



GA no 282826

Production of Solid Sustainable Energy Carriers from Biomass by Means of Torrefaction

Deliverable No. D8.6

General Material Safety Data Sheet

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Part I

1 Summary

This report deals with the development of a general material safety data sheet (MSDS) for torrefied biomass as fuel based on the Regulation (EC) No 1907/2006 of the European Parliament and of the Council [1]. It aims to highlight existing gaps in the knowledge about torrefied material. Therefore this deliverable consists of three parts:

- Part I: General description and additional information about the development of an MSDS.
- Part II: Detailed characterisation of the MSDS for torrefied biomass according to the requirements for the compilation of safety data sheets [1]. This includes consideration of the complete content and a full description of every section.
- Part III: Template made for MSDS users. Companies can use this template but have to modify it according to their own specific product. It shall ensure a safe and secure handling of torrefied biomass on the market including currently available scientific knowledge.

This document is the result of collaboration between members of the SECTOR project, supported by the International Biomass Torrefaction Council (IBTC).

The following information is supplied without liability and without legal obligation!

2 Introduction

Due to the thermo-chemical production process and its porous fine particle structure of torrefied biomass a safety data sheet (SDS)¹ is needed for distribution on the market. "Safety Data Sheets (SDS) should be produced for all substances and mixtures which meet the harmonized criteria for physical, health or environmental hazards under the GHS and for all mixtures which contain substances that meet the criteria for carcinogenic, toxic to reproduction or target organ systemic toxicity in concentrations exceeding the cut-off limits for SDS specified by the criteria for mixtures [...].The competent authority (CA) may also require SDS for mixtures not meeting the criteria for classification as hazardous but which contain hazardous substances in certain concentrations [...]. The CA may also require SDS for substances or mixtures that meet the criteria for classification as hazardous for non-GHS classes/end-points. An SDS is a well-accepted and effective method for the provision of information, and may be used to convey information for substances or mixtures that do not meet or are not included in the GHS classification criteria." [2] For that reason a document according to the European regulation (EC) No 1907/2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals, in further use abbreviated REACH, has been developed. According to the first preliminary remark "*the regulation should ensure a high level of protection of human health and the environment as well as the free movement*

¹ In the following also named as material safety data sheet (MSDS).

of substances², on their own, in mixtures³ and in articles⁴, while enhancing competitiveness and innovation. This Regulation should also promote the development of alternative methods for the assessment of hazards of substances.” [1]

3 Registration

Whether a registration under REACH for torrefied material is required cannot be determined unequivocally at the present time. The biomass feedstock does not require it, neither from lignocellulose plants nor from agriculture residues. By subjecting the biomass to a heat treatment in an oxygen deficient environment the resulting product is more comparable to coal, which is not under the obligation to register and is covered by the regulation in Annex V/7. The question is if the heat treatment can be considered as a chemical treatment or not (see Article 3/39), the torrefaction process tends to modify the natural occurring substance somewhat (see Article 3/40) by mainly removing water, and weakening the strength of the hemicellulose.

In spite of the question whether a registration is necessary or not, an MSDS facilitates safe trading between different countries and business partners. The present document provides a template for the independent development of an MSDS. Companies are expected to assume increased responsibility for the safe use of their products, where necessary. They must identify and manage the risks linked to the substances they manufacture and sell. Clear identification of the substance or mixture is a pre-condition to most of the REACH processes. If the substance or mixture has any hazards, no matter if it is from a chemical or natural compound, information on toxic effects concerning human-, physiochemical- or environmental hazards should be provided by the manufacturer or importer.

4 Methods

Safety Data Sheets have been made an integral part of the system of Regulation (EC) No 1907/2006. The original requirements of REACH for SDS have been further adapted to take into account the rules for safety data sheets of the Globally Harmonised System of Classification and Labelling of Chemicals and the implementation of other elements of the GHS into EU legislation that were introduced by Regulation (EC) No 1272/2008 (CLP Regulation) via an update to Annex II of REACH.

In part II of this document the requirements according to REACH and connected regulations are given and a suggestion how this possibly can be solved for already produced torrefied material regarding currently available scientific knowledge. As a guideline the requirements for the compilation of safety data sheets (see Annex II, [1]) is used. You find an explanation

² Substance “means a chemical element and its compounds in the natural state or obtained by any manufacturing process, including any additive necessary to preserve its stability and any impurity deriving from the process used, but excluding any solvent which may be separated without affecting the stability of the substance or changing its composition” (see Article 3(1), [1])

³ Mixture „means a mixture or solution composed of two or more substances“ (see Article 3(2), [1])

⁴ Article „means an object which during production is given a special shape, surface or design which determines its function to a greater degree than does its chemical composition” (see Article 3(3), [1])

under each section what is based on annex II, [1]. Information on specific points of each section is given, too, where appropriate and necessary. According to the definitions of substances, mixtures and articles torrefied biomass has to be assigned to the term substance. Because of that the following explanations will mainly consider issues in regard to substances.

ATTENTION: Please check annex II of the REACH regulation for additional information related to each section!

The suggestion for an individual MSDS is given in part III of this document. That version comprises necessary information and gives decision suggestions for potential MSDS users to adapt it on their product. There is no legal obligation on the correctness of the given information.

Solving the requirements is based on the outcome of the SECTOR project, most parts from WP6 and WP8, information from the European wide available REACH-HELPDESK websites and others.

Part II

5 MSDS

Material Safety Data Sheet for Torrefied Biomass	Author: SECTOR Project Date of preparation: 22th Dec 2014 Version: 2.0 Pages:
According to Regulation (EC) No. 1907/2006 (REACH)	

SECTION 1 — IDENTIFICATION OF THE SUBSTANCE/MIXTURE AND OF THE COMPANY/UNDERTAKING

1.1 Identification of the substance or preparation

Product Identifier: Carbon [C]

CAS Number: 7440-44-0

Product name: Torrefied biomass, torrefied lignocellulosic biomass, torrefied wood in form of, pellets or briquettes

Synonyms: Biocoal, torrefied pellets or black pellets (in pressed form)

Product description: Thermally treated biomass from wood or non-woody biomass

Appearance: Depending on feedstock and torrefaction process, the treated biomass appears as brownish to black. For transport and handling reasons it is densified it in form of pellets or briquettes.

REACH Registration Code: Not applicable

1.2 Product use

Sustainable energy source and fuel for conversion to energy in power plants (e.g. in power plants or CHP plants)

1.3 Details of the supplier of the safety data sheet

Street Address:

City:

Postal Code:

Province:

Non-Emergency assistance:

1.4 Emergency telephone

Emergency Contact: (phone number, name, office hours)

Official advisory body:

Explanation:

This chapter obtains information about the identification of the substance or mixture, its relevant use, details about the supplier as well as an emergency contact.

1.1: According to Annex II of the REACH regulation the term used for the identification shall be provided in accordance with Article 18(2) of Regulation (EC) No 1272/2008 or if the substance/mixture has to be registered the term shall be the same as under registration. Other means of identification available may also be indicated.

Because of the fact that torrefied biomass is a relative new fuel and still in a developing stage, only a very few torrefaction plants can be assigned to commercial stage, it is either included in Part 3 of Annex VI of Regulation (EC) No 1272/2008 nor included in the classification and labelling inventory of the CLP Regulation. Besides no CAS number can be assigned to torrefied biomass and no name is set out in the IUPAC Nomenclature. At the moment a REACH registration code is not available, too.

➔ Currently a product identifier for torrefied biomass does not exist, while it does exist for charcoal, for example.

Carbon is the main component of torrefied biomass. In case that this product identifier applies to torrefied biomass, the appropriate CAS Number for carbon is 7440-44-0 [3] according to the Classification & Labelling (C&L) Inventory.

1.2 The most common use shall be described including a brief description of what it actually does (e.g. flammable).

1.3 The supplier (importer, manufacturer, only representative, downstream user or distributor) has to be identified. Therefore give the full address and phone number of the person responsible for placing the substance or mixture on the market as well as an e-mail address for a person who is responsible for the safety data sheet.

1.4 Provide additional information and emergency telephone number.

SECTION 2 — HAZARDS IDENTIFICATION

According to the legislation of the European Union, the torrefied biomass is not classified as hazardous. Upon handling torrefied biomass could emit dust and/or gaseous substances, although torrefied material is expected to be less vulnerable with respect to biological degradation than untreated biomass.

2.1 Classification of the substance or mixture

Fire and Explosive Risk

- May be ignited by friction, heat, sparks or flames
- Powders, dusts or shavings, may explode or burn with explosive violence
- May re-ignite after fire is extinguished

Low Oxygen Risk

- Ventilate before entry
- Always measure carbon monoxide and oxygen content in enclosed areas

Potential Health Effects





Skin: May cause irritations to the skin (redness, scaling, itching)

Eyes: May cause irritations to the eyes (tearing, burning)

Ingestion: May cause gastrointestinal irritations (not applicable with normal use)

Inhalation: May cause irritations to the respiratory system (irritation to the lungs and mucous membrane)

2.2 Label elements

Hazard Statement	H315: Causes skin irritation	H319: Causes serious eye irritation	H335: May cause respiratory irritation	H251: Self-heating: may catch fire
GHS Pictograms				
Signal Word	Warning	Warning	Warning	Danger
Precautionary Statement Prevention	P264 P280	P264 P280	P261 P271	P235 + P410 P280
Precautionary Statement Response	P302+P352 P321 P332+P313 P362	P305+P351+ P338 P337 + P313	P304+P340 P312	
Precautionary Statement Storage			P403+P233 P405	P407 P413 P420
Precautionary Statement Disposal			P501	

2.3 Other hazards

Fire/explosion risk:

- Concentrated dust may present an explosion hazard

The product is not on the list of persistent, bio accumulative and toxic (PBT) or very persistent and very bio accumulative (vPvB) substances.

Explanation:

In this chapter potential risks shall be named and evaluated. Describe the most important adverse physiochemical, human health and environmental effects and symptoms relating to the uses and possible misuses the substance or preparation that can reasonably be foreseen.

2.1 The classification of the substance or mixture arises from the application of the classification rules in Regulation (EC) No 1272/2008. Additionally the classification of the substance according to Directive 67/548/EEC (replaced by Regulation (EC) No 1272/2008 from 1 June 2015) shall be given, too.

In (20) of Regulation (EC) No 1272/2008 it is stated that “while a manufacturer, importer or downstream user of any substance or mixture should not be obliged to generate new toxicological or eco-toxicological data for the purpose of classification, he should identify all relevant information available to him on the hazards of the substance or mixture and evaluate its quality. The manufacturer, importer or downstream user should also take into account historical human data, such as epidemiological studies on exposed populations, accidental or occupational exposure and effect data, and clinical studies. [...]”

As already mentioned in 1.1 torrefied biomass is not classified in the CLP Regulation. Because of that the data are based on available information, obtained from the SECTOR project as well as from experiences and knowledge collected from different experts. 2.2 Label Elements shall be provided according to the classification. This includes in accordance with Regulation (EC) No 1272/2008 at least: hazard pictogram(s), signal word(s), hazard statement(s) and precautionary statement(s).

By now potential health effects of torrefied biomass have never been correctly and comprehensively mapped. Thus in future these effects have to be determined (among others) based on dust exposure particularly during handling.

The table shows label elements [2] which can be allocated to torrefied biomass, but due to the missing classification no integrity can be given.

2.3 Additional to information on other hazards which do not result in classification it shall be stated if the substance meets the criteria for PBT or vPvB in accordance with Annex XIII of Regulation (EC) No 1272/2008.

SECTION 3 — COMPOSITION/INFORMATION ON INGREDIENTS

Product composition originates from woody or other lignocellulosic biomass. The product is thermally treated at a temperature of 200-300°C in an oxygen deficient environment.

Explanation:

Section 3 shall describe the identity of the ingredient(s) of the substance, including impurities and stabilising additives. Safety information shall be also given if appropriate and available.

The temperature range of the torrefaction process differs in dependence on different sources. The temperature range given above is taken from ISO 16559 [4].

▪ SECTION 4 — FIRST AID MEASURES

4.1 Description of first aid measures

General

- Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

Eye Contact

- Flush eyes with running water for at least 15 minutes.

Skin Contact

- Flush skin with running water.
- Wash clothing before reuse.

Ingestion

- Wash mouth with water.
- Get medical aid.

Inhalation

- Move victim to fresh air and call emergency medical service.
- Give artificial respiration if victim is not breathing.
- Administer oxygen if breathing is difficult.
- Keep victim warm and quiet.

4.2 Most important symptoms and effects, both acute and delayed

Eye contact: Tearing, burning

Skin contact: Irritation, redness, scaling, itching

Ingestion: Possible nausea and/or vomiting

Dust inhalation: Irritation to the lungs and mucus membrane

There are no known chronic effects of exposure to the product to date. Heat treated wood is not listed by NTP, IARC or regulated as a carcinogen by OSHA.

4.3 Indication of any immediate medical attention and special treatment needed

There are no other measures needed than mentioned in section 4.1.

Explanation:

This section shall describe the initial care and health measures that can be given by untrained personnel without the use of sophisticated equipment as well as most important symptoms and effects. The information on first aid measures and symptoms shall be brief and easy to understand and given in such a way that an untrained responder is able to give first aid without the use of sophisticated equipment and without the availability of special

medications. It should indicate whether professional assistance by a doctor is needed or advisable.

4.1 First aid measures relevant to specific subdivisions, such as inhalation, skin, eye and ingestion, shall be given.

4.2 Information on the most important symptoms and effects from exposure, both acute and delayed, shall be summarized.

4.3 In this subsection information on any clinical testing and medical monitoring for delayed effects, specific details on antidotes and contraindications and specific and immediate treatment shall be provided, where appropriate.

The results were taken from pre-tests with torrefied material and the experience gained from coal and wood because of their similarity to torrefied material.

▪ SECTION 5 — FIRE FIGHTING MEASURES

5.1 Extinguishing media

Use over measure water spray or dry chemical powder.

5.2 Special hazards arising from the substance or mixture

Explosion Risk: In case of concentrated airborne product keep at distance.

Flammable Class: Flammable at high temperatures, combustible. Will help to sustain a fire.

General Hazard: Evacuate personnel downwind of fire to avoid inhalation of irritating and/or harmful fumes and smoke.

Hazard combustion products: Carbon monoxide and carbon dioxide.

Sensitive of static discharge: When pneumatically transported, static discharge may occur.

5.3 Advice for fire fighters

Fire-fighting procedure: Use water to wet down dust to prevent generation of dust clouds. Remove burned or wet wood dust to an open area after fire is extinguished.

Fire-fighting equipment: Respiratory and eye protection are required for fire-fighting personnel. Full protective equipment (Bunker gear) and self-contained breathing apparatus should be used for all indoor fires and any significant outdoor fires.

Explanation:

This section shall detail the measures for fighting a fire caused by the substance, or arising in its vicinity.

5.1 Information on the appropriate extinguishing media as well as information on inappropriate extinguishing media shall be provided.

5.2 Hazards which may arise from the substance shall be mentioned.

5.3 Advice shall be given on protective actions during firefighting.

The results were taken from pre-tests with torrefied material and the experience gained from coal and wood because of their similarity to torrefied material.

▪ SECTION 6 — ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures

- Remove all sources of ignition.
- Respiratory, skin and eye protection are required for personnel.
- Use water to wet down dust to prevent generation of dust clouds.
- In case of concentrated airborne product, keep at distance.
- Always measure carbon monoxide and oxygen in enclosed areas.

6.2 Environmental precautions

- Pick up and arrange disposal without creating dust.

6.3 Methods and material for containment and cleaning up

- Any method and material used should avoid creating dust and ignition.

6.4 Reference to other sections

- Not applicable

Explanation:

This section shall give instructions for the right behaviour and measures in case of spills, leaks or releases, to prevent or restrict the adverse effects on persons, property and the environment.

6.1 For non-emergency personnel advice shall be provided regarding accidental spills and release of the substance and for emergency responder appropriate clothing shall be mentioned.

6.2 Advice shall be given for any environmental precautions.

6.3 Advice shall be given on how to contain a spill and how to clean up a spill. Additionally any other information shall be provided relating to spills and releases.

6.4 If appropriate sections 8 and 13 shall be referred to.

▪ SECTION 7 — HANDLING AND STORAGE

7.1 Precautions for safe handling

- Handle in accordance with good industrial hygiene and safety practice.
- Avoid dust formation.
- Ensure adequate ventilation.
- Wash thoroughly after handling.

7.2 Conditions for safe storage, including and incompatibilities

- Store in a well-ventilated area. Oxygen depletion and carbon monoxide emission can occur when material is stored in a confined space.
- Keep away from heat, sparks, flame or other sources of ignition.
- Keep away from strong oxidizing agents.
- Ventilate before entry.

➤ Always measure carbon monoxide and temperature in enclosed areas.

7.3 Specific end use(s)

See section 7.1 and 7.2. No other recommendations.

Explanation:

Safe handling practices are subject of this section. It shall identify precautions that are appropriate to the identified uses referred to under subsection 1.2 and to the specific properties of the substance.

7.1 Recommendations for safe handling shall be specified. Torrefied biomass tends to dust formation and emitting of gaseous substances. Therefore appropriate precautions have to be made.

7.2 Consistency with the physical and chemical properties described in section 9 is the basis for the advices given in 7.2.

7.3 Substances, which are designed for specific end use(s), detailed and operational recommendations related to the identified use(s) referred to in subsection 1.2 shall be given. References to an available exposure scenario and/or industry or sector specific guidance may be made.

▪ SECTION 8 — EXPOSURE CONTROL/PERSONAL PROTECTION

8.1 Control parameters

Because the product is new and still under development there are no national exposure limit values to date. Because of the fact that the main exposure problems might be expected from the exposure to the product dust, until reliable values for the product become available, known values for general dust nuisance are given instead.

- Threshold limit value, time weighted average (TLV-TWA): 10 mg/m³ (general dust nuisance)
- Permissible Exposure Limit: 10 mg/m³ (as dust)
- European Union professional exposure limit: 3 mg/m³ (as dust)

8.2 Exposure controls

Engineering controls

If user operations generate dust, make use of explosion proof equipment and ventilation equipment to assure airborne levels are below established exposure limits.

Personal Protective Equipment

Eyes protection: Wear safety glasses or safety goggles.

Skin protection: Where contact is likely wear protective gloves (nitrile rubber recommended).

Respiratory protection: Wear dusk mask (P2 filter) during handling.

Work hygienic practices: Clothing with long sleeves or an overall and protective skin cream or gloves increase personal hygiene contact with the material.

Explanation:

Applicable occupational exposure limits and necessary risk management measures shall be mentioned in this section.

8.1 National limit values and their legal basis, which are currently applicable in the member state in which the MSDS is being provided, shall be given here.

8.2 Appropriate exposure control measures shall relate to the identified use(s) of the substance as referred to in subsection 1.2. The given information shall enable the employer to carry out an assessment of risk to the safety and health of workers who are in contact with the substance or have to handle it. This subsection shall be complement with the information already given under section 7.

▪ **SECTION 9 — PHYSICAL AND CHEMICAL PROPERTIES**

9.1 Info on basic physical and chemical properties

Appearance: Solid, brown/black coloured

Colour: dark brown to black grainy material

Odour: light scorch (charred wood smell)

Odour threshold: Not determined

pH-Value: Not applicable, solid in normal use

Melting/freezing Point: Not applicable, solid in normal use

Initial boiling Point/range: Not applicable, solid in normal use

Flash Point: Not applicable, solid in normal use

Evaporation rate: Not applicable, solid in normal use

Flammability: Not determined

Vapour pressure: Not applicable, solid in normal use

Vapour density: Not applicable, solid in normal use

Relative density: 1000-1200 kg/m³

Solubility (water): Only volatile organic constituents are partly soluble in water

Partition coefficient: Not applicable, solid in normal use

Decomposition temperature: Not applicable, solid in normal use

Viscosity: Not applicable, solid in normal use

Auto-Ignition Temperature (layer): Has to be evaluated

Auto-Ignition Temperature (cloud): Has to be evaluated

Minimum Ignition Energy: Has to be evaluated

9.2 Other information

Product Density (at 20°C): 200 – 300 kg/m³ for chips, 600 – 800 kg/m³ for pellets

Bulk Density (at 20°C): 180 – 300 kg/m³ for chips, 600 – 800 kg/m³ for pellets

Explanation:

Section 9 shall describe the empirical data relating to the substance. The given information shall be consistent with the information in the registration and /or chemical safety report and with the classification of the substance, if available.

9.1 The above mentioned properties shall be clearly identified including, where appropriate, additional information on the test methods, on specification of appropriate units of measurement and/or reference conditions and, if relevant, the method of determination shall also be provided. If a specific property does not apply or information on a specific property is not available, the reasons shall be given.

Sufficient data on auto-ignition temperatures and minimum ignition energy are not available to date because of the big variety of different kind of feedstock for torrefied biomass. Extensive testing is needed to get a profound database on the ignition behaviour of torrefied material.

9.2 If necessary other physical and chemical properties shall be mentioned.

SECTION 10 – STABILITY AND REACTIVITY**10.1 Reactivity**

In contact with air, the product absorbs oxygen and could emit carbon monoxide, carbon dioxide and small levels of methane, these emissions typically decrease in time.

Conditions of Instability:

Higher temperature accelerates product decomposition. Moisture content accelerates product decomposition.

10.2 Chemical stability

The product is stable under ambient conditions of temperature and pressure.

10.3 Possibility of hazardous reactions

Not applicable.

10.4 Conditions to avoid

Avoid dust formation, heat, flames and sparks.

10.5 Incompatible materials

Strong oxidizing agents.

10.6 Hazardous decomposition products

Carbon monoxide, carbon dioxide, small levels of methane and other hydrocarbons.

Explanation:

This section is about the description of stability of the substance and possible hazardous reactions as a result of the use under certain conditions and of a release into the environment. In case a particular property does not apply or specific information is not available, the reasons shall be mentioned.

10.1 Here the reactivity hazards shall be described. Either specific test data for the substance or general data for the class or family of substance may be used. The extent of product decomposition depending on temperature and moisture content still has to be evaluated.

10.2 It shall be stated if the substance is stable under normal conditions of temperature and pressure.

10.3 If the substance will react or polymerise, releasing excess pressure or heat or creating other hazardous conditions, this shall be mentioned here, as well as the conditions which are required for that behaviour.

10.4 Conditions that may be resulting in a hazardous situation shall be listed and briefly described.

10.5 Families of substances or mixtures with which the substance could react with the result of a hazardous situation shall be stated as well as a brief description of measures to be taken to reduce risks shall be given, if appropriate.

10.6 Hazardous decomposition products generated as a result of use, storage, heating and spill shall be mentioned.

SECTION 11 – TOXICOLOGICAL INFORMATION**11.1 Information on toxicological effects**

Acute toxicity: There is no evidence to date that the product is of acute toxicological nature.

Skin corrosion/irritation: May cause skin irritation.

Serious eye damage/irritation: May cause eye irritation.

Respiratory or skin sensitisation: Is possible.

Germ cell mutagenicity: There is no evidence to date that the product is of acute toxicological nature.

Carcinogenicity: There is no evidence to date that the product is of acute toxicological nature.

Reproductive toxicity: There is no evidence to date that the product is of acute toxicological nature.

STOT-single exposure: May cause respiratory tract or skin irritation.

STOT-repeated exposure: May cause respiratory or skin irritation.

Aspiration hazard: May cause respiratory tract irritation.

Thermally treated wood is not listed by IARC, NTP and OSHA to be carcinogenic or reproductive toxic.

Effects on eyes: Not determined.

Effects through inhalation: Not determined.

Effects through ingestion: Not determined.

Effects on skin: Not determined.

Irritation of the eyes, skin and respiratory system is possible after exposure to low levels of dust, created during the handling of the product. There is no information available on the effects of exposure to higher levels of product dust or chronic effects of prolonged exposure.

Explanation:

Section 11 is primarily meant to be used by medical professionals, occupational health and safety professionals and toxicologists. The given information on toxicological (health) effects and the available data used to identify those effects shall be complete and comprehensible and consistent with the information provided in the registration and/or in the chemical safety report as well as with the classification of the substance, if available.

11.1 Information on relevant hazard classes, differentiations or effects (see above) shall be provided. If there is no information it shall be clearly stated whether this is due to lack of data, technical impossibility to obtain the data, inconclusive data or data which are conclusive although insufficient for classification.

Information on effects of exposure (ingestion, inhalation, skin/eyes) and all other relevant information on adverse health effects shall be stated.

Where statements about many toxicological effects can be made, the effects on eyes, skin, through inhalation and ingestion still has to be evaluated in detail. Detailed testing is suggested to collect information on the toxicological effects of torrefied biomass in general.

▪ SECTION 12 – ECOLOGICAL INFORMATION

12.1 Toxicity

There are no experimental ecological data on the toxicity of the product available to date.

12.2 Persistence and degradability

The persistence of the product in the environment is limited due to the biodegradable nature of the product.

12.3 Bio accumulative potential

There are no experimental ecological data on the bio accumulative potential of the product available to date.

12.4 Mobility in soil

Because of the solid nature of the product the mobility will be limited.

12.5 Results of PBT and vPvB assessment

Not applicable, because no chemical safety report is required to date.

12.6 Other adverse effects

No known other adverse effects.

Explanation:

This section shall give information on evaluation of environmental impact of the substance where it is released to the environment. A short summary of available data shall be provided as well as additional test data, media, units, clearly indicating species, test conditions and duration, if relevant. In case that a specific property does not apply or is not available, the reasons shall be indicated.

12.1 Issue of this subsection the toxicity using data from tests performed on aquatic and/or terrestrial organisms when available (aquatic toxicity, both acute and chronic for fish, crustaceans, algae and other aquatic plants) as well as toxicity data on soil micro and macro organisms and other environmental relevant organisms. Possible impact on sewage treatment plants shall be given, too. Only the slightly present volatile organic constituents are partly soluble in water and lead to a bit of (temporary) discoloration. This is unlikely to cause harm to the environment, since these substances are biodegradable. But experimental ecological data on the toxicity has to be made to confirm these assumptions.

12.2 Test results on the potential for the substance to degrade in the environment (through biodegradation, oxidation or hydrolysis) shall be given here, if available. Damage to the environment is not to be expected due to the biodegradability of torrefied material. At this moment there is no experimental determined ecological information available.

12.3 The potential of the substance to accumulate in biota and pass through the food chain, finally, is considered in this subsection.

12.4 The potential of the substance to move under natural forces to the groundwater or to a distance from the site of release, if released to the environment, shall be given where available.

12.5 Results of the PBT and vPvB assessment as made in the chemical safety report, where it is required, shall be given.

12.6 If available information on any other adverse effects shall be mentioned, e.g. ozone depletion potential.

SECTION 13 – DIPOSAL CONSIDERATIONS

13.1 Waste treatment methods

General:

Refers to section 6 for additional information.

Disposal Comment:

Dispose of waste at an appropriate waste disposal facility, according to current applicable laws and regulations.

Explanation:

Section 13 shall describe information for adequate waste management of the substance

13.1 Issues of this subsection are waste treatment containers and methods, physical/chemical properties that may affect waste treatment options, sewage disposal and the identification of any special precautions for waste treatment.

SECTION 14 – TRANSPORT INFORMATION

This material is not yet tested and/or classified under IMO dangerous goods. The product is not flammable or self-igniting when transported dry under normal conditions of transport. But the product is combustible and sustains a fire.

14.1 UN number

UN number: Not applicable

14.2 UN proper shipping name

UN proper shipping name: (resulting from UN number)

14.3 Transport hazard class(es)

RID/ADR-Class: (resulting from UN number)

14.4 Packing group

Packing group: (resulting from UN number)

14.5 Environmental hazards

This material is not yet tested and/or classified under IMO dangerous goods.

Symbols: Low oxygen risk area, no smoking, EX-area

CAS Number: See section 1

EINECS Number: 231-153-3

RID/ADR Class: (resulting from UN Number)

ADNR Class: Not applicable

IMDG Class: Not applicable

ICAO/IATA Class: Not applicable

14.6 Special precautions for user

The product is not flammable or self-igniting when transported dry under normal conditions of transport. But the product is combustible and sustains fire.

14.7 Transport in bulk according to Annex II of MARPOL 73/78 and IBC Code

-

Explanation:

Basic classification information for transport/shipment of substances shall be given in this section. Where information is not relevant or available this shall be stated. Because of a missing REACH registration of torrefied biomass, this section cannot be completed with the necessary information due to date.

14.1 The UN number from the UN Model Regulations⁵ shall be given. The UN number for carbon of animal or vegetable origin is 1361 [3]. Because of thermochemical treatment of biomass, what determines the torrefaction process, it cannot be stated that this UN number applies to torrefied biomass. As long as there is no classification of torrefied biomass no clear indication of the following subsections relating to torrefied biomass can be given.

14.2 Unless it has appeared as the product identifier in subsection 1.1, the UN proper shipping name from the UN Model Regulations shall be given.

14.3 The transport hazard class assigned to the substance in accordance with the UN Model Regulations shall be provided.

14.4 The packing group number from the UN Model Regulations shall be provided, if applicable.

14.5 If the substance is environmentally hazardous according to the criteria of the UN Model Regulations (as reflected in the IMDG Code, ADR, RID and AND) and/or a marine pollutant according to the IMDG Code, this shall be stated. The given EINECS number 231-153-3 is related to the CAS number of carbon (see section 1) [3].

14.6 Information on any special precautions for a safe transport or conveyance either within or outside of the users' premises shall be provided.

14.7 This subsection is only needed when cargoes are intended to be carried in bulk.

▪ SECTION 15 – REGULATORY INFORMATION

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

EUROPEAN COMMUNITY EEC LABEL AND CLASSIFICATION

R(isk) Phrases:

R 36/37 Irritating to eyes and respiratory system

R 38 Irritating to skin

S(afety) Phrases

S 16 Keep away from ignition sources – do not smoke

S 22 Avoid breathing dust

S 24/25 Avoid contact with skin or eyes

S 26 In case of contact with eyes, rinse immediately with plenty of water and seek medical advice

15.2 Chemical Safety Assessment

A Chemical Safety Assessment according to EC 1907/2006 has not been done.

⁵ UN Model Regulations means the Model Regulations annexed to the most recently revised edition of the Recommendations on the Transport of Dangerous Goods published by the United Nations [5].

Explanation:

Other regulatory information that is not already provided elsewhere in the safety data sheet shall be described in this section.

15.1 Any relevant national and/or regional information on the regulatory status of the substance regarding relevant safety, health and environmental issues shall be mentioned. R(isk) and S(afety) Phrases are defined in Annex III and IV of European Union Directive 67/548/EEC.

15.2 It shall be stated if a chemical safety assessment has been made for the substance by the supplier.

SECTION 16 – OTHER INFORMATION**Abbreviations**

CAS: Chemical Abstract Service registration number.

EINECS: European Inventory of Existing Commercial Substances.

UN: Substance identification number is a four digit number that identifies a hazardous substance during transport.

ADNR: European Agreement regarding the International Carriage of Dangerous Goods by Inland Waterways.

ICAO/IATA: International Civil Aviation Organization, International Air Transport Organization.

IARC: International Agency for Research on Cancer

IMDG: International Maritime Code for Hazardous Goods mg/m³ Milligram per cubic meter.

IMO: International Maritime Organization

NTP: National Toxicology Program

OSHA: Occupational Health and Safety Administration

PBT: Persistent, Bioaccumulative and Toxic substance

RID/ADR: European Agreement concerning the International Carriage of Dangerous Goods by Rail (RID) and by Road (ADR).

STOT: Specific Target Organ Toxicity

TLV-TWA: Threshold Limit Value, Time Weighted Average

vPvB: Very Persistent and Very Bioaccumulative substance

Above mentioned information, recommendations and suggestions concerning this product are up to date and taken from sources or based upon data believed to be reliable and reasonable care has been taken in the preparation of this information.

Explanation:

Information that is not mentioned in section 1 to 15 as well as information relevant to the compilation of the safety data sheet shall be indicated in section 16. These are e.g. a clear indication of where changes have been made to a previous version of the safety data sheet, a legend to abbreviations and acronyms used in the safety data sheet and key literature references and sources for data.

6 Conclusion

Torrefied biomass is, due to its missing broad commercial use, in the main still in a stage of development regarding its production technology and its optimal feedstock and process parameters. Currently first commercial plants enter the market with torrefied wood pellets. Against this background a possibly needed REACH registration has not been done yet. Because of the missing classification several issues still have to be examined what is mainly due to a broad range of appropriate feedstock. Studies on different issues, e.g. toxicological information, have to be made in future to collect a broad database for a potential classification and registration of torrefied biomass to accomplish the requirements given by REACH.

Information given in this MSDS is partial based on experiences and empirical values gained by dealing with torrefied material within and beyond the SECTOR project. In accordance with 0.2.3 of annex II of the REACH regulation to “take into account the specific needs and knowledge of the user audience”, a round of experts from several companies and institutions (e.g. Topell Energy, ECN, CENER, OFI, AEBIOM) discussed the sections to collect profound knowledge to ensure the protection of human health and safety at the workplace as well as the protection of the environment.

Altogether it can be stated that despite some open questions a safety data sheet for torrefied biomass can be generated by the use of the available knowledge to ensure an SDS with the required information in most parts.

Part III





7 MSDS for torrefied biomass (template)

Part III offers a template for an MSDS for torrefied biomass according to Regulation (EC) No. 1907/2006 to be used by potential producers of this product. It gives advice what parameters to choose and which sections still have to be kept up to date. For the right use take the left column and change it to your specific product characteristics according to the comments given in the right column. In the midterm it is expected that a solution regarding the registration and classification issue will be found. Thus every potential MSDS user has to be up to date regarding latest information on registration and classification status of torrefied biomass. If the MSDS is revised changes shall be brought to attention in section 16, unless they have been stated elsewhere.

Material Safety Data Sheet for Torrefied Biomass	Author: Date of preparation: Version number: (Revision number): Pages:	Comments for user
According to Regulation (EC) No. 1907/2006 (REACH)		- Add author, date of preparation, version number, revision number and number of pages
<p>SECTION 1 — IDENTIFICATION OF THE SUBSTANCE/MIXTURE AND OF THE COMPANY/UNDERTAKING</p> <p>1.1 Identification of the substance or preparation</p> <p>Product Identifier: Carbon [C] CAS Number: 7440-44-0 Product name: Torrefied biomass, torrefied lignocellulosic biomass, torrefied wood in form of, pellets or briquettes Synonyms: Biocoal, torrefied pellets or black pellets (in pressed form) Product description: Thermally treated biomass from wood or non-woody biomass Appearance: Depending on feedstock and torrefaction process, the treated biomass appears as brownish to black. For transport and handling reasons it is densified in form of pellets or briquettes. REACH Registration Code: Not applicable</p>		<p>- As long as a specific CAS number for torrefied biomass is available, exchange numbers</p> <p>- Select the appropriate product name & synonyms</p> <p>- If applicable to your product, select appropriate appearance according to ISO 17225-8 or ISO 17225-1</p> <p>- Add REACH Registration Code, if available</p>

<p>1.2 Product use</p> <p>Sustainable energy source and fuel for conversion to energy (e.g. in power plants or CHP plants)</p>	<p>- Indicate appropriate product use</p>
<p>1.3 Details of the supplier of the safety data sheet</p> <p>Street Address: City: Postal Code: Province: Non-Emergency assistance:</p>	<p>- Add details</p>
<p>1.4 Emergency telephone</p> <p>Emergency Contact: (phone number, name, office hours) Official advisory body:</p>	<p>- Add emergency telephone</p>
<p>SECTION 2 — HAZARDS IDENTIFICATION</p>	
<p>According to the legislation of the European Union, the torrefied biomass is not classified as hazardous. Due to the normal biodegradation of biomass, torrefied biomass material emits dust and gaseous substances.</p>	
<p>2.1 Classification of the substance or mixture</p>	
<p>Fire and Explosive Risk</p>	
<ul style="list-style-type: none"> ➤ May be ignited by friction, heat, sparks or flames ➤ Powders, dusts or shavings, may explode or burn with explosive violence ➤ May re-ignite after fire is extinguished 	
<p>Low Oxygen Risk</p>	
<ul style="list-style-type: none"> ➤ Ventilate before entry ➤ Always measure carbon monoxide and oxygen content in enclosed areas 	
<p>Potential Health Effects</p>	
<p>Skin: May cause irritations to the skin (Redness, scaling, itching)</p>	
<p>Eyes: May cause irritations to the eyes (tearing, burning)</p>	
<p>Ingestion: May cause gastrointestinal irritations (not applicable with normal use)</p>	
<p>Inhalation: May cause irritations to the respiratory system (Irritation to the lungs and mucous membrane)</p>	

2.2 Label elements

Hazard Statement	H315: Causes skin irritation	H319: Causes serious eye irritation	H335: May cause respiratory irritation	H251: Self-heating: may catch fire
GHS Pictograms				
Signal Word	Warning	Warning	Warning	Danger
Precautionary Statement Prevention	P264 P280	P264 P280	P261 P271	P235 + P410 P280
Precautionary Statement Response	P302+P352 P321 P332+P313 P362	P305+P351+ P338 P337 + P313	P304+P340 P312	
Precautionary Statement Storage			P403+P233 P405	P407 P413 P420
Precautionary Statement Disposal			P501	

2.3 Other hazards

Fire/explosion risk:

- Concentrated dust may present an explosion hazard

The product is not on the list of persistent, bio accumulative and toxic (PBT) or very persistent and very bio accumulative (vPvB) substances.

SECTION 3 — COMPOSITION/INFORMATION ON INGREDIENTS

Product composition originates from woody or other lignocellulosic biomass. The product is thermally treated at a temperature of 200-300°C in an oxygen deficient environment.

SECTION 4 — FIRST AID MEASURES

4.1 Description of first aid measures

General

- Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

Eye Contact

- Flush eyes with running water for at least 15 minutes.

Skin Contact

- Flush skin with running water.
- Wash clothing before reuse.

Ingestion

- Wash mouth with water.
- Get medical aid.

Inhalation

- Move victim to fresh air and call emergency medical service.
- Give artificial respiration if victim is not breathing.
- Administer oxygen if breathing is difficult.
- Keep victim warm and quiet.

4.2 Most important symptoms and effects, both acute and delayed

Eye contact: Tearing, burning

Skin contact: Irritation, redness, scaling, itching

Ingestion: Possible nausea and/or vomiting

Dust inhalation: Irritation to the lungs and mucus membrane

There are no known chronic effects of exposure to the product to date. Heat treated wood is not listed by NTP, IARC or regulated as a carcinogen by OSHA.

4.3 Indication of any immediate medical attention and special treatment needed

There are no other measures needed than mentioned in section 4.1.

SECTION 5 — FIRE FIGHTING MEASURES**5.1 Extinguishing media**

Use over measure water spray or dry chemical powder

5.2 Special hazards arising from the substance or mixture

Explosion Risk: In case of concentrated airborne product keep at distance.

Flammable Class: Flammable at high temperatures, combustible, will help to sustain a fire

General Hazard: Evacuate personnel downwind of fire to avoid inhalation of irritating and/or harmful fumes and smoke

Hazard combustion products: Carbon monoxide and carbon dioxide

Sensitive of static discharge: When pneumatically transported, static discharge may occur

5.3 Advice for fire fighters

Fire-fighting procedure: Use water to wet down dust to prevent generation of dust clouds. Remove burned or wet wood dust to an open area after fire is extinguished.

Fire-fighting equipment: Respiratory and eye protection are required for fire-fighting personnel. Full protective equipment (Bunker gear) and self-contained breathing apparatus should be used for all indoor fires and any significant outdoor fires.

SECTION 6 — ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures

- Remove all sources of ignition.
- Respiratory, skin and eye protection are required for personnel.
- Use water to wet down dust to prevent generation of dust clouds.
- In case of concentrated airborne product, keep at distance.
- Always measure carbon monoxide and oxygen in enclosed areas.

6.2 Environmental precautions

- Pick up and arrange disposal without creating dust.

6.3 Methods and material for containment and cleaning up

- Any method and material used should avoid creating dust and ignition.

6.4 Reference to other sections

- Not applicable

SECTION 7 — HANDLING AND STORAGE

7.1 Precautions for safe handling

- Handle in accordance with good industrial hygiene and safety practice.
- Avoid dust formation.
- Ensure adequate ventilation.
- Wash thoroughly after handling.

7.2 Conditions for safe storage, including and incompatibilities

- Store in a well-ventilated area. Oxygen depletion and carbon

monoxide emission can occur when material is stored in a confined space.

- Keep away from heat, sparks, flame or other sources of ignition.
- Keep away from strong oxidizing agents.
- Ventilate before entry.
- Always measure carbon monoxide and temperature in enclosed areas.

7.3 Specific end use(s)

See section 7.1 and 7.2. No other recommendations.

SECTION 8 — EXPOSURE CONTROL/PERSONAL PROTECTION

8.1 Control parameters

Because the product is new and still under development there are no national exposure limit values to date. Because of the fact that the main exposure problems might be expected from the exposure to the product dust, until reliable values for the product become available, known values for general dust nuisance are given instead.

- Threshold limit value, time weighted average (TLV-TWA):
10 mg/m³ (general dust nuisance)
- Permissible Exposure Limit: 10 mg/m³ (as dust)
- European Union professional exposure limit: 3 mg/m³ (as dust)

8.2 Exposure controls

Engineering controls

If user operations generate dust, make use of explosion proof equipment and ventilation equipment to assure airborne levels are below established exposure limits.

Personal Protective Equipment

Eyes protection: Wear safety glasses or safety goggles.

Skin protection: Where contact is likely wear protective gloves (nitrile rubber recommended).

Respiratory protection: Wear dust mask (P2 filter) during handling.

Work hygienic practices: Clothing with long sleeves or an overall and protective skin cream or gloves increase personal hygiene contact with the material.

SECTION 9 — PHYSICAL AND CHEMICAL PROPERTIES

9.1 Info on basic physical and chemical properties

Appearance: Solid, brown/black coloured

Colour: dark brown to black grainy material

Odour: light scorch (charred wood smell)

Odour threshold: Not determined

pH-Value: Not applicable, solid in normal use

Melting/freezing Point: Not applicable, solid in normal use

Initial boiling Point/range: Not applicable, solid in normal use

Flash Point: Not applicable, solid in normal use

Evaporation rate: Not applicable, solid in normal use

Flammability: Not determined

Vapour pressure: Not applicable, solid in normal use

Vapour density: Not applicable, solid in normal use

Relative density: 1000-1200 kg/m³

Solubility (water): Only volatile organic constituents are partly soluble in water

Partition coefficient: Not applicable, solid in normal use

Decomposition temperature: Not applicable, solid in normal use

Viscosity: Not applicable, solid in normal use

Auto-Ignition Temperature (layer): > 320°C

Auto-Ignition Temperature (cloud): > 490°C

Minimum Ignition Energy: > 1000 mJ

9.2 Other information

Product Density (at 20°C): 200 – 300 kg/m³ for chips, 600 – 800 kg/m³ for pellets

Bulk Density (at 20°C): 180 – 300 kg/m³ for chips, 600 – 800 kg/m³ for pellets

- Choose the appropriate product and bulk density, specify if possible

SECTION 10 – STABILITY AND REACTIVITY

10.1 Reactivity

In contact with air, the product absorbs oxygen and emits carbon monoxide, carbon dioxide, small levels of methane and several VOC's, decreasing in time.

Conditions of Instability:

Higher temperature accelerates product decomposition. Moisture content accelerates product decomposition.

10.2 Chemical stability

The product is stable under ambient conditions of temperature and pressure.

10.3 Possibility of hazardous reactions

Not applicable

10.4 Conditions to avoid

Avoid dust formation, heat, flames and sparks.

10.5 Incompatible materials

Strong oxidizing agents.

10.6 Hazardous decomposition products

Carbon monoxide, carbon dioxide, small levels of methane and other hydrocarbons.

SECTION 11 – TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity: There is no evidence to date that the product is of acute toxicological nature.

Skin corrosion/irritation: May cause skin irritation.

Serious eye damage/irritation: May cause eye irritation.

Respiratory or skin sensitisation: Is possible.

Germ cell mutagenicity: There is no evidence to date that the product is of acute toxicological nature.

Carcinogenicity: There is no evidence to date that the product is of acute toxicological nature.

Reproductive toxicity: There is no evidence to date that the product is of acute toxicological nature.

STOT-single exposure: May cause respiratory tract or skin irritation.

STOT-repeated exposure: May cause respiratory or skin irritation.

Aspiration hazard: May cause respiratory tract irritation.

Thermally treated wood is not listed by IARC, NTP and OSHA to be carcinogenic or reproductive toxic.

Effects on eyes: Not determined.

Effects through inhalation: Not determined.

Effects through ingestion: Not determined.

Effects on skin: Not determined.

Irritation of the eyes, skin and respiratory system is possible after exposure to low levels of dust, created during the handling of the product. There is no information available on the effects of exposure to higher levels of product dust or chronic effects of prolonged exposure.

SECTION 12 – ECOLOGICAL INFORMATION

12.1 Toxicity

There are no experimental ecological data on the toxicity of the product available to date.

12.2 Persistence and degradability

The persistence of the product in the environment is limited due to the biodegradable nature of the product.

12.3 Bio accumulative potential

There are no experimental ecological data on the bio accumulative potential of the product available to date.

12.4 Mobility in soil

Because of the solid nature of the product the mobility will be limited.

12.5 Results of PBT and vPvB assessment

Not applicable, because no chemical safety report is required to date.

12.6 Other adverse effects

No known other adverse effects.

SECTION 13 – DIPOSAL CONSIDERATIONS

13.1 Waste treatment methods

General:

Refers to section 6 for additional information.

Disposal Comment:

Dispose of waste at an appropriate waste disposal facility, according to current applicable laws and regulations.

SECTION 14 – TRANSPORT INFORMATION

This material is not yet tested and / or classified under IMO dangerous goods. The product is not flammable or self-igniting when transported dry under normal conditions of transport. But the product is combustible and sustains a fire.

14.1 UN number

UN number: Not applicable

14.2 UN proper shipping name

UN proper shipping name: (resulting from UN number)

14.3 Transport hazard class(es)

RID/ADR-Class: (resulting from UN number)

14.4 Packing group

Packing group: (resulting from UN number)

14.5 Environmental hazards

This material is not yet tested and/or classified under IMO dangerous goods.

Symbols: Low oxygen risk area, no smoking, EX-area

CAS Number: See section 1

EINECS Number: 231-153-3

RID/ADR Class: (resulting from UN Number)

ADNR Class: Not applicable

IMDG Class: Not applicable

ICAO/IATA Class: Not applicable

14.6 Special precautions for user

The product is not flammable or self-igniting when transported dry under normal conditions of transport. But the product is combustible and sustains fire.

- In case of an available UN number, update this section

SECTION 15 – REGULATORY INFORMATION

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

EUROPEAN COMMUNITY EEC LABEL AND CLASSIFICATION

R(isk) Phrases:

R 36/37 Irritating to eyes and respiratory system

R 38 Irritating to skin

S(afety) Phrases

S 16 Keep away from ignition sources – do not smoke

S 22 Avoid breathing dust

S 24/25 Avoid contact with skin or eyes

S 26 In case of contact with eyes, rinse immediately with plenty of water and seek medical advice

15.2 Chemical Safety Assessment

A Chemical Safety Assessment according to EC 1907/2006 has not been done.

SECTION 16 – OTHER INFORMATION

Abbreviations

CAS: Chemical Abstract Service registration number.

EINECS: European Inventory of Existing Commercial Substances.

UN: Substance identification number is a four digit number that identifies a hazardous substance during transport.

ADNR: European Agreement regarding the International Carriage of Dangerous Goods by Inland Waterways.

ICAO/IATA: International Civil Aviation Organization, International Air Transport Organization.

IARC: International Agency for Research on Cancer

IMDG: International Maritime Code for Hazardous Goods mg/m³
Milligram per cubic meter.

IMO: International Maritime Organization

NTP: National Toxicology Program

OSHA: Occupational Health and Safety Administration

PBT: Persistent, Bioaccumulative and Toxic substance

<p>RID/ADR: European agreements concerning the International Carriage of Dangerous Goods by Rail (RID) and by Road (ADR).</p> <p>STOT: Specific Target Organ Toxicity</p> <p>TLV-TWA: Threshold Limit Value, Time Weighted Average</p> <p>vPvB: Very Persistent and Very Bioaccumulative substance</p> <p>Above mentioned information, recommendations and suggestions concerning this product are up to date and taken from sources or based upon data believed to be reliable and reasonable care has been taken in the preparation of this information.</p>	
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8 References

- [1] REGULATION (EC) No 1907/2006 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC (Text with EEA relevance), European Parliament (2011)
- [2] *GLOBALLY HARMONIZED SYSTEM OF CLASSIFICATION AND LABELLING OF CHEMICALS (GHS)*. Fifth revised edition. Aufl. New York and Geneva, 2013 — ISBN 978-92-117067-2
- [3] *Classifications - CL Inventory - carbon*. URL <http://echa.europa.eu/information-on-chemicals/cl-inventory-database/-/cl-inventory/view-notification-summary/51605>. - abgerufen am 2014-11-26
- [4] ISO 16559:2014 (en) Solid biofuels - Terminology, definitions and descriptions (2014)
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Sluijsmans J. (2012) "Safety information sheet torrefied wood chips" Torr Coal document TPC-01-1 Kam-03 S01-R03, Torr Coal International BV

DTA: MSDS according to EU regulations number 453/2010 of 20 May 2010, http://torrefactie.nl/wp-content/uploads/DTA_MSDS_according_to_EU_regulations_2010.pdf