



Safety Data Sheet

Trade Name: Strawberry Mountain Torrefied Wood Fuel

SECTION 1: PRODUCT AND COMPANY IDENTIFICATION

MANUFACTURER'S NAME: Restoration Fuels, LLC

EMERGENCY telephone number: Joe Koerner, PE 541-520-7219 (8am – 4pm, PST)
TECHNICAL telephone number: Wayne Lei, PhD 503-530-6122 (8am – 4pm, PST)

**For Chemical Emergency
Spill, Leak, Fire, Exposure or Accident
Call CHEMTREC Day or Night
Within USA and Canada: 1-800-424-9300
Outside USA and Canada: 1-703-527-3887 (collect calls accepted)**

MANUFACTURER'S ADDRESS: PO Box 820, John Day, OR 97845

General Product Description: Torrefied wood briquettes for replacement of coal in power plants and as an industrial solid fuel.

Appearance: Various shapes, including but not limited to, dark brown cylindrical briquettes (40 to 90 mm in diameter) and pellets (6 to 10 mm in diameter).

Carbon CAS Number: 7440-44-0

SECTION 2: HAZARDS IDENTIFICATION

Torrefied Wood Fuel comprises woody biomass from U.S. western forests. The torrefaction utilizes high temperature and low oxygen conditions to reduce the biomass to carbon. The product is not listed as an Occupational Safety and Health Administration (OSHA) Air Contaminant (29CFR1910.1000) and does not have a Permissible Exposure Limit (PEL) assigned to it. An incidental amount of dust may occur during loading, shipping, and unloading of briquettes/pellets (briquettes). This dust, in sufficient quantities and under certain conditions, can be combustible. Worker exposure to airborne dust is subject to the OSHA (or State Plan) PEL for "Particulates Not Otherwise Regulated" (PNOR) (see Section 8). Containers of briquettes typically include very little dust, but dust levels should not be allowed to accumulate on surfaces or in the air.

Carbon (UN1361) is classified by the Department of Transportation (DOT) and is coded in the International Maritime Dangerous Goods and the UN Manual as (DOT) ADR 4.2, substances liable to spontaneous ignition. Torrefied Wood Fuel is exempt for this classification in packages less than three cubic meters. Briquettes have been reported to be less susceptible to spontaneous ignition than pellets. Response to unintended fire may result in water runoff and irritating and/or toxic gases.

Torrefaction and use of the product as a fuel may result in deposition of wood creosote, which the International Agency for Research on Cancer (IARC) has classified as a probable human carcinogen. Similar to the normal biodegradation of biomass, torrefied biomass emits volatile organic compounds (VOCs) including lipids, carbon monoxide (CO), carbon dioxide (CO₂), and small amounts of methane and



hydrogen in combination with oxygen depletion. If the storage location is a confined space (e.g., a cargo hold), ventilation followed by reassessment of gases must occur in accordance with the OSHA Confined Space regulations. The materials should be handled only by trained personnel and with necessary care.

Potential health effects include irritation of the skin, eyes, and respiratory and gastrointestinal systems. Torrefied wood fuel is not considered a carcinogen. Residues containing creosote (considered a possible human carcinogen by IARC) may build up over time on interior surfaces of furnaces.

Classification:

	Irritant Eye Irritation, Category 2A		Flammable Solids Category 1
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Signal Word: Danger

Hazard Statements:

- H228: Flammable solid
- H320: Causes eye irritation
- H335: May cause respiratory irritation

Precautionary Statements:

- P102: Keep out of the reach of children
- P103: Read label before use
- P210: Keep away from heat, hot surface, sparks, open flames, and other ignition sources. No smoking.
- P261: Avoid breathing dust/fume/gas/mist/vapors/spray
- P262: Do not get in eyes, on skin, or on clothing
- P262: Wash skin thoroughly after handling
- P270 Do not eat, drink, or smoke when using this product
- P281: Use personal protective equipment as required
- P303: IF ON SKIN (or hair): Gently wash with plenty of soap and water (see Section 4)
- P304: IF INHALED: Remove to fresh air (see Section 4)
- P305: IF IN EYES: Rinse cautiously with water (see Section 4)

SECTION 3: COMPOSITION / INFORMATION ON INGREDIENTS

Torrefied wood fuel is a stable, brown biomass, processed and compressed into a cylindrical briquette form. Product consists predominantly of carbon and may contain trace VOCs and background concentrations of earth metals from growth in forest soils. Use of the product as woody fuel may, over time, result in deposition of creosote on equipment.

During torrefaction, the biomass loses most of the low energy contents of the material, resulting in solids (sugar structures, carbon-rich char, ash), condensable liquids (lipids, alcohols, sugars), and gases (H₂ CO, CO₂, simple aromatics).

Chemical formula: C

Ingredients: Carbon (CAS No. 7440-44-0) >60%



SECTION 4: FIRST AID MEASURES

- Eyes** High concentrations of dust may cause reversible mechanical irritation to the eyes. Holding eyes open, gently flush with water until all foreign matter is completely removed. Seek medical attention if irritation develops or persists.
- Skin** May cause mechanical irritation and soiling. Wash material from skin with mild soap and water. Seek medical attention if irritation develops or persists.
- Inhalation** Remove to fresh air. Seek medical attention if breathing is difficult or if irritation of the respiratory tract is experienced.
- Ingestion** Rinse mouth with water and spit out. If conscious, give several glasses of water. Do not induce vomiting. Seek medical attention if a large amount has been ingested or if gastrointestinal symptoms appear.

Note to physicians Provide SDS to physician. Treat symptomatically.

Eye wash and hand wash stations should be located near break areas, in loading/off-loading areas, and in areas where accidental exposures are most likely to occur. These stations should be regularly cleaned and maintained. First Aid kits should be visible, easily accessible, and used in a clean area.

SECTION 5: FIRE FIGHTING MEASURES

Explosion Risk

Dust clouds of sufficient volume have explosion potential (see Section 9).

Extinguishing Media

Use dry chemical, CO₂, alcohol-resistant foam or water fog or spray. A fog spray is recommended if water is used. DO NOT USE A HIGH-PRESSURE WATER STREAM as this may spread burning dust, which will float on water.

Special Exposure Hazards

This material is subject to self-heating. It may not be obvious that the briquettes are burning prior to introduction into the furnace unless smoke emissions from the stockpile are observed or the material is stirred, and sparks are apparent. Briquettes that have ignited and been extinguished should be observed closely for at least 48 hours to ensure no smoldering material is present. Products of combustion include CO, CO₂, and a low concentration of VOCs.

Firefighter Protection

Full fire-fighting turnout gear, including National Institute for Occupational Safety and Health (NIOSH)-approved self-contained breathing apparatus (SCBA) should be worn. Avoid or minimize dust generation and disturbance. Use spark-proof tools and explosion-proof equipment.

SECTION 6: ACCIDENTAL RELEASE MEASURES

Personal Precautions

Wear appropriate personal protective equipment during cleanup of unintended releases, including disposable or launderable coveralls, gloves, and filtering facepieces or respirators. See Section 8, Exposure Controls and Personal Protection, Personal Protective Equipment.



Methods for Cleaning Up

Remove all sources of ignition. Clean up bulk material with a poly shovel, scoop, or broom directly into containers in a manner that will minimize dust generation. Dust minimization may include a light water spray.

Environmental Precautions

The use or storage of torrefied woody biomass is not known to result in significant environmental damage. As a matter of good practice, prevent release of material to soil, groundwater, surface water, drainage systems, etc. In areas of bulk material transfer, block accesses to stormwater drains, surface water, or soil. Maintain loading areas to prevent such releases.

SECTION 7: HANDLING AND STORAGE

Handling

Use engineering controls to minimize worker airborne exposures to less than the OSHA permissible exposure limit for PNOR. Avoid exposure to skin and eyes. If exposed, and before eating or drinking and prior to leaving the site, wash exposed skin with soap and water to avoid mechanical irritation and soiling. Keep any cuts or skin abrasions clean and well-protected.

Adequate local exhaust ventilation in the workplace and optimal process design are highly recommended. Minimization of accumulations of fugitive dust is recommended through proper maintenance of facilities. From a safety perspective, storage, loading and unloading, milling and feeding operations of torrefied wood fuel are the most relevant points; however, dust formation during conveyance of torrefied biomass may occur.

Fine dust may cause electrical shorts and is capable of penetrating electrical equipment unless tightly sealed. If hot work (welding, cutting, etc.) is required, the immediate work area must be cleared of torrefied wood fuel product and dust. The product is electrically non-conductive but may allow a build-up of static charge during handling. Take measures to prevent such build up, such as ensuring all conveyance and handling equipment is electrically grounded/earthed.

Storage

Store material away from ignition sources and strong oxidizers. Dust coincidentally present with torrefied wood briquettes is considered combustible and potentially explosive (see Section 9). Self-heating due to biological activity is a possibility in storage stockpiles, and criteria are volume dependent, i.e., the auto-ignition temperature decreases with increasing volume. Stockpiles should be spread out, kept under about 3 feet in height, if possible, and monitored for signs of self-heating. Humidity control for dust suppression could be considered for controlled-area storage to minimize dust generation and lower the risk of self-heating.

If storage or conveyance systems comprise confined spaces that must be entered for maintenance or inspection, OSHA-compliant confined space entry programs must be in place and followed.

SECTION 8: EXPOSURE CONTROLS AND PERSONAL PROTECTION

Engineering controls are preferred to keep airborne exposures well below the following Permissible Exposure Level. These controls include general and local exhaust ventilation, enclosed and sealed process design, automation of activities, etc. These controls will also minimize skin exposure. Producers and purchasers of torrefied wood fuel should select personal protective equipment using a hazard assessment in accordance with the OSHA PPE Standard (29CFR 1910.132). The information in this section is offered as a guide.



Permissible Exposure Levels (PEL)

OSHA PEL ACGIH TLV NIOSH REL

Particulates Not Otherwise Regulated, 8-hour TWA

Total dust	15 mg/m ³	10 mg/m ³	N/A
Respirable dust	5 mg/m ³	3 mg/m ³	N/A

No Short-Term Exposure Limits (STEL) or “skin” designations have been set by any U.S. agency.

Below background concentrations of trace earth metals from tree growth in forest soils and VOCS from biomass are likely to be present, very similar to biochar, which is sold as a soil amendment. The PELs for total dust (PNOR) are believed to be protective for exposure to airborne dusts.

Personal Protective Equipment

Eye Protection

Safety goggles or glasses are recommended as a sound safety practice to keep particles out of the eyes.

Skin Protection

Wear general protective clothing to minimize skin contact in controlled spaces. Impacted work clothes should not be worn or taken home and should be washed daily. Disposable single-use coveralls are appropriate for high-exposure process equipment maintenance and confined space entries.

No special glove composition is required for torrefied wood fuel, but impermeable nitrile or latex is recommended over more porous gloves to protect hands from soiling. For tasks requiring greater glove durability, sturdy work gloves can be worn over the thinner protective gloves. Use of a barrier cream may help to prevent skin drying. Wash hands and other exposed skin with mild soap and water.

Foot Protection

Protective steel-toe footwear is recommended as a sound industrial safety practice. Styles that are easy to clean are recommended.

Respiratory Protection

NIOSH-approved elastomeric or air purifying respirators (APRs) for particles (including filtering facepieces such as N95 and P100) should be used when airborne torrefied wood fuel dust concentrations are expected to exceed the PEL or a lower action level set by the using company. Higher levels of protection should be used if there is an uncontrolled release, exposure levels are not known, or in circumstances where APRs may not provide adequate protection.

APRs do not provide oxygen and may not be appropriate for some exposures. Confined space entry procedures should always include atmospheric monitoring. Use of respirators must be accompanied by a complete and compliant respiratory protection program in accordance with federal and/or state regulations and best practices (e.g., 29CFR1910.134).

General Hygiene Practices

Wash face and hands with soap and water to remove product before eating, drinking, or smoking; prior to leaving work; and whenever accumulations on skin produce unexpected symptoms. Keep any cuts or skin abrasions clean and well-protected.

Emergency eyewash stations should be located in areas where accidental exposures are most likely to occur. Hand/face wash stations should be located near break rooms and furnace loading areas where workers are present. A deluge/safety shower should be located on site. First Aid kits should be visible, maintained, and located and used in a clean area.



SECTION 9: PHYSICAL AND CHEMICAL PROTECTION

Appearance:	dark brown, log-shaped briquettes
Odor:	odorless
Molecular weight:	12 g/mol (Carbon)
Physical state:	various solid shapes, including briquette (40 to 90 mm) and pellets (6 to 10 mm in diameter)
pH:	6.0 to 9.0
P_{max} (barg):	5.71 (max explosive pressure of dispersed dust cloud)
K_{st} (bar m/sec):	26 (max rate of explosion pressure rise of dispersed dust cloud) ¹
St Class:	1 (< 200 bar m/sec) ² (ASTM E1226)
Minimum Explosible Concentration (g/m ³):	75 < MEC < 100 (ASTM E1515)
Minimum Auto-Ignition Temp (MAIT):	≤ 520°C for dispersed dust cloud (ASTM E1491)
Minimum Ignition Energy (mJ)	300 < MIE < 1000 (ASTM E2019)
SOLUBILITY IN H ₂ O:	insoluble
PERCENT COMBUSTIBLE MATERIAL:	97.2% of dust (OSHA NEP Test #3)
BULK DENSITY (briquettes/pellets):	36 to 40 lbs/ft ³

SECTION 10: STABILITY AND REACTIVITY

Stability

Torrefaction is conducted in an oxygen-deficient environment. Over time, torrefied wood fuel will absorb oxygen. Reactivity and dust explosions, self-heating, and self-ignition have been reported for torrefied biomass. Dust levels within briquette shipments are low; however, standard test data (see Section 9) indicate that the dust accumulations must be regarded as providing a dust explosion hazard. Self-heating can occur during contact with humid air, most likely following the same mechanism known for the self-heating occurring in some coal piles.

Conditions to Avoid

Prevent exposures to very high temperatures and open flames prior to use as a fuel. If possible, stockpiles should be spread out and kept under 3 feet in height and monitored for signs of self-heating.

Materials to Avoid

Incompatible materials, inadvertent ignition sources, and strong oxidizers such as chlorates, bromates, and nitrates, especially when heated.

Storage Considerations

Torrefied wood briquettes are impermeable to water. Dust accumulations could be transported during heavy rains or water spray if stored on uneven surfaces.

Hazardous Decomposition Products

When used as fuel, release of carbon monoxide (CO), carbon dioxide (CO₂), and small concentrations of methane and VOCs, similar to a campfire.

Possible Hazardous Reactions

None under normal use and storage conditions.

¹ ASTM E1226



Static Discharge Effects

Dust content is low but could increase during certain storage conditions. Based on standard dust test results (Section 9), precautionary measures against static discharge should be taken. All metal parts of mixing and processing equipment should be grounded/earthed. It is imperative to have electrical grounding systems checked and validated.

SECTION 11: TOXICOLOGICAL INFORMATION

Acute and Chronic Toxicity

No studies that reported oral, inhalation, skin or eye acute or chronic toxicity of torrefied wood fuel were identified. Acute oral toxicity (LD50) results of >5000 mg/kg are generally considered to be non-toxic. In comparison to carbon black, a product that is also primarily carbon, acute oral toxicity in rats was >8000 to 15,400 mg/kg and no tumors were identified by any route of exposure in 2-year (lifetime) rat studies.

A 2016 report published in Applied Energy entitled *Life Cycle Human Health and Ecotoxicological Impacts Assessment of Electricity Production from Wood Biomass Compared to Coal Fuel* utilized two impact assessment methods. It found that the human health impact category for biofuels was a reduction in toxicity of 89% to 95% for carcinogens, 68% to 81% for non-carcinogens, and 66% to 76% in ecotoxicity impacts when compared to coal-fired electricity. The human health impacts were primarily due to product transport and ash disposal processes. Respiratory effects were reported to be greater for biofuels, which were the result of fuel combustion for all sources. The report did not identify exposures to specific chemicals.

Carcinogenicity

Torrefied wood fuel is not listed as a carcinogen by IARC or OSHA and does not appear in the National Toxicology Program 14th Report on Carcinogens. Use of torrefied wood fuel may result in a build up over time of creosote on interior furnace surfaces. Creosote is considered a probable human carcinogen by IARC.

Specific Target Organ Toxicity (STOT) Classification

None reported.

Reproductive and Teratogenic Effects

No studies regarding reproductive effects of exposure to torrefied wood fuel were identified.

Human Epidemiology

No studies or reports of incidence, distribution, and possible control of diseases and other factors relating to exposure to torrefied wood fuel were identified.

SECTION 12: ECOLOGICAL INFORMATION

Aquatic Toxicity

No studies that reported acute or chronic hazards to the aquatic environment of torrefied wood fuel were identified. It is not known how closely the carbon content of torrefied wood fuel would mimic what is known about aquatic toxicity of carbon. Carbon black, a product that is also primarily carbon, was not shown to be acutely toxic to fish (zebrafish), water fleas, or algae when tested in accordance with OECD guidelines 203, 202, and 201, respectively. If released in very large volumes to an aquatic environment, however, it may be harmful to terrestrial plant and animal life.

Environmental Fate and Persistence

The major component in torrefied wood fuel is carbon, which cannot be further degraded by microorganisms, hydrolysis, or photodegradation in air or in surface water. It is inert, has negligible vapor pressure, and contains no functional or water-soluble groups. Other post-torrefaction components include



solids (sugars, char, ash), VOCs (alcohols, ketones, acids, furans), lipids (terpenes, fatty acids, tannins, waxes), and gases (H₂, CO, CH₄, CO₂, toluene, benzene). These components are part of the fuel and will be mostly consumed. Emissions should be treated by the power plant systems in conformance with local regulations.

Torrefied wood fuel briquettes/pellets are not soluble in water and will not leach if stored and the product becomes wet. It is not expected to migrate, although minor dust levels could do so if sprayed down outdoors in a manner that could enter storm drains, water bodies, or swales.

Bioaccumulation

Bioaccumulation is not expected due to the physiochemical properties of torrefied wood fuel. Carbon re-enters the soil through normal decomposition processes of plants and animals, but no new carbon is created.

Ecological Information Overview

No significant environmental hazards are associated with use of torrefied wood fuel. Torrefied wood fuel is very similar to biochar sold as a soil amendment to improve soil drainage, reduce soil compaction, increase nutrient cycling, increase water retention, improve germination, and improve plant resistance to disease and infestations.

Hazards to the Ozone Layer

Torrefied wood fuel does not contain any U.S. Environmental Protection Agency Class 1 (chlorofluorocarbons) or Class 2 (hydrochlorofluorocarbons) Ozone-Depleting Substances.

SECTION 13: DISPOSAL CONSIDERATIONS

Waste Minimization:

Recover or recycle spilled materials or unused product whenever possible.

Waste Classification:

In the U.S., (non-contaminated) torrefied wood fuel is not considered a hazardous waste under RCRA (40CFR261).

Disposal:

Disposal of waste that cannot be recycled must be in accordance with national, provincial, state, and local regulations that are current at the time of disposal. It is the ultimate responsibility of the purchaser of the material to determine appropriate and compliant disposal practices.

SECTION 14: TRANSPORT INFORMATION

Torrefied wood fuel is primarily carbon. For shipment purposes, the U.S. Department of Transportation classified carbon as UN 1361 (carbon from animal or vegetable sources). Note that packages of not more than 3 cubic meters in volume are exempt from the Class, Packing Group and Tunnel Restrictions listed below. Test results for shipment are found in Section 9.

CAS:	7440-44-0 (carbon)
RID/ADR Class:	ADR 4.2 (substance liable to spontaneous combustion)
Packing Group:	III
Tunnel Restrictions:	D/E



The Cargo Incident Notification System (CINS) *Guidelines for the Carriage of Charcoal and Carbon in Containers* include Class 4.2, UN 1361. CINS recommends that the shipment type of container and size selection be based on the principal of maximum filling to reduce the free space in the container and thus reduce the air (oxygen) in the container. Air circulation should be reduced as much as possible. A vanning survey be done prior to carriage to confirm proper loading.

Transport stowage codes set forth by IMDG include:

SW1: Protected from sources of heat

H2: Keep as cool as reasonably practicable

SECTION 15: REGULATORY INFORMATION

OSHA (and State Plan states) have set PELs for Particulates Not Otherwise Regulated (PNOR) (29CFR1910.1000, Table Z-1) (see Section 8). Worker exposure to dusts coincident with torrefied wood fuel product stockpiles or from handling product, ash, or waste must comply with the PEL.

Carbon, char, and ash are not considered Hazardous Air Pollutants under Section 112 of the Clean Air Act and do not deplete ozone. Title IV of the Clean Air Act lists SO_x, NO_x, benzene, and cresols as hazardous air pollutants, which may be emitted by the burning of torrefied wood fuel depending on feedstock, furnace efficiency, and treatment technology. Emissions are expected to be significantly less than burning coal.

Torrefied wood fuel is not listed on the USEPA "List of Lists," which includes the Emergency Right to Know Act (EPCRA), the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), and Section 112 of the Clean Air Act. The product is also not listed as a Toxic or Priority Pollutant under Section 307 or included in Section 311 (Oil and Hazardous Substance Liability) of the Clean Water Act. In Japan, torrefied wood fuel is not listed in the regulated substances under the Japan Chemical Substance Control Law, Industrial Safety and Health Law (644 substances), or in the Poisonous and Deleterious Substances Control Law.

Torrefied wood fuel is not subject to the Superfund Amendments and Reauthorization Act (SARA) Section 313, Toxic Chemical Release Inventory Reporting. In Japan, this product does not appear on the Class 1, 2, or Specified Class 1 Designated Chemical Substances lists subject to the Pollutant Release and Transfer Register (PRTR) reporting law.

Torrefied wood fuel does contain certain solids, lipids, and gases (see Section 12). Users are advised to evaluate their applications and reporting responsibilities.

SECTION 16: OTHER INFORMATION

National Fire Protection Association (NFPA) rating

Health: 1
Flammability: 1
Instability: 0
Special Hazards: none



This SDS was prepared in accordance with the Globally Harmonized System of Classification and Labelling of Chemicals (GHS), 7th Edition, dated 2017.

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The data and information presented in this document corresponds to the present state of our knowledge and experience and intended to describe the product with respect to possible occupational health and safety concerns. The user of this product has sole responsibility to determine the suitability of the product for any use and manner of use intended, and for determining the regulations applicable to such use in the relevant jurisdiction. It does not represent any guarantee of the properties of the product. Restoration Fuels, LLC and Trenary & Associates, LLC are not liable for any damage resulting from handling or from contact with this product.