %		
	Bulk density (BD) (kg/m^3 as received) ISO 17828			
	BD130	≥ 130 kg/m^3		
	BD150	≥ 150 kg/m^3		
	Net calorific value, Q (MJ/kg or kWh/kg as received) ISO 18125			Minimum value to be stated

[a] Fixed carbon (%) is calculated by the following: 100 – [moisture (w-%) + ash (w-%) + volatile matter (w-%)]. All percentage are on the same moisture basis.

Table 15 — Specification of properties for thermally treated biomass (e.g. mild form pyrolysis/torrefaction)

Master table			
Normative	**Origin:** According to 6.1 and Table 1		Woody biomass (1); Herbaceous biomass (2); Fruit biomass (3); Aquatic biomass (4); Blends and mixtures (5).
	Traded Form (see Table 2)		Thermally treated biomass
	Dimensions (mm)		to be stated
	Moisture, M (w-% as received) ISO 18134-1, ISO 18134-2		
	M3	≤ 3 %	
	M5	≤ 5 %	
	M8	≤ 8 %	
	M10	≤ 10 %	
	M10+	> 10 % (maximum value to be stated)	
	Ash, A (w-% of dry basis) ISO 18122		
	A0.5	≤ 0,5 %	
	A0.7	≤ 0,7 %	
	A1.0	≤ 1,0 %	
	A1.5	≤ 1,5 %	
	A2.0	≤ 2,0 %	
	A3.0	≤ 3,0 %	
	A5.0	≤ 5,0 %	
	A7.0	≤ 7,0 %	
	A10.0	≤ 10,0 %	
	A10.0+	> 10,0 % (maximum value to be stated)	
	Bulk density (BD) (kg/m^3 as received) ISO 17828		
	BD200	≥ 200 kg/m^3	
	BD250	≥ 250 kg/m^3	
	BD300	≥ 300 kg/m^3	
	Net calorific value, Q (MJ/kg or kWh/kg as received) ISO 18125		≥ 17 MJ/kg (minimum value to be stated)
	Fixed carbon, C (w-% of dry basis) [a]		
	C20	≥ 20 %	
	C25	≥ 25 %	
	C30	≥ 30 %	
	C35	≥ 35 %	
	C40	≥ 40 %	
	Volatiles, VM, (w-% of dry basis), ISO 18123		Maximum value to be stated
[a] Fixed carbon (%) is calculated by the following: 100 – [moisture (w-%) + ash (w-%) + volatile matter (w-%)]. All percentage are on the same moisture basis.			

NOTE 11 Thermally treated biomass briquettes and pellets are specified in Table 3 and Table 4.

Table 16 — General master table for specification of properties for other solid biofuels

General Master Table			
Normative	**Origin**		To be specified in accordance with to 6.1 and Table 1, as detailed as needed.
	Traded Form		A short description of the form of the biofuel (see Table 2 for guidelines).
	Dimensions (mm)		If dimensions are not suitable to express as diameter and length other formats may be used, but shall then be clearly stated.
	D_x	x = Maximum diameter	
	L_y	y = Maximum length	
	Moisture, M (w-% as received) ISO 18134-1, ISO 18134-2		Recommended to be stated as a class: M10, M15, M20, M25, M30; M35, M40, M45, M50; M55, M60; M65, M65+ (maximum value to be stated)
	MXX	≤ XX %	
	Ash, A (w-% of dry basis) ISO 18122		Recommended to be stated as a class: A0.5, A0.7, A1.0, A1.5, A2.0, A3.0, A5.0, A7.0, A10, A10+ (maximum value to be stated)
	AXX.X	≤ XX,X %	
Normative/ Informative	**Additives** (w-% of dry basis)		If any type of additive is added to the fuel, amount and type shall be stated. The maximum amount of additive is 20 w-% of in solid biofuels. If amount is greater, then solid biofuel is a blend.
	Type and content of additives to be stated		
	Net calorific value, Q (MJ/kg or kWh/kg as received) or **energy density, E** (MJ/m^3 or kWh/m^3 loose) ISO 18125		Minimum value to be stated.
	Bulk density (BD) (kg/m^3 as received) ISO 17828		Recommended to be stated in the classes (minimum value): BD200, BD250, BD300, BD300, BD350, BD400, BD450, BD500, BD550, BD600, BD650, BD750, DB850+.
	Nitrogen, N (w-% of dry basis) ISO 16948		Nitrogen is normative only for chemically treated biomass. Recommended to be stated as a class N0.5, N1.0, N1.5, N_2.0, N3.0, N3.0+ (maximum value to be stated)
	NX.X	≤ X,X %	
	Sulfur, S (w-% of dry basis) ISO 16994		Sulfur is normative only for chemically treated biomass or if sulfur containing additives have been used. Recommended to be stated as a class S0,03, S0,05, S0,1, S0,2 and S0,2+ (if S > 0,2 % maximum value to be stated)
	SX.XX	≤ X,XX %	
	Chlorine, Cl (weight of dry basis, w-%) ISO 16994		Chlorine is normative only for chemically treated biomass. Recommended to be state as a class: Cl 0.01, Cl 0.02, Cl 0.03, Cl 0.07, Cl 0.10 and Cl 0.10+ (if Cl > 0,10 % maximum value to be stated)
	ClX.XX	≤ X,XX %	
	Further specification of dimensions		It is recommended that maximum allowed amount of fine and coarse particles of the fuel should be stated.
	Others e.g. major (ISO 16967) and minor elements (ISO 16968)		Properties that are specific to the actual solid biofuel and considered as containing useful information.
Informative	**Ash melting behaviour** [a] (°C), CEN/TS 15370–1 [4]		Should be stated
[a] It is recommended that all characteristic temperatures (shrinkage starting temperature (SST), deformation temperature (DT), hemisphere temperature (HT) and flow temperature (FT)) in oxidizing conditions should be stated.			

NOTE 12 Property classes from Tables 3 to 15 can be used if also appropriate in this master table.

Annex A
(informative)

Illustrations of typical forms of wood fuels

A.1 Visually classifying wood fuels based on a typical particle size[15)]

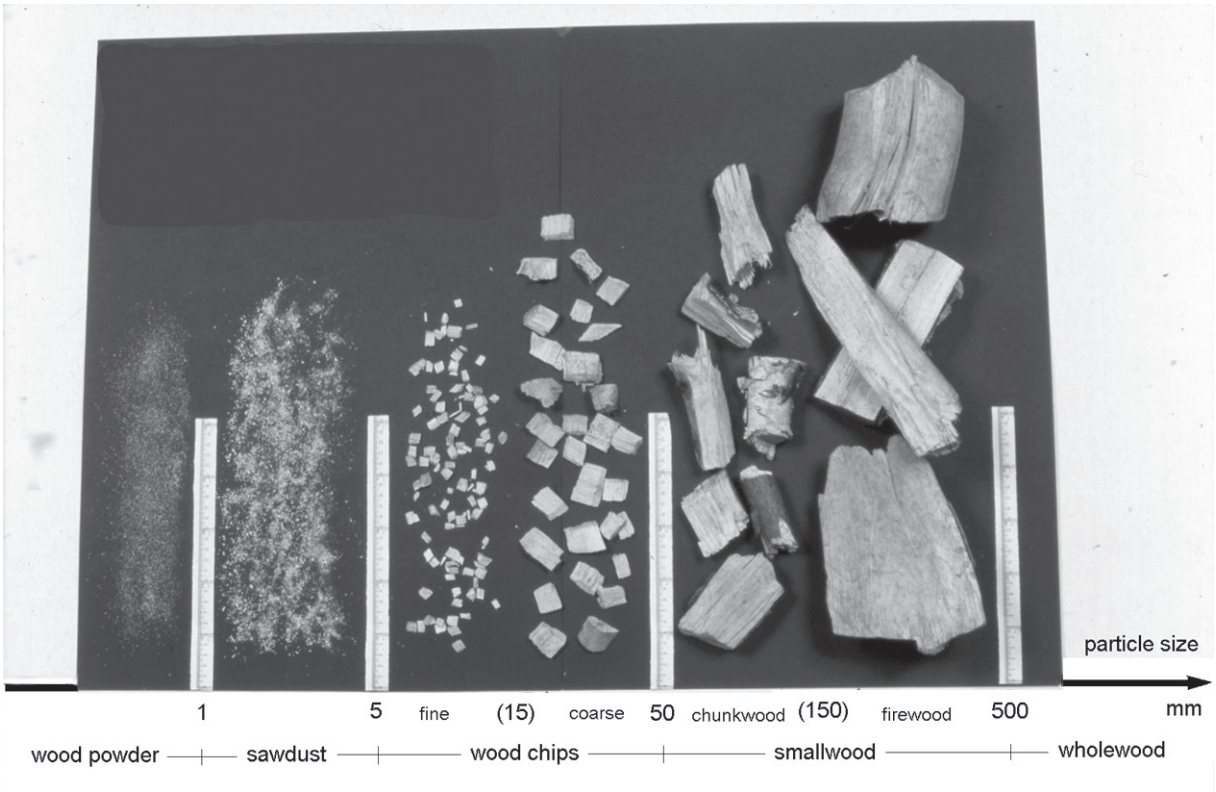


Figure A.1 — Classification of wood fuels based on fuel particle size

15) Source: Jan Erik Mattsson, Swedish University of Agricultural Science, Department of Agricultural Engineering, PO Box 66, SE-23066, Alnarp, Sweden.

A.2 Differentiating between wood chips and hog fuel[16)]

a) Wood chips (cut with sharp tools)

b) Hog fuel (crushed with blunt tools)

Figure A.2 — Close examination of wood chips and hog fuel

16) Source: Jan Erik Mattsson, Swedish University of Agricultural Science, Department of Agricultural Engineering, PO Box 66, SE-23066, Alnarp, Sweden.

Annex B
(informative)

Typical values of solid biomass fuels

Table B.1 — Typical values for virgin wood materials, without or with insignificant amounts of bark, leaves and needles

Parameter	Unit	Coniferous wood (1.1.3.2 and 1.2.1.2)		Broad-leaf wood (1.1.3.1 and 1.2.1.1)	
		Typical value	Typical variation	Typical value	Typical variation
Ash	w-% d	0,3	0,1 to 1,0	0,3	0,2 to 1,0
Gross calorific value *qV,gr,d*	MJ/kg d	20,5	20,0 to 20,8	20,1	19,4 to 20,4
Net calorific value *qp,net,d*	MJ/kg d	19,1	18,5 to 19,8	18,9	18,4 to 19,2
Carbon, C	w-% d	51	47 to 54	49	48 to 52
Hydrogen, H	w-% d	6,3	5,6 to 7,0	6,2	5,9 to 6,5
Oxygen, O	w-% d	42	40 to 44	44	41 to 45
Nitrogen, N	w-% d	0,1	< 0,1 to 0,5	0,1	< 0,1 to 0,5
Sulfur, S	w-% d	< 0,02	< 0,01 to 0,02	0,02	< 0,01 to 0,05
Chlorine, Cl	w-% d	0,01	< 0,01 to 0,03	0,01	< 0,01 to 0,03
Fluorine, F	w-% d	< 0,000 5	< 0,000 5	< 0,000 5	< 0,000 5
Aluminium, Al	mg/kg d	100	30 to 400	20	< 10 to 50
Calcium, Ca	mg/kg d	900	500 to 1 000	1 200	800 to 20 000
Iron, Fe	mg/kg d	25	10 to 100	25	10 to 100
Potassium, K	mg/kg d	400	200 to 500	800	500 to 1 500
Magnesium, Mg	mg/kg d	150	100 to 200	200	100 to 400
Manganese, Mn	mg/kg d	100	40 to 200	83	not specified
Sodium, Na	mg/kg d	20	10 to 50	50	10 to 200
Phosphorus, P	mg/kg d	60	50 to 100	100	50 to 200
Silicon, Si	mg/kg d	150	100 to 200	150	100 to 200
Titanium, Ti	mg/kg d	< 20	< 20	< 20	< 20
Arsenic, As	mg/kg d	< 0,1	< 0,1 to 1,0	< 0,1	< 0,1 to 1,0
Cadmium, Cd	mg/kg d	0,10	< 0,05 to 0,50	0,10	< 0,05 to 0,50
Chromium, Cr	mg/kg d	1,0	0,2 to 10,0	1,0	0,2 to 10,0
Copper, Cu	mg/kg d	2,0	0,5 to 10,0	2,0	0,5 to 10,0
Mercury, Hg	mg/kg d	0,02	< 0,02 to 0,05	0,02	< 0,02 to 0,05
Nickel, Ni	mg/kg d	0,5	< 0,1 to 10,0	0,5	< 0,1 to 10,0
Lead, Pb	mg/kg d	2,0	< 0,5 to 10,0	2,0	< 0,5 to 10,0
Vanadium, V	mg/kg d	< 2	< 2	< 2	< 2
Zinc, Zn	mg/kg d	10	5 to 50	10	5 to 100
a Data are obtained from a combination of mainly Swedish, Finnish, Danish, Dutch and German research. Formulas how to calculate different bases are given in ISO 16993					

Table B.2 — Typical values for virgin bark materials

Parameter	Unit	Bark from coniferous wood (1.1.6 and 1.2.1.5)		Bark from broad-leaf wood (1.1.6 and 1.2.1.5)	
		Typical value	Typical variation	Typical value	Typical variation
Ash	w-% d	1,5	< 1 to 5	1,5	0,8 to 3,0
Gross calorific value $q_{V,gr,d}$	MJ/kg d	20,4	18,0 to 21,4	20	18,0 to 22,7
Net calorific value $q_{p,net,d}$	MJ/kg d	19,2	17,5 to 20,5	19	17,1 to 21,3
Carbon, C	w-% d	52	48 to 55	52	47 to 55
Hydrogen, H	w-% d	5,9	5,5 to 6,4	5,8	5,3 to 6,4
Oxygen, O	w-% d	38	34 to 42	38	32 to 42
Nitrogen, N	w-% d	0,5	0,3 to 0,9	0,3	0,1 to 0,8
Sulfur, S	w-% d	0,03	< 0,02 to 0,05	0,03	< 0,02 to 0,20
Chlorine, Cl	w-% d	0,02	< 0,01 to 0,05	0,02	< 0,01 to 0,05
Fluorine, F	w-% d	0,001	< 0,000 5 to 0,002	not specified	not specified
Aluminium, Al	mg/kg d	800	400 to 1 200	50	30 to 100
Calcium, Ca	mg/kg d	5 000	1 000 to 15 000	15 000	10 000 to 20 000
Iron, Fe	mg/kg d	500	100 to 800	100	50 to 200
Potassium, K	mg/kg d	2 000	1 000 to 3 000	2 000	1 000 to 3 200
Magnesium, Mg	mg/kg d	1 000	400 to 1 500	500	400 to 1 000
Manganese, Mn	mg/kg d	500	9 to 840	190	not specified
Sodium, Na	mg/kg d	300	70 to 2 000	100	20 to 1 000
Phosphorus, P	mg/kg d	400	20 to 600	400	300 to 700
Silicon, Si	mg/kg d	2 000	500 to 5 000	2 500	2 000 to 20 000
Arsenic, As	mg/kg d	1,0	0,1 to 4,0	0,4	0,1 to 4
Cadmium, Cd	mg/kg d	0,5	0,2 to 1,0	0,5	0,2 to 1,2
Chromium, Cr	mg/kg d	5	1 to 10	5	1 to 30
Copper, Cu	mg/kg d	5	3 to 30	5	2 to 20
Mercury, Hg	mg/kg d	0,05	0,01 to 0,1,	< 0,05	not specified
Nickel, Ni	mg/kg d	10	2 to 20	10	2 to 10
Lead, Pb	mg/kg d	4	1 to 30	15	2 to 30
Vanadium, V	mg/kg d	1,0	0,7 to 2,0	2	1 to 4
Zinc, Zn	mg/kg d	100	70 to 200	50	7 to 200

[a] Data are obtained from a combination of mainly Swedish, Finnish, Danish, Dutch and German research. Formulas how to calculate different bases are given in ISO 16993.

Table B.3 — Typical values for virgin wood materials, logging residues

Parameter	Unit	Coniferous wood (1.1.4.2 and 1.1.4.4)		Broad-leaf wood (1.1.4.1 and 1.1.4.3)	
		Typical value	Typical variation	Typical value	Typical variation
Ash	w-% d	3,0	< 1 to 10	5,0	2 to 10
Gross calorific value $q_{V,gr,d}$	MJ/kg d	20,5	19,5 to 21,5	19,7	19,5 to 20,0
Net calorific value $q_{p,net,d}$	MJ/kg d	19,2	18,5 to 20,5	18,7	18,3 to 18,5
Carbon, C	w-% d	51	48 to 52	51	50 to 51
Hydrogen, H	w-% d	6,0	5,7 to 6,2	6,0	5,8 to 6,1
Oxygen, O	w-% d	40	38 to 44	40	40 to 43
Nitrogen, N	w-% d	0,5	0,3 to 0,8	0,5	0,3 to 0,8
Sulfur, S	w-% d	< 0,02	< 0,02 to 0,06	0,04	0,01 to 0,08
Chlorine, Cl	w-% d	0,01	< 0,01 to 0,04	0,01	< 0,01 to 0,02
Fluorine, F	w-% d	0,001	not specified	0,002	0,0 to 0,001
Aluminium, Al	mg/kg d	not specified	not specified	250	1 to 3000
Calcium, Ca	mg/kg d	5 000	2 000 to 8 000	4 000	3 000 to 5 000
Iron, Fe	mg/kg d	1500	500 to 2000	150	10 to 1500
Potassium, K	mg/kg d	2 000	1 000 to 4 000	1 500	1 000 to 4 000
Magnesium, Mg	mg/kg d	800	400 to 2 000	250	100 to 400
Manganese, Mn	mg/kg d	130	80 to 170	120	10 to 800
Sodium, Na	mg/kg d	200	75 to 300	100	20 to 200
Phosphorus, P	mg/kg d	500	not specified	300	30 to 1 000
Silicon, Si	mg/kg d	3 000	200 to 10 000	150	75 to 250
Titanium, Ti	mg/kg d	not specified	not specified	7	1 to 40
Arsenic, As	mg/kg d	0,6	0,2 to 1	1	0 to 2
Cadmium, Cd	mg/kg d	0,2	0,1 to 0,8	0,5	0 to 3
Chromium, Cr	mg/kg d	1	0,7 to 1,2	8	1 to 40
Copper, Cu	mg/kg d	10	10 to 200	10	1 to 100
Mercury, Hg	mg/kg d	0,03	not specified	0,02	0 to 2
Nickel, Ni	mg/kg d	1,6	0,4 to 3	10	1 to 80
Lead, Pb	mg/kg d	1,3	0,4 to 4	1,5	0,5 to 5
Vanadium, V	mg/kg d	0,6	0,1 to 1	0,5	0,1 to 3
Zinc, Zn	mg/kg d	20	8 to 30	50	2 to 100

[a] Data are obtained from a combination of mainly Swedish, Finnish, Danish, Dutch, Spanish and German research. Formulas how to calculate different bases are given in ISO 16993.

Table B.4 — Typical values for virgin wood materials, short rotation coppice

Parameter	Unit	Willow (Salix) (1.1.1.3)		Poplar (1.1.1.3)		Eucalyptus (1.1.1.3)	
		Typical value	Typical variation	Typical value	Typical variation	Typical value	Typical variation
Ash	w-% d	2,0	1,1 to 4,0	2,0	1,5 to 3,4	2,0	0,5 to 4,0
Gross calorific value $q_{V,gr,d}$	MJ/kg d	19,9	19,2 to 20,4	19,8	19,5 to 20,1	19,5	19,3 to 21,2
Net calorific value $q_{p,net,d}$	MJ/kg d	18,4	17,7 to 19,0	18,4	18,1 to 18,8	18,1	17,6 to 18,4
Carbon, C	w-% d	48	46 to 49	48	46 to 50	49	46 to 52,7
Hydrogen, H	w-% d	6,1	5,7 to 6,4	6,2	5,7 to 6,5	5,8	4,8 to 6,2
Oxygen, O	w-% d	43	40 to 44	43	39 to 45	42	42 to 43
Nitrogen, N	w-% d	0,5	0,2 to 0,8	0,4	0,2 to 0,6	0,5	0,1 to 1,4
Sulfur, S	w-% d	0,05	0,02 to 0,10	0,03	0,02 to 0,10	< 0,02	< 0,01 to 0,11
Chlorine, Cl	w-% d	0,03	0,01 to 0,05	< 0,01	< 0,01 to 0,05	0,1	< 0,09 to 0,18
Fluorine, F	w-% d	0,003	0 to 0,01	not specified		< 0,01	< 0,01
Aluminium, Al	mg/kg d	50	3 to 100	10	not specified	10	1 to 14
Calcium, Ca	mg/kg d	5 000	2 000 to 9 000	5 000	4 000 to 6 000	1 200	900 to 3 000
Iron, Fe	mg/kg d	100	30 to 600	30	not specified	7	3 to 14
Potassium, K	mg/kg d	2 500	1 700 to 4 000	2 500	2 000 to 4 000	5 000	1 500 to 6 000
Magnesium, Mg	mg/kg d	500	200 to 800	500	200 to 800	400	380 to 1 500
Manganese, Mn	mg/kg d	97	79 to 160	20	not specified	not specified	
Sodium, Na	mg/kg d	not specified	10 to 450	25	10 to 60	50	20 to 85
Phosphorus, P	mg/kg d	800	500 to 1 300	1 000	800 to 1 100	500	90 to 1 000
Silicon, Si	mg/kg d	500	2 to 2 000	not specified		30	28 to 46
Titanium, Ti	mg/kg d	10	< 10 to 50	not specified		0,3	0,2 to 1,7
Arsenic, As	mg/kg d	< 0,1	< 0,1	< 0,1	< 0,1 to 0,2	< 0,4	< 0,4
Cadmium, Cd	mg/kg d	2	0,2 to 5	0,5	0,2 to 1	0,1	< 0,2
Chromium, Cr	mg/kg d	1	0,3 to 5	1	0,3 to 2	0,4	< 1
Copper, Cu	mg/kg d	3	2 to 4	3	2 to 4	3	3 to 4
Mercury, Hg	mg/kg d	< 0,03	< 0,03	< 0,03	< 0,03	not specified	
Nickel, Ni	mg/kg d	0,5	0,2 to 2	0,5	0,2 to 1,0	1	0,3 to 3
Lead, Pb	mg/kg d	0,1	0,1 to 0,2	0,1	0,1 to 0,3	1	0,3 to 2
Vanadium, V	mg/kg d	0,3	0,2 to 0,6	not specified		0,3	< 0,5
Zinc, Zn	mg/kg d	70	40 to 100	50	30 to 100	6	< 10

[a] Data are obtained from a combination of mainly Swedish, Finnish, Danish, Dutch, Spanish, French and German research. Formulas how to calculate different bases are given in ISO 16993.

Table B.5 — Typical values for virgin straw materials, with or without insignificant amounts of grains

Parameter	Unit	Straw from wheat, rye, barley (2.1.1.2)		Straw from oilseed rape (2.1.3.2)	
		Typical value	Typical variation	Typical value	Typical variation
Ash	w-% d	5	2 to 10	5	2 to 10
Gross calorific value $q_{V,gr,d}$	MJ/kg d	18,8	16,6 to 20,1	18,8	16,6 to 20,1
Net calorific value $q_{p,net,d}$	MJ/kg d	17,6	15,8 to 19,1	17,6	15,8 to 19,1
Carbon, C	w-% d	47	41 to 50	48	42 to 52
Hydrogen, H	w-% d	6,0	5,4 to 6,5	6,0	5,4 to 6,5
Oxygen, O	w-% d	41	36 to 45	41	36 to 45
Nitrogen, N	w-% d	0,5	0,2 to 1,5	0,8	0,3 to 1,6
Sulfur, S	w-% d	0,1	< 0,05 to 0,2	0,3	< 0,05 to 0,7
Chlorine, Cl	w-% d	0,4	< 0,1 to 1,2	0,5	< 0,1 to 1,1
Fluorine, F	w-% d	0,000 5	not specified	not specified	not specified
Aluminium, Al	mg/kg d	50	Up to 700	50	Up to 700
Calcium, Ca	mg/kg d	4 000	2 000 to 7 000	15 000	8 000 to 20 000
Iron, Fe	mg/kg d	100	Up to 500	100	Up to 500
Potassium, K	mg/kg d	10 000	2 000 to 26 000	10 000	2 000 to 26 000
Magnesium, Mg	mg/kg d	700	400 to 1 300	700	300 to 2 200
Manganese, Mn	mg/kg d	40	20 to 100	not specified	not specified
Sodium, Na	mg/kg d	500	Up to 3 000	500	Up to 3 000
Phosphorus, P	mg/kg d	1 000	300 to 2 900	1 000	300 to 2 700
Silicon, Si	mg/kg d	10 000	1 000 to 20 000	1 000	100 to 3 000
Titanium, Ti	mg/kg d	70	5 to 200	not specified	not specified
Arsenic, As	mg/kg d	< 0,1	< 0,1 to 2,0	< 0,1	< 0,1 to 0,5
Cadmium, Cd	mg/kg d	0,10	< 0,05 to 0,30	0,10	< 0,05 to 0,30
Chromium, Cr	mg/kg d	10	1 to 60	10	1 to 60
Copper, Cu	mg/kg d	2	1 to 10	2	1 to 10
Mercury, Hg	mg/kg d	0,02	< 0,02 to 0,05	0,02	< 0,02 to 0,05
Nickel, Ni	mg/kg d	1,0	0,2 to 4,0	1,0	0,2 to 4,0
Lead, Pb	mg/kg d	0,5	0,1 to 3,0	2,0	1,0 to 13,0
Vanadium, V	mg/kg d	3	1 to 6	not specified	not specified
Zinc, Zn	mg/kg d	10	3 to 60	10	5 to 20

[a] Data are obtained from a combination of mainly Swedish, Finnish, Danish, Dutch and German research. Formulas how to calculate different bases are given in ISO 16993.

Table B.6 — Typical values for virgin cereal grain materials

Parameter	Unit	Grain from wheat, rye, barley (2.1.1.3)		Grains from rape (2.1.1.3)	
		Typical value	Typical variation	Typical value	Typical variation
Ash	w-% d	2	1,2 to 4	4,3	3,75 to 5,5
Gross calorific value $q_{V,gr,d}$	MJ/kg d	18, 0	16,5 to 19, 6	28,1	27,5 to 29,0
Net calorific value $q_{p,net,d}$	MJ/kg d	16,5	15,0 to 18,1	26,6	not specified
Carbon, C	w-% d	45	42 to 50	60	not specified
Hydrogen, H	w-% d	6,5	5,5 to 6,5	7,1	not specified
Oxygen, O	w-% d	44	43 to 50	23	not specified
Nitrogen, N	w-% d	2	not specified	3,8	not specified
Sulfur, S	w-% d	0,16	0,05 to 0,1	0,1	not specified
Chlorine, Cl	w-% d	0,11	0,05 to 0,5	0,07	0,01 to 0,15
Aluminium, Al	mg/kg d	not specified	< 20	not specified	not specified
Calcium, Ca	mg/kg d	600	100 to 1 200	5 000	3 200 to 6 400
Iron, Fe	mg/kg d	75	15 to 200	93	not specified
Potassium, K	mg/kg d	5 000	3 700 to 6 500	8 400	not specified
Magnesium, Mg	mg/kg d	1 400	1 000 to 2 100	2 600	not specified
Manganese, Mn	mg/kg d	30	9 to 60	39	not specified
Sodium, Na	mg/kg d	100	50 to 120	100	50 to 120
Phosphorus, P	mg/kg d	3 400	2 100 to 4 300	7 300	not specified
Silicon, Si	mg/kg d	50	10 to 200	not specified	not specified
Titanium, Ti	mg/kg d	not specified	< 50 to 100	not specified	not specified
Arsenic, As	mg/kg d	≤ 0,5	0,0 to 0,7	not specified	not specified
Cadmium, Cd	mg/kg d	0,01	0,0 to 0,7	not specified	not specified
Chromium, Cr	mg/kg d	0,5	< 0,5 to 1,0	not specified	not specified
Copper, Cu	mg/kg d	5	1,5 to 12	2,6	not specified
Mercury, Hg	mg/kg d	< 0,02	< 0,02	not specified	not specified
Nickel, Ni	mg/kg d	1,0	0,2 to 2,0	not specified	not specified
Lead, Pb	mg/kg d	0,9	≤ 0,1 to 1	not specified	not specified
Vanadium, V	mg/kg d	not specified	not specified	not specified	not specified
Zinc, Zn	mg/kg d	22	17 to 34	not specified	not specified

[a] Data are obtained from a combination of mainly Swedish, Finnish, Danish, Dutch, French (including rye) and German research. Formulas how to calculate different bases are given in ISO 16993.

Table B.7 — Typical values for virgin reed canary grass

Parameter	Unit	Summer harvest (July – Oct) (2.1.2.1)		Delayed harvest (March – May) (2.1.2.1)	
		Typical value	Typical variation	Typical value	Typical variation
Ash	w-% d	6,5	2,5 to 10	6,9	1,0 to 8,0
Gross calorific value $q_{V,gr,d}$	MJ/kg d	17,7	not specified	17,8	17,7 to 18,0
Net calorific value $q_{p,net,d}$	MJ/kg d	16,6	not specified	16,5	16,5 to 17,0
Carbon, C	w-% d	46	not specified	46	45 to 50
Hydrogen, H	w-% d	5,7	not specified	5,8	5,7 to 6,2
Oxygen, O	w-% d	40	not specified	42	40 to 43
Nitrogen, N	w-% d	1,3	not specified	0,9	0,4 to 2,0
Sulfur, S	w-% d	0,1	0,1 to 0,2	0,13	0,04 to 0,17
Chlorine, Cl	w-% d	0,5	0,2 to 0,6	0,025	0,01 to 0,09
Aluminium, Al	mg/kg d	not specified	not specified	not specified	20
Calcium, Ca	mg/kg d	3 500	1 300 to 5 700	2 000	800 to 3 200
Iron, Fe	mg/kg d	not specified	not specified	140	60 to 220
Potassium, K	mg/kg d	12 000	3 100 to 22 000	2 700	< 800 to 6 000
Magnesium, Mg	mg/kg d	1 300	300 to 2 300	500	100 to 900
Manganese, Mn	mg/kg d	not specified	not specified	160	< 200
Sodium, Na	mg/kg d	200	< 100 to 400	200	< 20 to 400
Phosphorus, P	mg/kg d	1 700	500 to 3 000	1 100	300 to 2 000
Silicon, Si	mg/kg d	12 000	< 1 000 to 25 000	18 000	2 300 to 30 000
Arsenic, As	mg/kg d	0,1	< 0,1 to 0,2	0,2	< 0,1 to 0,5
Cadmium, Cd	mg/kg d	0,04	< 0,04 to 0,10	0,06	< 0,04 to 0,20
Chromium, Cr	mg/kg d	not specified	not specified	not specified	not specified
Copper, Cu	mg/kg d	not specified	not specified	not specified	not specified
Mercury, Hg	mg/kg d	0,03	< 0,02 to 0,05	0,03	< 0,02 to 0,05
Nickel, Ni	mg/kg d	not specified	not specified	not specified	not specified
Lead, Pb	mg/kg d	1,0	< 0,5 to 4,0	2,0	< 0,5 to 5,0

[a] Data are obtained from a combination of mainly Swedish, Finnish, Danish and German research. Formulas how to calculate different bases are given in ISO 16993.

Table B.8 — Typical values for virgin grass in general (hay) and miscanthus

Parameter	Unit	Grass, in general (2.1.2.1)		Miscanthus (China reed) (2.1.2.1)	
		Typical value	Typical variation	Typical value	Typical variation
Ash	w-% d	7	4 to 10	4	1 to 6
Gross calorific value $q_{V,gr,d}$	MJ/kg d	18,0	18 to 20	19,0	17 to 20
Net calorific value $q_{p,net,d}$	MJ/kg d	17,1	16 to 19	17,7	16 to 19
Carbon, C	w-% d	46	45 to 50	47	46 to 52
Hydrogen, H	w-% d	5,9	5 to 7	6,1	5 to 6,5
Oxygen, O	w-% d	40	38 to 48	42	40 to 45
Nitrogen, N	w-% d	1,3	1 to 2	0,7	0,1 to 1,5
Sulfur, S	w-% d	0,2	0 to 0,5	0,2	0,02 to 0,6
Chlorine, Cl	w-% d	0,7	0,02 to 1,3	0,2	0,02 to 0,6
Fluorine, F	w-% d	0,001	0,001 to 0,003	0,002	0,001 to 0,003
Aluminium, Al	mg/kg d	200	20 to 300	100	50 to 200
Calcium, Ca	mg/kg d	3 500	2 500 to 5 500	2 000	900 to 3 000
Iron, Fe	mg/kg d	600	100 to 1 200	100	40 to 400
Potassium, K	mg/kg d	15 000	4 900 to 24 000	7 000	1 000 to 11 000
Magnesium, Mg	mg/kg d	1 700	800 to 2 300	600	300 to 900
Manganese, Mn	mg/kg d	1 000	200 to 2 600	20	10 to 100
Sodium, Na	mg/kg d	3 000	1 400 to 6 300	70	20 to 100
Phosphorus, P	mg/kg d	15 000	3 000 to 25 000	500	200 to 800
Silicon, Si	mg/kg d	not specified	not specified	8 000	2 000 to 10 000
Titanium, Ti	mg/kg d	not specified	not specified	5	3 to 10
Arsenic, As	mg/kg d	0,1	< 0,1 to 1,4	0,2	< 0,1 to 0,2
Cadmium, Cd	mg/kg d	0,20	0,03 to 0,60	0,10	0,05 to 0,2
Chromium, Cr	mg/kg d	1,0	0,2 to 3,0	1	0,4 to 6
Copper, Cu	mg/kg d	5	2 to 10	2	1 to 6
Mercury, Hg	mg/kg d	< 0,02	< 0,02 to 0,03	0,03	< 0,02 to 0,1
Nickel, Ni	mg/kg d	2,0	0,5 to 5,0	2	0,5 to 5
Lead, Pb	mg/kg d	1,0	< 0,5 to 2,0	2	< 0,5 to 5
Vanadium, V	mg/kg d	3	not specified	< 1	not specified
Zinc, Zn	mg/kg d	25	10 to 60	10	3 to 30

[a] Data are obtained from a combination of mainly Swedish, Finnish, Danish, Dutch and German research. Formulas how to calculate different bases are given in ISO 16993.

Table B.9 — Typical values for olive and grape cake

Parameter	Unit	Olive cake			Grape cake	
		Crude olive cake 3.2.1.4	Exhausted olive cake 3.2.2.4	Olive kernels 3.2.1.2	Crude grape cake 3.2.1.1	Exhausted grape cake 3.2.1.1, 3.2.2.1
Ash	w-% d	10	3,4 to 11,3	1,2 to 4,4	4,5 to 11,2	6 to 13
Gross calorific value $q_{V,gr,d}$	MJ/kg d	19,4 to 21,4	18,1 to 21,6	18,6 to 20,8	19,3 to 22,0	
Net calorific value $q_{p,net,d}$	MJ/kg d	18,1 to 20,7	13,9 to 19,2	17,3 to 19,3	16,7	19,0
Carbon, C	w-% d	50	48 to 52	45,7 to 52,3	54	46,0 to 54,4
Hydrogen, H	w-% d	6,9	4,6 to 6,3	6,1 to 6,8	6,8	5,8 to 7,5
Oxygen, O	w-% d	30	33	38,5 to 42,1	not specified	not specified

Table B.9 *(continued)*

Parameter	Unit	Olive cake			Grape cake	
		Crude olive cake 3.2.1.4	Exhausted olive cake 3.2.2.4	Olive kernels 3.2.1.2	Crude grape cake 3.2.1.1	Exhausted grape cake 3.2.1.1, 3.2.2.1
Nitrogen, N	w-% d	1,5	1,4 to 2,7	0,8 to 1,6	1,5	1,9 to 2,4
Sulfur, S	w-% d	0,2	0,0 to 0,5	0,0 to 0,5	0,20	0,03 to 0,18
Chlorine, Cl	w-% d	0,2	0,1 to 0,4	0,1 to 0,4	not specified	< 0,05
Aluminium	mg/kg d	1 250	2 700	559	not specified	not specified
Calcium, Ca	mg/kg d	6 900	17 200	968	not specified	not specified
Iron, Fe	mg/kg d	1 000	1 900	391	not specified	not specified
Potassium, K	mg/kg d	6 000 to 16 000	17 500	6 950	not specified	12 500 to 35 700
Magnesium, Mg	mg/kg d	3 400	4 000	316	not specified	not specified
Manganese, Mn	mg/kg d	< 26	17 to 44	12	not specified	14 to 36
Sodium, Na	mg/kg d	44 to 1 000	250 to 450	120	not specified	34 to 180
Phosphorus, P	mg/kg d	2 450	30 to 1 750	590	not specified	not specified
Silicon, Si	mg/kg d	14 to 6 600	20 to 11 850	9 to 3 500	not specified	not specified
Titanium,Ti	mg/kg d	53	145	39	not specified	not specified
Arsenic, As	mg/kg d	0,4	4	0,8	not specified	not specified
Cadmium, Cd	mg/kg d	< 0,1	< 0,5	0,2	not specified	0,05 to 0,18
Chromium, Cr	mg/kg d	3	3 to 13	3	not specified	0,73 to 1,54
Copper, Cu	mg/kg d	14	10 to 20	9	not specified	48 to 190
Mercury, Hg	mg/kg d	not specified	0,1	not specified	not specified	not specified
Nickel, Ni	mg/kg d	2	2 to 17	0,05	not specified	0,66 to 1,64
Lead, Pb	mg/kg d	2	15	2,1	not specified	0,35 to 2,70
Vanadium, V	mg/kg d	not specified	5	not specified	not specified	not specified
Zinc, Zn	mg/kg d	19	19	7	not specified	not specified
Cobalt, Co	mg/kg d	not specified	1	not specified	not specified	not specified
Silver, Ag	mg/kg d	not specified	4	not specified	not specified	not specified
Tin, Sn	mg/kg d	not specified	4	not specified	not specified	not specified

[a] Data are obtained from a combination of mainly Austrian, Dutch, Italian, Greek and Spanish research. Formulas how to calculate different bases are given in ISO 16993.

NOTE 1 Crude olive cake is a by-product of the first industrial olive oil extraction process. The chemical composition can vary according to the pressing method utilized.

NOTE 2 Exhausted olive cake is a by-product of the second industrial olive oil extraction process that remains after oil extraction (chemical treatment from the above mentioned crude olive cake).

NOTE 3 Olive kernels is a by-product of the first industrial olive oil extraction process, by which a certain quantity of the olive cake produced is separated, giving as a result this high quality biofuel.

NOTE 4 Crude grape cake is a by-product that remains after the grapes have been pressed.

NOTE 5 Exhausted grape cake is a residual material, which remains after water or chemical treatment from crude grape cake.

Table B.10 — Typical values for fruit stones and shells

Parameter	Unit	Fruit stones and shells		
		Apricot, peach, cherry fruit stone 3.2.1.2	Almond, hazelnut, pinenut shells 3.1.3.2	Oil palm shell, nut, fibre
Ash	w-% d	0,2 to 1,0	0,95 to 3,00	1,4 to 7,4
Gross calorific value $q_{V,gr,d}$	MJ/kg d	not specified	19 to 20	not specified
Net calorific value $q_{p,net,d}$	MJ/kg d	19,5 to 22,9	17,5 to 19,0	18,0 to 24,8
Carbon, C	w-% d	51 to 55	44 to 50	46,3 to 58,5
Hydrogen, H	w-% d	5 to 7	5 to 6	5,9 to 12,6
Oxygen, O	w-% d	43	40 to 45	43,0 to 50,2
Nitrogen, N	w-% d	0,2 to 0,3	0,1 to 1,2	0,04 to 0,5
Sulfur, S	w-% d	0,05 to 0,50	0,04 to 0,22	0,03 to 0,09
Chlorine, Cl	w-% d	0,04	0,004 to 0,09	0,10 to 0,25
Aluminium, Al	mg/kg d	not specified	65	600 to 16 500
Calcium, Ca	mg/kg d	not specified	300 to1200	1 200 to 4 500
Iron, Fe	mg/kg d	not specified	58 to 66	2 000 to 13 400
Potassium, K	mg/kg d	not specified	1 500 to 1 750	2 800 to 21 000
Magnesium, Mg	mg/kg d	not specified	175 to 300	1 300 to 2 300
Manganese, Mn	mg/kg d	not specified	3 to 12	30 to 45
Sodium, Na	mg/kg d	not specified	62 to 73	30 to 40
Phosphorus, P	mg/kg d	not specified	79 to 82	500 to 2 000
Silicon, Si	mg/kg d	not specified	580 to 4 200	2 200 to 34 000
Titanium,Ti	mg/kg d	not specified	1 to 6	20 to 400
Zinc, Zn	mg/kg d	not specified	2,3 to 5,3	500 to 1 600

[a] Data are obtained from a combination of mainly Austrian, Dutch, Italian, Greek, Spanish and Malaysian research. Formulas how to calculate different bases are given in ISO 16993.

Table B.11 — Typical values for selected types of husks, stalks, cotton gin trash and malva

Parameter	Unit	Rice husk 2.1.1.4	Cotton stalks 2.1.1.2	Cotton gin trash 2.1.1.2	Sunflower husk 2.1.6.2	Pensylvanian malva 2.1.6.2
Ash	w-% d	13 to 23	6,0 to 6,7	1,6 to 9,4	1,9 to 7,6	2,8
Gross calorific value $q_{V,gr,d}$	MJ/kg d	14,7 to 6,6	15,8 to 18,3	16,4 to 17,5	18 to 23	19,0
Net calorific value $q_{p,net,d}$	MJ/kg d	14,5 to 16,2			17 to 22	17,7
Carbon, C	w-% d	38 to 43	39,5 to 47,0	39,6 to 43,7	51,5 to 52,9	not specified
Hydrogen, H	w-% d	4,3 to 5,1	5,1 to 5,8	5,3 to 6,1	5,0 to 6,6	5,9
Oxygen, O	w-% d	35 to 47	not specified	not specified	36 to 43	not specified
Nitrogen, N	w-% d	0,1 to 0,8	0,65 to 1,25	0,2 to 2,9	0,6 to 1,4	not specified
Sulfur, S	w-% d	0,02 to 0,10	0,02 to 0,21	not specified	0	0,05
Chlorine, Cl	w-% d	0,03 to 0,3	0,08	not specified	0 to 0,1	0,02
Potassium, K	mg/kg d	2 800 to 4 300	not specified	not specified	not specified	not specified
Sodium, Na	mg/kg d	33 to 38	not specified	not specified	not specified	not specified

[a] Data are obtained from a combination of mainly Italian, Greek and Finnish research. Formulas how to calculate different bases are given in ISO 16993.

Annex C
(informative)

Examples of possible causes for deviant levels for different properties and of consequences of handling and treatments for the properties of biomass

Table C.1 — Examples of possible causes for deviant levels for different properties

Property	Deviation	Possible causes
Ash, d	High value	Contamination with soil/sand Higher content of bark than specified (only wood) Inorganic additives Chemical treatments such as paint, preservation (only wood)
Net calorific value $q_{p,net,d}$	Low value	High ash content Content of combustible material with lower calorific value as e.g. glues (only wood)
Net calorific value $q_{p,net,d}$	High value	Content of combustible material with higher calorific value as e.g. resin, vegetable or mineral oils, plastic
N, d	High value	Higher content of bark than specified (only wood) Glue (only wood) Plastic (laminate)
S, d	High value	Higher content of bark than specified (only wood) Organic additives as corn flour, potato flour Additives containing sulfur compounds Treatment with chemicals containing sulfur, as sulfuric acid
Cl, d	High value	Higher content of bark than specified (only wood) Origin of biomass from coast near locations and exposed from seawater Contamination during storage/transportation by road salting Preservation chemicals (only wood)
Si, d	High value	Contamination with soil/sand Higher content of bark/needles/leaves than specified (only wood)
Ti, d	High value	Paint (only wood)
As, d	High value	Preservation chemicals
Cr, d	High value	Preservation chemicals Contamination with soil/sand
Cu, d	High value	Preservation chemicals Contamination with soil/sand
Hg, d	High value	Contamination with soil/sand
Cd, d	High value	Paint (only wood) Plastic Fertilizer, e.g. ash, sewage sludge (issued from waste water treatment or chemical process)

Table C.1 *(continued)*

Property	Deviation	Possible causes
Ni, d	High value	Contamination from working up machinery
		Mineral oils
Pb, d	High value	Environmental contamination (e.g. traffic)
		Paint (only wood)
		Plastic
		Fertilizer, e.g. ash, sewage sludge (issued from waste water treatment or chemical process)

NOTE Chemically treated wood waste that may contain halogenated organic compounds or heavy metals, is not included in the scope of the standard. As the presence of such materials or the remains of other materials can occur accidentally, examples for these incidents are given also.

Table C.2 — Examples of consequences of handling and treatments for the properties of biomass

Circumstance	Possible consequences
Handling, storage or transportation	— increased content of ash and Si due to contamination with soil/sand (may also lead to decrease of ash melting; DT, especially if alkali (Na, K) present)
	— increased content of Cl due to contamination with road salting
Mechanical contamination	— increased content of metals as Fe, Cr and Ni from the working tools/machinery
Environmental contamination	— increased content of Cl due to deposition from the sea spray/fog
	— increased content of heavy metals as Pb and Zn due to exposition to society activities as traffic
	— increased content of Cd, Pb due to fertilizer (e.g. sewage sludge)
Additives (pellets and briquettes)	**Possible consequences**
Inorganic additives:	— increased content of ash and Ca
Limestone	— increased content of ash, Si and Al
Kaolin	
Organic additives:	— changes, depending on type and quality of the particular material. Higher amounts of e.g. corn or potato flour may cause increased content of e.g. ash and S
Other solid biomass	
Vegetable oils	— increased calorific value
Chemical treatments	**Possible consequences**
Glue	— increased content of N
	— decreased calorific value
Lye	— increased content of Na
Paints [a]	— increased content of ash
	— increased content of metals as Pb, Ti and Zn depending of the actual pigments
Plastics (laminate) [a]	— increased calorific value
	— increased content of N (e.g. ABS or celluloid plastics)
	— increased content of Cl or F (e.g. PVC or polytetrafluoroethylene (PTFE) plastics)
	— increased contents of metals as Cd, Pb, Zn depending of the content of additives in the plastic
Preservations [a]	— increased content of ash
	— increased content of As, B, Cl, Cr, Cu, F, P or Zn depending of the used type of preservation chemical
Sulfuric acids	— increased content of S
[a] Chemical treatments containing halogenated organic compounds (as Cl, F) or heavy metals (as As, Pb) is not included in the scope of the standard.	

Annex D
(informative)

Calculation of the net calorific value at different bases and energy density as received

D.1 The net calorific value of dry basis

The net calorific value at a constant pressure for a dry sample (dry basis, in dry matter) is derived from the corresponding gross calorific value at a constant volume according to Formula (1)

$$q_{\mathrm{p,net,d}} = q_{V,\mathrm{gr,d}} - 212{,}2 \times w(\mathrm{H})_{\mathrm{d}} - 0{,}8 \times \left[w(\mathrm{O})_{\mathrm{d}} + w(\mathrm{N})_{\mathrm{d}} \right] \quad (1)$$

where

$q_{\mathrm{p,net,d}}$ is the net calorific value for dry matter at a constant pressure in joules per gram(J/g) or kilojoules per kilogram (kJ/kg);

$q_{\mathrm{V,gr,d}}$ is the gross calorific value for dry matter in joules per gram(J/g) or kilojoules per kilogram (kJ/kg);

$w(\mathrm{H})\mathrm{d}$ is the hydrogen content, in percentage by mass, of the moisture-free (dry) biofuel (including the hydrogen from the water of hydration of the mineral matter as well as the hydrogen in the biofuel substance);

$w(\mathrm{O})\mathrm{d}$ is the oxygen content, in percentage by mass, of the moisture-free biofuel;

$w(\mathrm{N})\mathrm{d}$ is the nitrogen content, in percentage by mass, of the moisture-free biofuel.

For the calculation of the net calorific value as received using Formula (2) in D.2, the result from Formula (1) in in joules per gram(J/g) or kilojoules per kilogram (kJ/kg), shall be divided by 1 000 to get the result in megajoules per kilogram (MJ/kg).

NOTE $\left[w(\mathrm{O})_{\mathrm{d}} + w(\mathrm{N})_{\mathrm{d}} \right]$ can be derived by subtracting from 100 (w-%) the percentages of ash, carbon, hydrogen and sulfur.

D.2 The net calorific value as received

a) Calculation from dry basis

The net calorific value (at constant pressure) on as received (the moist biofuel) can be calculated on the net calorific value of the dry basis according to Formula (2).

$$q_{p,\mathrm{net,ar}} = q_{p,\mathrm{net,d}} \times \left(\frac{100 - M_{\mathrm{ar}}}{100}\right) - 0{,}024\,43 \times M_{\mathrm{ar}} \quad (2)$$

where

$q_{\mathrm{p,net,ar}}$ is the net calorific value (at constant pressure) as received in megajoules per kilogram (MJ/kg);

$q_{\mathrm{p,net,d}}$ is the net calorific value (at constant pressure) in dry matter in megajoules per kilogram (MJ/kg);

M_{ar} is the moisture content as received [w-%].

0,024 43 is the correction factor of the enthalpy of vaporization (constant pressure) for water (moisture) at 25 °C (in megajoules per kilogram (MJ/kg) per 1 w-% of moisture).

b) Calculation from dry and ash-free basis

The net calorific value (at constant pressure) on as received (the moist biofuel) can be calculated from a net calorific value of the dry and ash-free basis according to Formula (3).

$$q_{p,\mathrm{net,ar}} = \left[q_{p,\mathrm{net,daf}} x \left(\frac{100 - A_{\mathrm{d}}}{100} \right) \times \left(\frac{100 - M_{\mathrm{ar}}}{100} \right) \right] - 0{,}024\,43 \times M_{\mathrm{ar}} \quad (3)$$

where

$q_{\mathrm{p,net,ar}}$ is the net calorific value (at constant pressure) as received, in megajoules per kilogram (MJ/kg);

$q_{\mathrm{p,net,daf}}$ is the net calorific value (at constant pressure) in dry and ash-free basis, in megajoules per kilogram (MJ/kg);

M_{ar} is the moisture content as received (w-%);

A_{d} is the ash content in dry basis (w-%).

0,024 43 is the correction factor of the enthalpy of vaporization (constant pressure) for water (moisture) at 25 °C (in megajoules per kilogram (MJ/kg) per 1 w-% of moisture).

In both the above cases a) and b), the calorific value can be either determined for that particular lot or a typical value can be used.

1) If the ash content of the fuel is low and rather constant, the calculation can be based on the dry basis equation with a typical value of $q_{p,\mathrm{net,\,d}}$;

2) If the ash content varies quite a lot (or is high) for the specific biofuel then using the equation for dry and ash-free basis with a typical value of $q_{p,\mathrm{net,daf}}$ is preferable.

The result shall be reported to the nearest 0,01 MJ/kg.

D.3 Energy density as received

The wood fuels for small-scale heating plants and households are traded usually on a volume basis and energy content (net calorific value) is informed often as megawatts hour (MWh) per bulk volume. Bulk density and moisture content is measured or estimated.

The energy density as received can be calculated according to Formula (4).

$$E_{ar} = \frac{1}{3\,600} \times q_{p,net,ar} \times BD_{ar} \quad (4)$$

where

E_{ar} is the energy density of the biofuel as received, in megawatts hour per cubic metre (MWh/m^3) of bulk volume;

$q_{p,net,ar}$ is the net calorific value (at constant pressure) as received, in megajoules per kilogram (MJ/kg);

BD_{ar} is the bulk density, i.e. volume weight of the biofuel as received, in kilograms per cubic metre (kg/m^3) of bulk volume;

$\frac{1}{3\,600}$ is the conversion factor for the energy units (megajoules (MJ) to megawatts hour (MWh)).

The result shall be reported to the nearest 0,01 MWh/m^3 of bulk volume.

The values of net calorific value and bulk density used in equations can be either measured or based on typical values of biofuels. The typical net calorific values of solid biofuels are reported in Annex B of this International Standard.

Annex E
(informative)

Comparison of moisture content as received and dry basis

Table E.1 — Comparison of moisture content as received (M) and dry basis (U)

Moisture content, wet basis (M), w-%	Moisture content, dry basis (U), w-%		Moisture content, dry basis (U), w-%	Moisture content, wet basis (M), w-%
12	13,6		12	10,7
13	14,9		13	11,5
14	16,3		14	12,3
15	17,6		15	13,0
16	19,0		16	13,8
17	20,5		17	14,5
18	22,0		18	15,2
19	23,5		19	16,0
20	25,0		20	16,7
21	26,6		21	17,4
22	28,2		22	18,0
23	29,9		23	18,7
24	31,6		24	19,4
25	33,3		25	20,0
26	35,1		26	20,6
27	37,0		27	21,3
28	38,9		28	21,9
29	40,9		29	22,5
30	42,9		30	23,1
31	44,9		31	23,7
32	47,1		32	24,2
33	49,5		33	24,8
34	51,5		34	25,4
35	53,9		35	25,9
36	56,3		36	26,5
37	58,7		37	27,0
			38	27,5
			39	28,1
			40	28,6
			41	29,1
			42	29,6
			43	30,1
			44	30,6

Table E.1 *(continued)*

Moisture content, wet basis (M), w-%	Moisture content, dry basis (U), w-%		Moisture content, dry basis (U), w-%	Moisture content, wet basis (M), w-%
			45	31,1
			46	31,5
			47	32,0
			48	32,4
			49	32,9
			50	33,3
			51	33,8
			52	34,2
			53	34,6
			54	35,1

The relation between moisture on dry basis, U_d, or wet basis, M_{ar}, expressed as a percentage by mass shall be calculated using Formulae (1) and 2 according to ISO 18134-1.

$$U_d = \frac{M_{ar}}{100 - M_{ar}} \text{ x } 100 \quad \text{(E.1)}$$

$$M_{ar} = \frac{U_d}{100 + U_d} \text{ x } 100 \quad \text{(E.2)}$$

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[10] ISO 18125, *Solid biofuels — Determination of calorific value*[22)]

[11] ISO 18846, *Solid biofuels — Determination of fines content in quantities of pellets — Manual sieve method using 3,15 mm sieve aperture*[23)]

[12] ISO 18847, *Solid biofuels — Determination of particle density*[24)]

17) Under preparation.

18) Under preparation.

19) Under preparation.

20) Under preparation.

21) Under preparation.

22) Under preparation.

23) Under preparation.

24) Under preparation.

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