Chapter 2
European Standards for Fuel Specification and Classes of Solid Biofuels

Eija Alakangas

Abstract The technical committee developing the draft standard to describe all forms of solid biofuels within Europe (CEN/TC 335) has published 27 technical specifications for solid biofuels. The two most important are classification and specification (CEN/TS 14961) and quality assurance (CEN/TS 15234). Now these technical specifications are upgraded to full European standards (EN). Both these standards will be published as multipart standards. Part 1 – General requirements of EN 14961-1 includes all solid biofuels and is targeted for all user groups. The classification of solid biofuels is based on their origin and source and biofuels are divided to four sub-categories: (1) Woody biomass, (2) Herbaceous biomass, (3) Fruit biomass, and (4) Blends and mixtures. The quality tables were prepared only for major traded forms. Parts 2–6 are product standards, which are targeted for non-industrial use. Non-industrial use means fuel intended to be used in smaller appliances, such as in households and small commercial and public sector buildings. In the product standards all properties are normative and they are bound together to form a class, for example A1, A2, and B. Although these product standards may be obtained separately, it should be recognized that they require an understanding of the standards based on and supporting EN 14961-1. This chapter concentrates on Part 1 of EN 14961, which was published in 2010. The remaining five product standards are being drafted and are at the voting stage, with an expected publication date within 2010.

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E. Alakangas (✉)
VTT, Technical Research Centre of Finland, P.O. Box 1603,
FI-40101 Jyväskylä, Finland
e-mail: eija.alakangas@vtt.fi

2.1 Introduction

The European Committee for Standardization, CEN under committee TC335 has published 27 technical specifications (pre-standards) for solid biofuels. Now these technical specifications are upgraded to full European standards (EN).When EN-standards are in force the national standards in Europe have to be withdrawn or adapted to these EN-standards. The two most important technical specifications being developed deal with classification and specification (EN 14961 [14]) and quality assurance for solid biofuels (EN 15234 [23]). Both these standards will be published as multipart standards. Part 1 – General requirements of EN 14961-1 includes all solid biofuels and is targeted for all user groups [1, 6–10].

This European Standard determines the fuel quality classes and specifications for solid biofuels. The scope of the CEN/TC 335 only includes solid biofuels originating from the following sources:

- products from agriculture and forestry;
- vegetable waste from agriculture and forestry;
- vegetable waste from the food processing industry;
- wood waste, with the exception of wood waste which may contain halogenated organic compounds or heavy metals as a result of treatment with wood preservatives or coating, and which includes in particular such wood waste originated from construction and demolition waste;
- fibrous vegetable waste from virgin pulp production and from production of paper from pulp, if it is co-incinerated at the place of production and heat generated is recovered;
- cork waste.

Note 1 To avoid any doubt, demolition wood is not included in the scope of this European Standard. Demolition wood is "used wood arising from demolition of buildings or civil engineering installations" (EN14588[17]).
Note 2 Aquatic biomass is not included in the scope of EN 14961-1 [14].

Development of standards has been supported by several projects. EUBIONET II [5] has collected experiences of the CEN solid biofuels standards from the market workers during 2006. A selected group of fuel market workers (47) in different countries were interviewed to decide on the concept of the functionality of the EN 14961. The level at which the standards are used or will be used in everyday fuel trade was studied, and the experienced advantages and disadvantages were collected. In the BioNorm II project 25 partners from 11 European countries tested different versions of EN 14961-1 in specifying their solid biofuels according to standards [4]. Companies involved in the testing were producing pellets, briquettes, wood chips, and hog fuel from woody biomass. Olive residues and reed canary grass bales were also within specified fuels. These experiments have helped in setting threshold values for solid biomass fuels and also drafting property tables for new traded forms, *e.g.*, bales from herbaceous biomass, olive residues, and energy grain.

2.2 Classification of Biomass Sources

The classification of solid biofuels is based on their origin and source. The fuel production chain of fuels shall be unambiguously traceable back over the whole chain.

The solid biofuels are divided into the following sub-categories for classification in EN 14961-1 [14]:

1. woody biomass (Tables 2.1 and 2.2);
2. herbaceous biomass (Tables 2.3 and 2.4);
3. fruit biomass (Tables 2.5 and 2.6);
4. blends and mixtures.

The purpose of classification is to allow the possibility to differentiate and specify raw material based on origin with as much detail as needed. The quality classification in a table form was only prepared for major traded solid biofuels.

Table 2.1 Classification of 1.1 Forest, plantation and other virgin wood in EN 14961-1 [14]

1.1.1 Whole trees without roots	1.1.1.1 Broadleaf
	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 Broadleaf
	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 Broadleaf
	1.1.3.2 Coniferous
	1.1.3.3 Blends and mixtures
1.1.4 Logging residues	1.1.4.1 Fresh/Green, Broadleaf (including leaves)
	1.1.4.2 Fresh/Green, Coniferous (including needles)
	1.1.4.3 Stored, broadleaf
	1.1.4.4 Stored, coniferous
	1.1.4.5 Blends and mixtures
1.1.5 Stumps/roots	1.1.5.1 Broadleaf
	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)[a]	
1.1.7 Segregated wood (Figure 2.1) from gardens, parks, roadside maintenance, vineyards, and fruit orchards	
1.1.8 Blends and mixtures	

[a] Also includes cork

Table 2.2 Classification of 1.2 By-products and residues from wood processing industry and 1.3 Used wood in EN 14961-1 [14]

1.2 By-products and residues from wood processing industry	
1.2.1 Chemically untreated wood residues	1.2.1.1 Without bark, broadleaf
	1.2.1.2 Without bark, coniferous
	1.2.1.3 With bark, broadleaf
	1.2.1.4 With bark, coniferous
	1.2.1.5 Bark (from industry operations)[a]
1.2.2 Chemically treated wood residues (Figure 2.2), fibers and wood constituents	1.2.2.1 Without bark
	1.2.2.2 With bark
	1.2.2.3 Bark (from industry operations)[a]
	1.2.2.4 Fibers and wood constituents
1.2.3 Blends and mixtures	
1.3 Used wood	
1.3.1 Chemically untreated wood	1.3.1.1 Without bark
	1.3.1.2 With bark
	1.3.1.3 Bark[a]
1.3.2 Chemically treated wood	1.3.2.1 Without bark
	1.3.2.2 With bark
	1.3.2.3 Bark[a]
1.3.3 Blends and mixtures	

[a] Also includes cork

Note 1 If appropriate, the actual species (*e.g.*, spruce, wheat) of biomass can also be stated. Wood species can be stated, *e.g.*, according to EN 13556 Round and sawn timber Nomenclature [11].
Note 2 Chemical treatment before harvesting of biomass does not need to be stated. Where any operator in the fuel supply chain has reason to suspects serious contamination of land (*e.g.*, coal slag heaps) or if planting has been used specifically for the sequestration of chemicals or biomass is fertilized by sewage sludge (issued from waste water treatment or chemical process), fuel analysis should be carried out to identify chemical impurities such as halogenated organic compounds or heavy metals.

The EN14961-1 also includes wood waste if it does not contain halogenated organic compounds or heavy metals as a result of treatment with wood preservatives or coating. The EU-funded BioNormII project clarified which fractions of wood waste can be defined as solid biofuel [2, 27].

In addition to virgin wood, solid biofuels derived from the by-products and residues of the wood processing industry, as well as post-society used wood, are also part of woody biomass (Figure 2.3). Part of the woody material under the heading "used wood" (class 1.3) can justifiably be classified as biomass. Due to the absence of clear guidelines and definitions, the classification of used wood into either waste or biomass remains debatable in the case of certain fractions of wood residues and wastes. Classes A, B, C, and D for used wood and industrial wood residues and by-products were proposed as a result of the study. Wood waste in

Table 2.3 Classification of 2.1 Herbaceous biomass from agriculture and horticulture [14]

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 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	

classes A and B is solid biofuel as defined, with given restrictions (do not contain halogenated organic compounds or heavy metals as a result of treatment with wood preservatives or coating). Wood waste in class C falls under the Waste Incineration Directive (WID) 2000/76/EC, and is solid recovered fuel. Wood waste in class D includes preservatives and shall be disposed of according to the Hazardous Waste Incineration Directive (94/67/EC).

Figure 2.1 Segregated wood from road maintenance

Figure 2.2 Chemically treated wood residues from process industry, which do not contain heavy metals or halogenated organic compounds

Table 2.4 Classification of 2.2 By-products and residues from herbaceous processing industry [14]

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	

Group 2.2 also includes residues and by-products from the food processing industry.

Table 2.5 Classification of 3.1 Fruit biomass [14]

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
		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	

Table 2.6 Classification of 3.2 By-products and residues from fruit processing industry, 3.3 Blends and mixtures of fruit, and 4 Blends and mixtures [14]

3.2 By-products and residues from fruit processing industry	3.2.1 Chemically untreated fruit residues	3.2.1.1 Berries
		3.2.1.2 Stone/kernel fruits
		3.2.1.3 Nuts and acorns
		3.2.1.4 Crude olive cake (Figure 2.4)
		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		

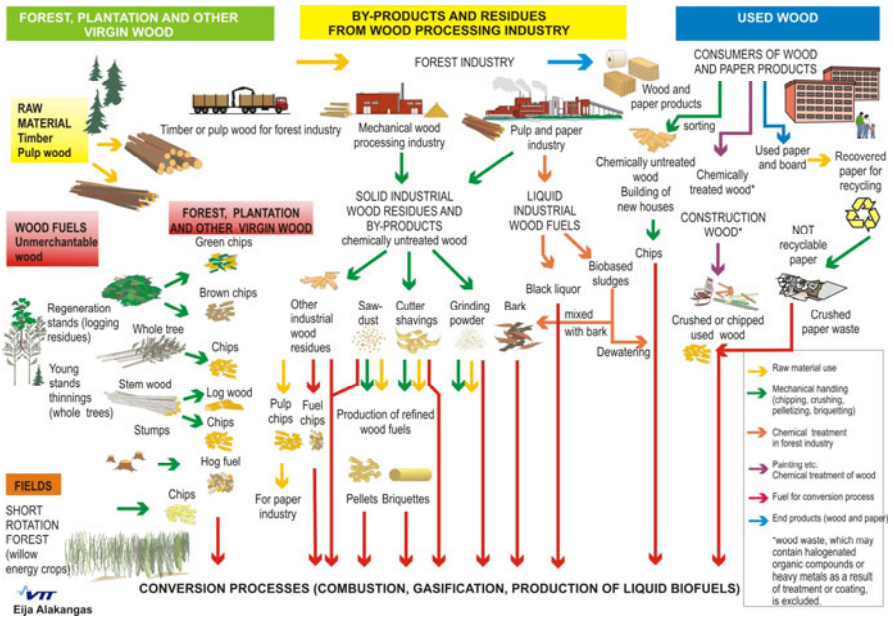

Figure 2.3 Classification of woody biomass

Figure 2.4 Olive residues

2.3 Fuel Specification and Classes – Multipart Standard

EN 14961 consists of the following parts, under the general title Solid biofuel – Fuel specification and classes [14]:

Part 1: General requirements (final draft) [14]
Part 2: Reed canary grass (Figure 2.5) for non-industrial use (under development) [18]
Part 3: Wood briquettes for non-industrial use (under development) [19]
Part 4: Wood chips for non-industrial use (under development) [20]
Part 5: Firewood for non-industrial use (under development) [21]
Part 6: Non-woody pellets for non-industrial use (under development) [22]

Properties to be specified are listed in Tables 3–14 of EN 14961-1 for the following traded forms of solid biofuels: (EN 14961-1) briquettes, pellets, wood chips, hog fuel, log wood/firewood, sawdust, shavings, bark, straw bales, reed canary grass (Figure 2.6) bales and Miscanthus bales, energy grain, olive residues, and fruit seeds. A general master table (Table 15 in EN 14961-1) is to be used for solid biofuels not covered by Tables 3–14. [14]. In Appendix 1 the classification table for wood pellets and in Appendix 2 for wood chips is presented.

The classification is flexible in EN 14961-1, and hence the producer or the consumer may select from each property class the classification that corresponds to the produced or desired fuel quality. This so-called "free classification" in Part 1 does not bind different characteristics with each other. An advantage of this classification is that the producer and the consumer may agree upon characteristics case-by-case.

The most significant characteristics are mandatory (= normative) and shall be given in the fuel specification EN 14961-1. These characteristics vary for different traded forms, while the most significant characteristics for all solid biofuels are moisture content (M), particle size/dimensions (P or D/L), and ash content (A). For example, the average moisture content of fuels is given as a value after the symbol (*e.g.*, M10), which means that the average moisture content of the fuel shall be ≤10 wt%. Some characteristics, *e.g.*, bulk density (BD), are voluntary, informative (see appendices 1 and 2 for pellets and wood chips respectively).

In these product standards, non-industrial use means fuel intended to be used in smaller appliances, such as in households and small commercial and public sector buildings. Although these product standards may be obtained separately, it should be recognized that they require an understanding of the standards based on and supporting EN 14961-1. The product standards will be drafted and they will be ready for voting at the end of 2009.

In the product standards all properties are normative and they are bound together to form a class, for example A1, A2, and B for wood pellets. Property class A1 for wood pellets represents virgin woods and chemically untreated wood residues low in ash and chlorine content. Fuels with slightly higher ash content and/or chlorine content fall within grade A2. In property class B chemically treated industrial wood by-products and residues and used wood are allowed (Appendix 2) if threshold values for minor elements are fulfilled.

Figure 2.5 Wood pellets classified according to EN 14961-1

Figure 2.6 Reed canary grass. Photo Vapo Oy

To support the development of product standards BioNormII project carried out combustion tests [3, 15, 16, 24–26] with small-scale wood burning appliances to find out if fuel properties (moisture, particle size, different biomass species, and ash content) affected the combustion, boiler efficiency, and emission formation. Tests were carried out by using standard EN303-5 (boilers [12]) and EN15250 (stove [13]). The appliances used were a conventional and modern log wood boiler, wood chips boiler, conventional and modern pellet boiler, and conventional heat retaining stove. The most important fuel properties were changed in tests, *e.g.*, moisture content, particle size, and ash content. Different wood species were used for log wood [16, 24] and different fruit biomass was tested in a conventional wood chip boiler [15]. Particle size of log wood did not have a big influence on emissions and boiler efficiency when a modern log wood boiler was used, but it had an effect on stoves. It was recommended that the diameter for stoves should be less than 15 cm. Based on the combustion tests the moisture content for log wood should be less than 20 wt%, but not lower than 10 wt%. Wood and agrobiomass pellets (diameters 6 mm and 8 mm) were used with different ash contents [26]. If ash content is higher than 0.5 wt% on a dry basis, particle size emissions increased. Ash content of woody biomass is usually low, but some wood species have higher ash content than 0.5 wt%.

Emissions were higher for different agrobiomass pellets and residues than for wood fuels [26]. Appliances used in tests were not designed for agrobiomass so this also affected the results. CEN/TC 335 is also developing a product standard for non-woody pellets.

To protect the small-scale consumer some minor elements are normative for wood pellets [18] and briquettes [19]. For wood chips [20] minor elements are normative if wood chips are produced from short rotation forestry and used wood.

If the properties being specified are sufficiently known through information about the origin and handling (or preparation method combined with experience) then physical/chemical analysis may not be needed.

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

1. using typical values, *e.g.*, laid down in Annex B in EN 14961-1, or obtained by experience;
2. calculation of properties, *e.g.*, by using typical values and considering documented specific values;
3. carrying out of analysis: (a) with simplified methods if available, (b) with reference methods.

2.4 Examples of Fuel Specification

The quality management system in ISO 9001 generally consists of quality planning, quality control, quality assurance, and quality improvement. The EN 15234 [23] covers fuel quality assurance and quality control. It covers quality assurance

of the supply chain and information to be used in quality control of the product, so that traceability exists and confidence is given by demonstrating that all processes along the overall supply chain of solid biofuels up to the point of the delivery to the end-user are under control.

Quality assurance aims to provide confidence that a steady quality is continually achieved in accordance with customer requirements.

The methodology shall allow producers and suppliers of solid biofuels to design a fuel quality assurance system to ensure that:

- traceability exists;
- requirements that influence the product quality is controlled;
- the end-user can have confidence in the product quality.

A fuel quality declaration for the solid biofuel shall be issued by the supplier to the end-user or retailer. The fuel quality declaration shall be issued for each defined lot. The quantity of the lot shall be defined in the delivery agreement. The supplier shall date the declaration and keep the records for a minimum of 1 year after the delivery. The fuel quality declaration shall state the quality in accordance with EN 14961 (see example in Figure 2.7).

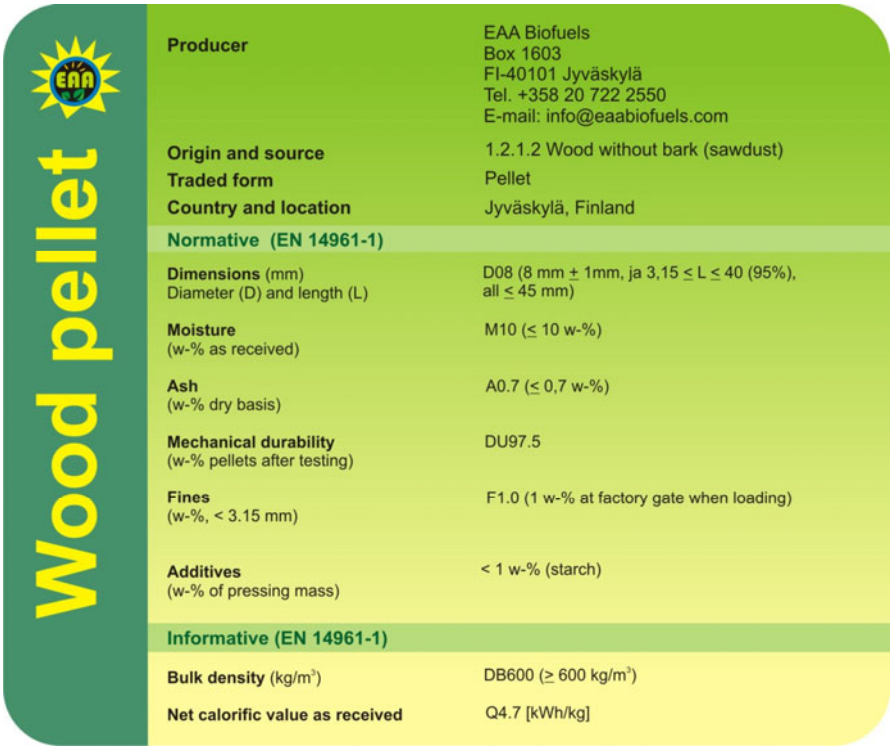

Figure 2.7 Example of quality declaration for wood pellets

Table 2.7 Specification of fuel properties according to EN 14961-1 for wood chips

	Wood chips – EN 14961-1	
Normative	Origin	1.1.1.1 Whole trees without roots (broadleaf)
	Particle size, P (mm)	P45A
	Ash, A (wt% of dry matter)	A1.5
Informative	Bulk density (BD) as received, kg/m^3 (loose)	BD250

The fuel quality declaration shall as a minimum include:

- supplier (body or enterprise) including contact information;
- a reference to EN 15234 – Fuel quality assurance;
- origin and source (according to appropriate part of EN 14961;
- country and location where the biomass is harvested or first traded as biofuel;
- traded form (*e.g.*, pellet);
- normative properties;
- chemical treatment if chemically treated biomass is traded;
- signature (by operational title or responsibility), name, date, and place.

The fuel quality declaration can be approved electronically. Signature and date can be approved by signing of the waybill or stamping of the packages in accordance with the appropriate part of EN 14961.

In Table 2.7 and Figure 2.8 there are examples of specification of wood chips and wood pellets.

Figure 2.8 Wood chips (*left*) and hog fuel (*right*)

2.5 Summary

CEN/TC 335 of Solid biofuels has published 27 technical specifications for solid biofuels and these are upgraded to EN-standards. The two most important are Fuel classification and specification [14] and Fuel quality assurance [23]. The classification of solid biofuels is based on their origin and source and biofuels are divided to four sub-categories: (1) Woody biomass, (2) Herbaceous biomass, (3) Fruit biomass, and (4) Blends and mixtures. The quality tables were prepared only for major traded forms. The classification is flexible, and this "free classification" does not bind different characteristics with each other.

The upgrading of the solid biofuels technical specifications is also supported by EU-funded projects. EUBIONET II has collected feedback from 47 market workers in Europe [4]. The FP6 project BioNorm II [1, 3] is carrying out pre-normative research for all technical specifications. Fuel classification and classes standards have been tested in BioNormII project by ten companies. Also, combustion tests [3, 15, 24, 25, 26] were carried out to support setting threshold values especially for product standards. The Phydades-project (www.phydades.info) is collecting property information of solid biofuels for Biodat-database and training laboratory staff for fuel analysis based on CEN methods.

Traders and fuel suppliers of pellets, wood chips, and hog fuel (Figure 2.8) to district heating and power stations have found the free classification system practical according to the studies of EUBIONET II [4]. Quality declaration is also used in pellet packages. More quality categories, in which properties are bound together and form a class, are used in conveyance from log wood traders and retailers to domestic consumers. The Committee CEN/TC 335 made a decision to prepare product standards for non-industrial use.

Part 1 of EN 14961 was published in 2010. The remaining five product standards are being drafted and are at the voting stage, with an expected publication date within 2010.

Appendix 1. Specification of Properties for Pellets (EN 14961-1) [14]

Table 2.8 Specification of properties for wood pellets

Normative

Master table	
Origin: According to Table 1 of EN 14961-1	Woody biomass (1), Herbaceous biomass (2), Fruit biomass (3), Blends and mixtures (4)
Traded Form	Pellets
Dimensions (mm)	Diameter (D) and Length (L)[a]
D06	6 mm ± 1.0 mm and 3.15 ≤ L ≤ 40 mm
D08	8 mm ± 1.0 mm, and 3.15 ≤ L ≤ 40 mm
D10	10 mm ± 1.0 mm, and 3.15 ≤ L ≤ 40 mm
D12	12 mm ± 1.0 mm, and 3.15 ≤ L ≤ 50 mm
D25	25 mm ± 1.0 mm, and 10 ≤ L ≤ 50 mm
Moisture, M (wt% as received)	Method: EN14774
M10	≤ 10 %
M15	≤ 15 %
Ash, A (wt% of dry basis)	Method: EN 14775
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%
Mechanical durability, DU (wt% of pellets after testing) Method: EN15210-1	
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 (wt%, < 3.15 mm) after production when loaded or packed[b] (EN 15149-1)	
F1.0	≤ 1.0%
F2.0	≤ 2.0%
F3.0	≤ 3.0%
F5.0	≤ 5.0%
F5.0+	> 5.0% (maximum value to be stated)
Additives (wt% of pressing mass)	
Type and content of pressing aids, slagging inhibitors or any other additives have to be stated	
Bulk density (BD) as received (kg/m^3) (Method: EN 15103)	
BD550	≥ 550 kg/m^3
BD600	≥ 600 kg/m^3
BD650	≥ 650 kg/m^3
BD700	≥ 700 kg/m^3
BD700+	> 700 kg/m^3 (minimum value to be stated)
Net calorific value as received, Q (MJ/kg or kWh/kg) (Method: EN 14918) Minimum value to be stated	

Specification of properties for wood pellets (*continued*)

Informative/Normative[d]	**Sulfur, S** (wt% of dry basis) (Method: EN15289)	
	S0.02	≤ 0.02%
	S0.05	≤ 0.05%
	S0.08	≤ 0.08%
	S0.10	≤ 0.10%
	S0.20	≤ 0.20%
	S0.20+	> 0.20% (maximum value to be stated)
	Nitrogen, N (wt% of dry basis) (Method: EN 15104)	
	N0.3	≤ 0.3%
	N0.5	≤ 0.5%
	N1.0	≤ 1.0%
	N2.0	≤ 2.0%
	N3.0	≤ 3.0%
	N3.0+	> 3.0% (maximum value to be stated)
Normative/Informative[d]	**Chlorine, Cl** (wt% of dry basis) (Method: EN15289)	
	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)
Informative	**Ash melting behavior** (°C)	Deformation temperature, DT should be stated (method: EN 15370-1)

[a] Amount of pellets longer than 40 (or 50 mm) can be 5 wt%. Maximum length for classes D06, D08 and D10 shall be < 45 mm

[b] Fines shall be determined by EN 15149-1

[c] The maximum amount of additive is 20 wt% of pressing mass. Type stated (*e.g.*, starch). If amount is greater, then raw material for pellet is blend

[d] Sulfur, nitrogen and chlorine are normative for the following biomass:
Chemically treated biomass (1.2.2; 1.3.2; 2.2.2; 3.2.2) or if sulfur containing additives have been used. Sulfur, nitrogen, and chlorine are informative for all fuels that are not chemically treated (see the exceptions above)

Note Special attention should be paid to the ash melting behavior for some biomass fuels, for example eucalyptus, poplar, short rotation coppice, straw, miscanthus, and olive stone

Appendix 2. Specification of Properties for Wood Chips (EN 14961-1) [14]

Table 2.9 Specification of properties for wood chips

	Master table			
	Origin:	According to Table 2.8	Woody biomass (1)	
	Traded Form	Wood chips		
	Dimensions (mm)	Method: EN 15149-1, sieves according ISO3310-1		
		Minimum 75 wt% in main fraction, mm[a]	Fines fraction, wt-% (< 3.15 mm)	Coarse fraction, wt%, max. length of particle, mm
Normative	P16A[c]	3.15 < P < 16 mm	< 12%	< 3% > 16 mm and all < 30 mm
	P16B[c]	3.15 < P < 16 mm	< 12%	< 3% > 45 mm and all < 120 mm
	P45A[c]	8 < P < 45 mm	< 8%[b]	< 6% > 63 mm and maximum 3.5% > 100 mm, all < 120 mm
	P45B[c]	8 < P < 45 mm[b]	< 8%[b]	< 6% > 63 mm and maximum 3.5% > 100 mm, all < 350 mm
	P63[c]	8 < P < 63 mm[b]	< 6%[b]	< 6% > 100 mm, all < 350 mm
	P100[c]	16 < P < 100 mm[b]	< 4%[b]	< 6 % > 200 mm, all < 350 mm

[a] The numerical values (P-class) for dimension refer to the particle sizes (at least 75 wt%) passing through the mentioned round hole sieve size (EN 15149-1). The cross sectional area of the over-sized particles shall be P16 < 1 cm², for P45 < 5 cm², for P63 < 10 cm² and P100 < 18 cm²

[b] For logging residue chips, which include thin particles like needles, leaves and branches, the main fraction for P45B is $3.15 \leq P \leq 45$ mm, for P63 is $3.15 \leq P \leq 63$ mm, and for P100 is $3.15 \leq P \leq 100$ mm and amount of fines (< 3.15 mm) can be maximum 25 wt%

[c] Property classes P16A, P16B, and P45A are for non-industrial and property class P45B, P63, and P100 for industrial appliances. In industrial classes P45B, P63, and P100 the amount of fines can be stated from the following F04, F06, F08

Specification of properties for wood chips (*continued*)

Normative	**Moisture content** (wt% as received)		Method EN 14774
	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)	
	Ash, A (wt% of dry basis)		Method: EN 14775
	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** (wt% of dry basis) (Method: EN 15104)		
	N0.3	≤0.3%	*Normative:*
	N0.5	≤0.5%	Chemically treated biomass (1.2.2; 1.3.2)
	N1.0	≤1.0%	*Informative:*
	N2.0	≤2.0%	All fuels that are not chemically treated
	N3.0	≤3.0%	(see the exceptions above)
	N3.0+	>3.0% (maximum value to be stated)	
	Chlorine, Cl (wt% of dry basis) (Method: EN15289)		
	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
	Cl0.10+	>0.10% (maximum value to be stated)	(see the exceptions above)
Informative	Net calorific value as received, Q (MJ/kg or kWh/kg) (Method: EN 14918)		
	Minimum value to be stated		
	Bulk density (BD) as received (kg/m^3) (Method: EN 15103)		
	BD150	>150	
	BD200	>200	
	BD250	>250	
	BD300	>300	
	BD350	>350	
	BD400	>400	
	BD450	>450	
	BD450+	>450 (minimum value to be stated)	
	Recommended to be stated if traded by volume basis		
	Ash melting behavior (°C) Method: EN 15370-1		
	Deformation temperature, DT should be stated		

Note Special attention should be paid to the ash melting behavior for some biomass fuels, for example eucalyptus, poplar, short rotation coppice.

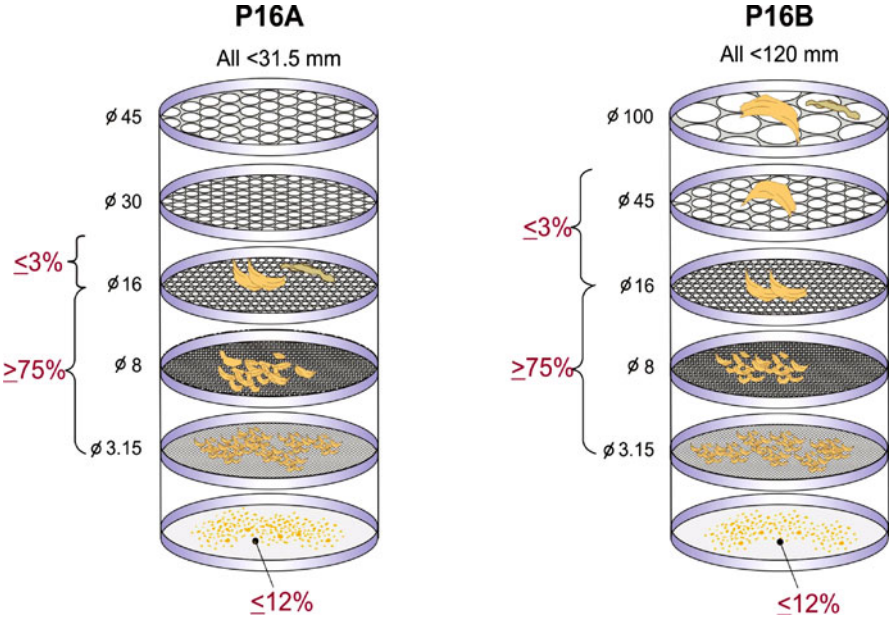

Figure 2.9 Particle size distribution for P16

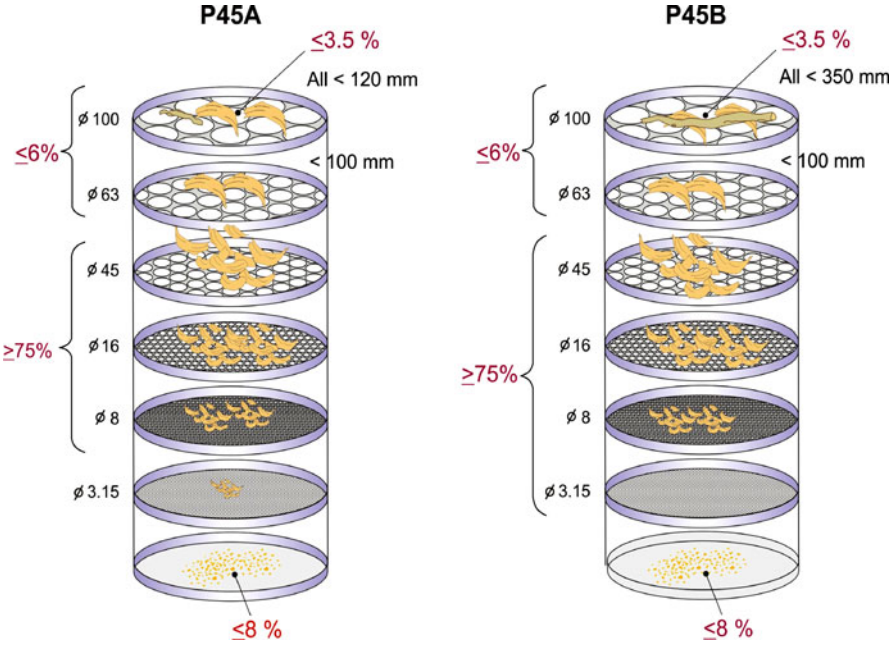

Figure 2.10 Particle size distribution for P45

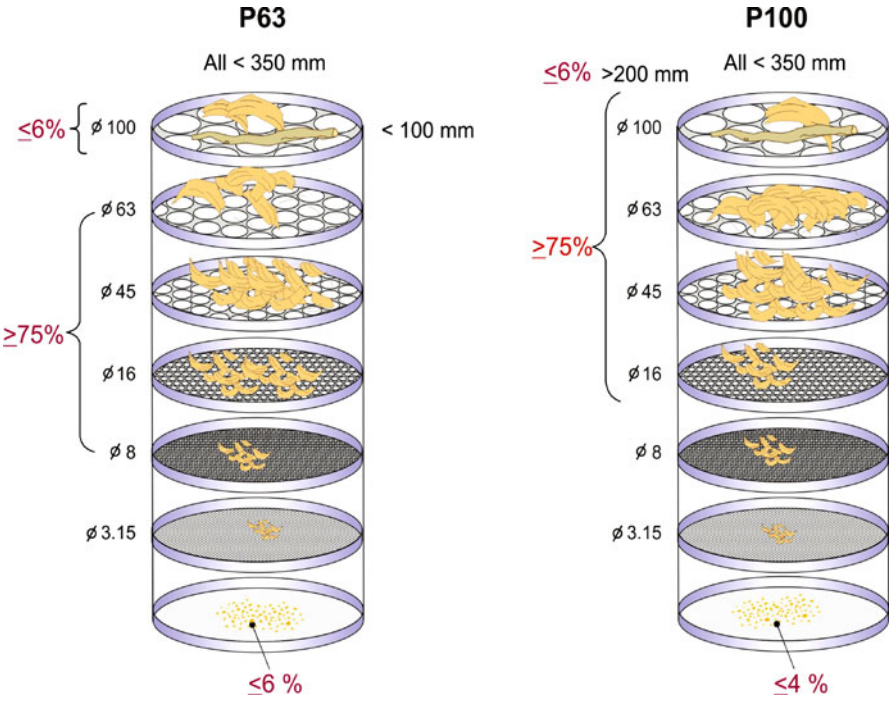

Figure 2.11 Particle size distribution for P63 and P100

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