DYNAMOTIVE

The BioOil Information Book

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General BioOil Information

What is BioOil and where does it come from?

BioOil is a dark brown, free flowing liquid fuel with a smoky odour reminiscent of the plant from which it was derived. BioOil is formed in a process called pyrolysis wherein plant material, such as sawdust or bagasse from sugar cane, is exposed to very high temperature in an oxygen free environment. Pyrolysis therefore is not a combustion but rather is a cracking process wherein the plant material, consisting of largely cellulose, hemicellulose and lignin, is rapidly decomposed into a multitude of different compounds, some of which are small and some are very large. However, when cooled down to room temperature, they condense and form a single-phase liquid, BioOil, in which they all appear dissolved.

BioOil is not extracted from plant material. Plant material is converted into BioOil. BioOil is not an oil in the traditional sense, in that is does not have oil based properties and it is not considered a hydrocarbon. From a chemistry point of view, the overall composition of BioOil does not deviate significantly from the chemical composition of the feedstock it is derived from. For example, since about 50% of wood is oxygen then oxygen in wood based BioOil is also about 50%. Similarly, the high heating value of BioOil also closely resembles that of wood.

BioOil contains about 25% water, without which it would not be a liquid. The water component in BioOil is not a separate phase and is important because it lowers the viscosity of the fuel. BioOil is not a hydrocarbon-water mix like Orimulsion. Another feature of BioOil is its propensity to change slowly but steadily with time. This is not to be considered an instability because it will take time. Chemical processes are at work as the BioOil contains a very large variety of compounds that will react with each other and reform into larger molecules that with time will also separate out. However, this separation does not result in a separate phase but rather the formation of a very viscous bottom layer that can easily be stirred back into the bulk.

BioOil is an excellent fuel. It ignites and burns readily when atomized.

What are typical and basic BioOil properties and how do they compare with diesel fuel?

Table 1 BioOil Properties compared with Diesel Oil

Parameter	Units	BioOil – wood based	Diesel Oil
High Heating Value	MJ/kg	16-19	42
Flash Point	^{o}C	48-55	35-60
Viscosity	cSt	8 (60 ^{o}C)	6
Moisture	Wt%	20-25	0
Density (25^{o}C)	Kg/liter	1.2	0.84
Surface Tension	mN/m	35-39	29
Acidity	pH	2-3	5
Solids (char)	wt %	0.01-0.2	-
Ash	wt %	0.01-0.04	0.01

Table 2 BioOil Kinematic Viscosity

Temperature	Viscosity
0 °C	500 cSt
20 °C	70 cSt
40 °C	19 cSt
50 °C	13 cSt
60 °C	8 cSt
80 °C	4 cSt

Table 3 BioOil Fuel Ultimate Analysis (%w)

Feed	Pine	Pine	Maple
%Ash	0.025	0.02	0.02
%Carbon	46.27	47.02	45.37
%Hydrogen	6.81	7.09	7.17
%Nitrogen	<.01	<.01	<.01
%Sulfur	<.01	<.01	0.14
%Oxygen (by difference)	46.90	45.85	47.30

Table 4 BioOil Characteristics, SGS Test Analysis (Spruce/Pine/Fir origin)

	ASTM Method	Average
PH	pHmeter	2.2
Density @ 15deg C(kg/l)	D4052	1.205
High Heating value (MJ/Kg)	DIN51900	17.41
Low Heating Value (MJ/Kg)	DIN51900	15.69
Solids Content (%w)	Insolubles in Ethanol	0.06
Ash Content (%w)	D1319	0.0028
Pour point (deg C)	D97	-27
Flash Point	D93	51
Conradson carbon (%wt)	D4530	15.7
Kinematic Viscosity (cst)	D445	
@ 20 deg C		49.25
@50 deg C		9.061
Ash Analysis, typical (ppm)	ICP, AAS	
Aluminum		2
Calcium		7
Iron		7
Potassium		4
Magnesium		<2
Sodium		7
Phosphorus		7
Lead		<2
Sulfur		48
Silicon, soluble		7
Trace amounts of other metals		<1ppm

Is BioOil dangerous?

For people with basic training and knowledge of the product, BioOil is not dangerous. Direct contact with skin, as well as inhalation of its vapors should be avoided. BioOil can be difficult to ignite but it will burn. Keep it away from heat sources, especially open flame.

What precautions should be taken when using BioOil?

BioOil is acidic. Avoid contact with the eyes. Vapors alone can cause eye irritation. If BioOil does come in contact with the eyes, flush it for fifteen minutes with lukewarm water, then see a doctor.

In general, BioOil does not require any unusual handling precautions. BioOil can be safely handled wearing gloves, goggles and protective clothing such as coveralls. Dermal exposure to BioOil will result in a tanning of the skin; however, the toxicity of the oil to the skin is low.

The eyes and respiratory tract are sensitive to BioOil vapors and therefore, NIOSH approved masks should be worn when being exposed to high levels of vapors. ALWAYS wear eye protection in any industrial setting. This is especially true if you are working with BioOil in open containers. Safety glasses with side shields are sufficient most of the time, but when handling BioOil in open containers, wear sealed goggles. Wear latex or vinyl gloves when handling or cleaning BioOil.

Store BioOil in stainless steel or HDPE plastic containers.

Do not store BioOil in ordinary steel containers – they will rust and eventually leak because BioOil is acidic.

How to clean up BioOil

Should you get BioOil on your skin, it will probably stain. The stain takes a few days to wear off. To minimize staining, wash the skin as soon as possible with a good industrial hand cleaner like Fast Orange or Great White. Do not use a solvent to clean your skin as it may penetrate your skin and increase the staining caused by BioOil.

To clean BioOil from equipment, ethyl alcohol and methyl alcohol are both excellent cleaning agents. Remember that these high concentration alcohols have their own dangers. They are poisonous and very flammable. Make sure that you use them in well-ventilated areas, and avoid breathing the vapors. If you spill more than a litre of BioOil, clean it with a sweeping compound like saw dust or Floor Dry.

Though alkali solutions work quite well in cleaning BioOil, avoid their use for safety reasons.

Effect of the water content in the fuel?

The water or moisture content is a part of the fuel make-up and not a separate phase. Water in BioOil is an essential component to keep BioOil as a liquid. In combustion processes, water will lower flame temperatures, which in turn will reduce NO_x formation. Firing BioOil produces less NO_x than a fossil fuel like diesel oil.

Water (and the oxygen content) decreases the heating value of the BioOil. Because of this, a larger quantity of BioOil must be fired to achieve the same heat output. In volumetric terms one must fire about twice as much BioOil as fuel oil to achieve this.

Key Properties to Accommodate For Switching fuel to BioOil

Viscosity	Preheat BioOil to 40° C. Select air or steam atomized nozzles Select generous pipe sizes and avoid diameters < 1.5" ID in longer runs.
Acidity	Avoid carbon steel, use stainless or e.g. polyethylene in all BioOil wetted surfaces. Instrumentation too.
Lower heating value	Select larger feed pump and preferably consider a positive displacement type.
Aging	Avoid sustained heating to > 60° C and use the BioOil within 3 months.
Ignition	Not a problem – what works with fuel oil generally works with BioOil. But do attend to the fuel / combustion air ratio before ignition.

While the properties of BioOil are somewhat different from the fuel type the user may be accustomed to, the modifications required for switching to BioOil usually will be fairly simple and mechanically traditional. Standard inspection and maintenance procedures as described by the equipment manufacturers still apply. DynaMotive can provide expertise and consultation on all aspects of BioOil combustion. This includes for instance, equipment & material suitability, modification requirements or a tailored maintenance and inspection program for burning BioOil.

Review of BioOil Applications

BioOil's potential use as a fossil fuel replacement is already well established. Customers for BioOil can include local, regional and national electrical utilities and power producers operating with partial or complete fuel substitution depending on scale and application. The opportunities for industrial applications are too numerous to list but some immediate applications in primary industry are kilns and boilers in pulp and paper, process heat in boilers in sawmills, metallurgy, oil and gas industries, as well as in secondary industries such as greenhouses, district heating and stationary engines.

BioOil has a very complex chemical composition, containing a multitude of different compounds. The specialty applications of these compounds in industrial processes and manufacturing are just beginning to be explored. They represent a potentially very large market for value-added products derived from BioOil.

Utility fuel, Power Generation

DynaMotive is working with manufacturers of gas turbines and stationary diesel engines to further test and develop BioOil fuels for heat and power generation. The first application was the installation of an OGT 2500 gas turbine with a combined cycle in DynaMotive's first commercial BioOil plant in West Lorne, Ontario.

Industrial fuel, Cogeneration

DynaMotive's successful burner tests have created opportunities for early commercial applications of BioOil as a clean burning fuel to replace natural gas, diesel and other liquid fossil fuels in the multi-billion dollar industrial boilers and kiln markets.

Lime kilns and lumber kilns

Field tests showed that BioOil and natural gas were equivalent in thermal performance and product quality.

Boilers

BioOil is an effective substitute for diesel, heavy fuel oil, light fuel oil or natural gas in essentially any type of boilers where these fuels are fired or contemplated to be fired. These are relatively simple applications requiring basic modifications limited mainly to fuel nozzles and transport systems. DynaMotive already has demonstrated the successful burning of BioOil in a variety of boilers. The most recent demonstration was in June 2005 and involved firing BioOil alone in a Dutch oven-type wood fired boiler at the West Lorne BioOil plant satisfying steam demand, production and pressure for over an hour as part of the demonstration phase of the West Lorne BioOil Cogeneration Project. The steam produced in the boilers was used to heat Erie Flooring's lumber kilns.

Diesel Engines

BioOil has been successfully demonstrated as a clean fuel substitute in slow and medium speed stationary diesel engines. This application has the potential to achieve thermal

efficiencies of >40%. Applications include on and off-grid distributed power generation including continuous and peak power production. Ormrod Diesels (UK), Wartsilla Diesels (Finland), Pasquali/Lombardini (Italy) and Sener-Tec (Germany) have undertaken diesel engine demonstrations. DynaMotive is in discussion with other engines manufacturers to establish fuel test programs. (MAN / B&W / Wartsila / Caterpillar).

Green House Gas credits

Replacing fossil fuel use with BioOil will also generate Green House Gas emissions reduction credits. These credits can then be traded through domestic trading systems or through the established international mechanisms set out under the Kyoto Protocol. The quantity and value of these credits will depend on what type of fossil fuel BioOil is displacing and where the credits are traded.

For example, combustion of Natural Gas emits approximately 50kg of CO_2 per GJ, while combustion of Light Fuel Oil emits approximately 74kg of CO2 per GJ.[1] Given that BioOil is CO_2 neutral and has 16-19GJ per tonne, and the current price for 1 tonne of GHG emissions reduction credits on the European ETS is $CAD 36.40, these credits will add significant value to BioOil as a fossil fuel displacement. [2]

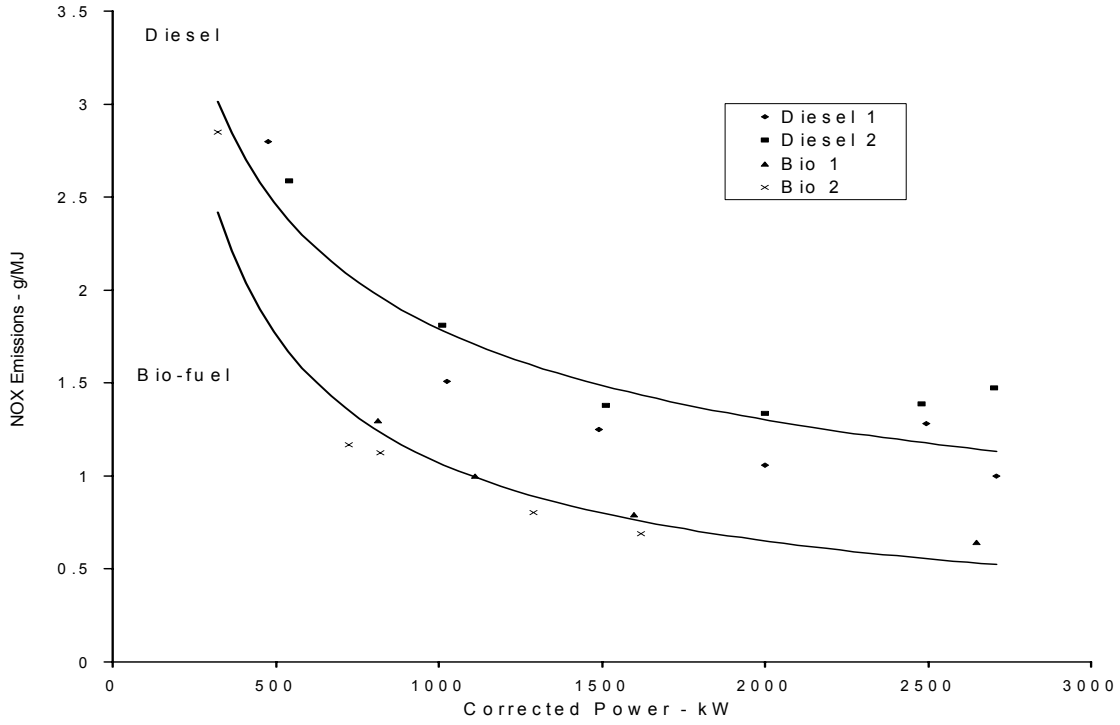
[1] Combustion Emission Factors: Environment Canada, Canada's Greenhouse Gas Inventory (SMART Report)
[2] February 14th, 2006. www.pointcarbon.com

Combustion Characteristics of BioOil

Properly atomized BioOil produces a stable, “bushy” brilliantly white to yellow flame visually similar to that of natural gas or diesel oil.

Measured levels of CO, SO_2, and NO_x in BioOil off gases are similar to those of natural gas, and lower than those of diesel oil. BioOil is essentially a sulphur-free fuel and therefore SO_2 levels are almost zero. Figure 1 shows the NO_x emissions profile from burning BioOil in a Magellan, Orenda division gas turbine (OGT 2500).

Figure 1 Measured levels of NOx in a gas turbine burning BioOil



BioOil Application Demonstrations

Orenda, Magellan Aerospace Corp.

One of the first major opportunities for BioOil utilization came about through co-operation with Orenda Aerospace Corporation and the proposal to use BioOil to run their aero-derivative turbine to generate electric power. Initial trials clearly indicated BioOil could substitute for the kerosene distillate that usually serves as turbine fuel. With a few alterations to the fuel preparation and firing systems of the OGT 2500 gas turbine package, a full-scale demonstration test was set up at the Magellan Aerospace Center in Toronto with the 2.5MW turbine operating successfully on BioOil. This project culminated with the transfer of the turbine to the Erie Flooring Plant in West Lorne, Ontario, Canada, combining it with DynaMotive's 100 tonnes per day pyrolysis plant, making this project the world's first BioOil fired co-gen plant.

Natural Resources Canada – BioOil fuel firing nozzle tests

DynaMotive received a grant from NRCAN to experiment with and develop a burner nozzle suitable for combustion of BioOil in collaboration with CANMET. This test was based on CANMET's previous experience with the coal liquid mixture (CLM) nozzle test. DynaMotive forwarded to CANMET BioOil from whitewood and whitewood/bark feed stock for this test. The test was completed successfully November 1st 2000 at CANMET's facilities in Ottawa when it was established that BioOil firing can burn to completion and with a controllable flame configuration using standard burner nozzle and registered technology.

Top Gro Greenhouse, Aldergrove, British Columbia, Canada

This test was a simple demonstration of substituting #2 fuel with BioOil fired in a standard industrial type 100 psig Cleverbrook hot water fire tube boiler. The existing fuel train was used with changes made to the electronic flame safety system, the mechanical fuel air ratio and the burner management. One tonne of BioOil was fired as a single fuel, maintaining the heating requirements for several hours. Substantial reductions in flue gas NO_x emission were noted. The existing automatic instrumentation followed the load demand and no smoke or lingering BioOil odour was noticed clearly indicating complete and successful combustion.

Lime Kiln, University of British Columbia, Vancouver, BC, Canada

Burner tests with BioOil fuel showed it to be a viable alternative to Natural Gas (NG) because it atomizes and burns well with a similar "bushy" flame. The axial temperature and calcinations profiles were similar and the lime reactivity was not affected by firing BioOil.

Lumber Kiln, Canfor Lumber Mill, Prince George, British Columbia, Canada

A combustion test of whitewood and whitewood/bark BioOil was carried out in Prince George on a lumber kiln dryer. Two loads of lumber (each 168,000 fbm) were dried in two separate runs. The initial and final moisture of lumber was 42% and 12.8% for the first load and 56% and 15.4% for the second load respectively (46.9 hrs drying time for each load). 9,987 kg of whitewood / bark and 8,501 kg of whitewood BioOil were used for drying the two loads of

lumber. The testing results showed that BioOil exhibited good ignition characteristics and was an effective substitute for natural gas in the lumber kiln dryer.

Aluminum Smelter, ALCOA Baie-Comeau, Québec, Canada

This was the largest burn test carried out by DynaMotive. A total of 12 tonnes of BioOil from hardwoods was combusted. The BioOil came from DynaMotive's pyrolysis plant at Erie Flooring in West Lorne, Ontario

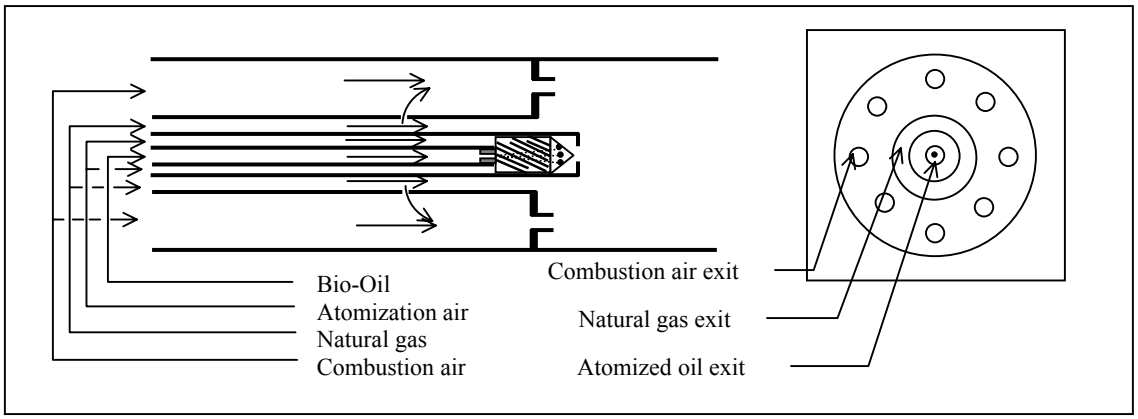
The test comprised two phases; both of which were successfully completed. The first and most important phase involved increasing the temperature of an aluminium furnace to the required operational parameters within a specific timeframe. The second phase required the maintenance of temperature in the furnace at operational parameters. The strict Alcoa test conditions and temperature requirements were met fully, indicating that BioOil can be used as a viable fuel alternative.

Further, the tests indicated that firing BioOil may be able to meet even more stringent conditions than those met by heating oil #2 (the fuel currently used by Alcoa) because it can offer an improvement in heat transfer and provide energy savings from an overall reduction in heat input.

All the burners above (except the turbine) were regular single or dual fuel burners that were designed to burn Fuel No. 2 oil (diesel).

For firing BioOil in an existing the burner nozzle the first step is to ensure good atomization for the larger flow. This may need some modifications. In some types of burners the BioOil spray (BioOil pressure at the burner nozzle = ~ 15 psig) mixes with atomizing air (~ 10 psig) hereafter the spray will be lit and combustion air or secondary air will complete the combustion. (Figure#2 illustrates a typical burner of this type with burner air and BioOil flow patterns). Some pre-heating of the BioOil to 30 – 40 °C will assist in better BioOil atomization.

Figure 2 Dual Fuel Burner, Natural gas and BioOil arrangement.



Bulk Characteristics of BioOil

Storage stability

BioOil is very stable. However, with time and when left at extended standstill (usually weeks or months) it will slowly begin to separate into a heavier component (lignin components) that may develop into a thick bottom layer that is several inches thick and is viscous like honey. This bottom layer shows no distinct line of separation from the bulk but rather a gradual transition, unlike oil and water separation for example. Also, a 0.5"-2" thick floating layer may also form at the top. With vigorous stirring, however, both these layers will mix back into the BioOil, particularly if helped by the addition of 5% alcohol and/or by heating to 40° – 60°C It should be noted that these processes will accelerate if the BioOil is exposed to higher temperatures and thus extended exposure to > 60° C should be avoided.

In the bottom "lignin fragment" layer, the water content can reduce to 15% while the density remains 1.2 kg/litre and the High Heating Value increases to 18-22 MJ/kg.

Under ideal conditions BioOil should be used within 3 months to avoid separation.

Storage and transport temperature

With a pour point of -30° C, BioOil can be stored below freezing but it will become very viscous and very difficult to pump or transport (see BioOil viscosities in Table 2). The recommended storage is continuous agitation, insulated, and heated to at least 10°C with ability to heat it (electrically or with steam) to +40° C. As mentioned before, heating BioOil to 60°C or higher will promote internal reactions and polymerization that can be significant if left at elevated temperatures for prolonged periods. Another consequence of over heating will be the reduction / elimination of certain extractives and commercially viable products.

BioOil sampling procedures from tanks or containers

In order to take a representative sample of BioOil it should be thoroughly mixed beforehand.

Typically whitewood (pine/spruce) based BioOil is a single-phase with little or no floating layer on the top (typically wax related if bark was in the pyrolysis feed stock). Where thicker phases start to form at the top and bottom, these must be stirred back into the bulk. The bottom phase has a tendency to cling to the floor so the agitation has to be effective throughout the container. Heating up the content to 30 - 40°C will assist the agitation. After thorough mixing, three samples should be taken with intervals of several minutes while their contents are being stirred. These samples should then be mixed, and the final sample drawn from that mix.

Technical Requirements for BioOil Handling

- *Material of container for shipment & storage*

  All BioOil wetted surfaces should be in Stainless 304, 316, HDPE, EPDM, PVC or Teflon because of BioOil's acidity (pH of 2.5 - 3.0).

- *Temperature*

  During storage and transportation BioOil should be kept above 15 ^{O}C to maintain good fluidity, but should not be stored at temperatures higher than 60 ^{O}C for long to avoid polymerization.

- *Mixing*

  During storage BioOil should be agitated or circulated to maintain good homogeneity.

- *Pumping*

  For pumping, all piping must be generous and not less than 3" on suction (keep as short as possible with generous NPSH) and 2" diameter on discharge-use reinforced PVC hose if practical.

- *Pressure*
  BioOil does not exert pressures at temperature much different from water. Carriers designed to handle diesel fuels or equal will suffice for BioOil.

- *Cleaning BioOil out of tanker*

  Cleaning is best done with denatured ethanol. It will depend on end user requirements of the BioOil but it may be possible to add the collected wash spill to the BioOil, in particular if the end use is as a fuel... Do not wash with water as it will cause separation. Ethanol is preferable to methanol. Carrier is advised to carry a small amount of denatured ethanol with him to clean tools and valves.

- *Cleaning of spills in water*

  Contrary to oil spills, BioOil being heavier, in water it will quickly sink to the bottom where much of it will dissolve with time (up to 65%), because parts of it are water-soluble (J.Blin, G. Volle, P. Girard, "Biodegradability of Fast Pyrolysis Oil", CIRAD Forestry Department, International Research Centre for Agricultural and Development, France).

  BioOil is a natural product and therefore a spill is believed not to cause nearly the catastrophic damage of fossil oil. However, work is ongoing to determine its exact effect on marine life (C. Peacocke, "Transport, Handling and Storage of Fast Pyrolysis Liquids", Conversion and Resource Evaluation Ltd., Ireland). Since BioOil has a density greater than 1, marine transport may have to follow similar regulations as higher density chemicals.

  Initial report of toxicology tests by CIRAD, France on EU funded project advises that BioOil (defined as hydrolyzed wood) is not explosive and non-toxic, further testing is ongoing.

BioOil data sheet for tanker shipment

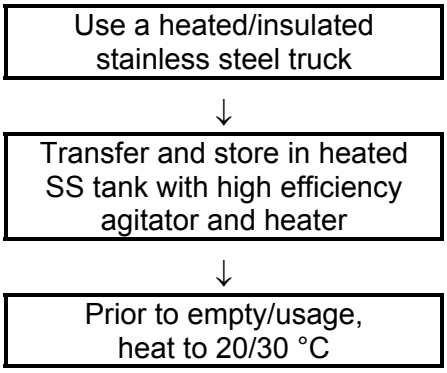
TDG information

UN number: UN1993
TDG Shipping Name: Flammable Liquid N.O.S. (lignin solution)
TDG Classification: Class 3, Packing Group III

Cleaning agents

To clean BioOil from equipment, denatured ethanol (recommended) and methanol are both good cleaning agents for BioOil. Obtain their MSDS information and observe that they have their own dangers (poisonous and flammable).

Shipment of BioOil



Note:

1. BioOil made from bark usually contains some wax (floating on top) and needs to be heated15 °C more than wax free BioOil.
2. Heated container truck is needed in cold weather to transport BioOil.
3. To empty Whitewood BioOil from the truck a temperature above 15/20 °C is recommended and for Whitewood/bark BioOil >30 °C is required.

BioOil Material Safety Data Sheet

Section I Hazardous Ingredients

Ingredients	CAS Registry Number	Concentration (%-weight/weight)
Acetic acid	64-19-7	from 1 to 5 %
Acetone	67-64-1	from 1 to 5 %
Formaldehyde	50-00-0	from 1 to 5 %
Formic acid	64-18-6	from 1 to 5 %
Glyoxal	107-22-2	from 1 to 5 %

Section II Preparation Information

Prepared by: DynaMotive Energy Systems Corporation, 230 - 1700 West 75th Avenue, Vancouver, B.C. V6P 6G2, phone 604-267-6000.
Date: June 23, 2005

Section III Product Information

Manufacturer:	Emergency Phone Numbers:
DynaMotive Energy Systems Corporation	
230 - 1700 West 75th Avenue	DynaMotive (604) 267-6000
Vancouver, B.C.	CANUTEC (24 hours) (613) 996-6666
V6P 6G2	

Product Name: BioOil
Synonyms: Pyrolysis oil, biomass pyrolysis oil
UN number: UN1993
TDG Shipping Name: Flammable Liquid N.O.S. (lignin solution)
TDG Classification: Class 3, Packing Group III
Use: Applications as a liquid fuel or raw material for industrial processes

Section IV Physical Data

Physical State: liquid
Appearance: dark brown liquid
Odour: smoky odour
Odour Threshold: not applicable
Vapour Pressure: not available
Vapour Density: not available
Evaporation Rate: not available
Boiling Point: not available
Freezing Point: not available
pH: ~2.2
Specific gravity: ~1.2 / ASTM D4052
Pour point: -21 °C to -33 °C / ASTM D97
Coefficient of Water/Oil Distribution: not available

Section V Fire or Explosion Hazard

Conditions of flammability:	WHMIS Class B, Division 3. Combustible liquid. Flammable at extremely high temperatures. BioOil consists of about 25% water. When BioOil is distilled to 250 °C, the collected distillate is about 35% of original weight.
Extinguishing media:	water, foam, carbon dioxide, dry chemical. Fire fighters should wear self-contained breathing apparatus.
Flash point/method:	48 - 55 °C / ASTM D93
UEL:	not available
LEL:	not available
Auto-ignition temperature:	not available
Hazardous Combustion Products:	CO_x
Explosion Data	- sensitivity to mechanical impact: no - sensitivity to static discharge: no

Section VI Reactivity Data

Conditions of Instability:	normally stable
Incompatibilities:	oxidizers, elevated temperatures,
Conditions of Reactivity:	high temperatures may generate highly flammable volatile organics.
Hazardous Decomposition Products:	carbon monoxide, acetone, formaldehyde and other volatile organics.

Section VII Toxicological Properties

Route of Entry:

• Skin contact:	may irritate
• Skin absorption:	no information available
• Eye contact:	Eyes are sensitive to BioOil with probable corneal damage resulting from exposure. Refer to section IX for first aid measures.
• Inhalation:	irritating and can be harmful to respiratory tract
• Ingestion:	irritating and can be harmful to gastro-intestinal tract

LC_{50}:	not available
LD_{50}:	not available
Exposure limits:	not established
Effects of Acute Exposure:	Coughing or mild breathing difficulties may result.
Effects of Chronic Exposure:	no information available
Irritancy:	no experimental information available
Sensitizing capability:	no information available
Carcinogenicity:	no information available
Reproductive toxicity:	no information available
Teratogenicity:	no information available
Mutagenicity:	no information available
Toxicologically Synergistic Products:	no information available

Section VIII Preventive Measures

Engineering Controls:	Engineering control measures to reduce hazardous exposures are preferred. Methods include mechanical ventilation (dilution and local exhaust), control of personnel exposure, control of process conditions and process modification. Administrative controls and personal protective equipment may also be required.

Personal protective equipment:

- Gloves: neoprene, latex or equivalent
- Respiratory protection: fume hood or NIOSH/MSHA approved organic vapour respirator as appropriate
- Eye protection: chemical safety goggles
- Clothing: plastic apron, sleeves and boots as appropriate

Storage Requirements:	Store in suitable labeled containers. Keep containers tightly closed when not in use and when empty. Protect from damage. Store in a cool, dry, well ventilated area, out of direct sunlight. Store away from oxidants.

Handling Procedures and Equipment: Follow routine safe handling procedures .

Generally, in case of BioOil spills and disposal, BioOil should be treated in the same manner as fuel oil.

Leak or Spill Cleanup:	Before dealing with spills take necessary protective measures, inform others to keep at a safe distance and shut off all possible sources of ignition. Mix with absorbent such as floor dry, transfer carefully to container and arrange removal by disposal company. Wash site of spill thoroughly with water.
Disposal:	Follow all federal, provincial and local regulations for disposal. Use only licensed disposal and waste hauling companies. Disposal of small amounts of spilled material may be handled as described under “Leak or Spill Cleanup”. Large spills must be dealt with separately and must be handled by qualified disposal companies.
Special Shipping Information:	Follow all TDG regulations and see classification in Section III.

Section IX First Aid Measures

Skin:	flush the contact area with lukewarm running water for at least 15 minutes. Remove contaminated clothing, taking care not to spread the chemical. If contamination is extensive, remove the clothing under running water. Discard

or decontaminate clothing before use. Unless contact has been slight, seek medical attention. Seek medical attention if irritation persists.

Eye: flush the contaminated eye(s) for at least 15 minutes with lukewarm running water, holding the eyelids open. Take care not to rinse contaminated water into the non-affected eye. Always seek medical attention for accidents involving the eyes.

Inhalation: Take proper precautions to ensure your own safety before attempting rescue. Remove source of contamination or move victim to fresh air. If breathing has stopped, trained personnel should begin artificial respiration, or if the heart has stopped, cardiopulmonary resuscitation (CPR) immediately. Seek medical attention.

Ingestion: Never give anything by mouth if victim is rapidly losing consciousness, or is unconscious or convulsing. Rinse mouth thoroughly with water. Do not induce vomiting. Have victim drink 200 to 400 mL of water to dilute. If breathing has stopped, trained personnel should begin artificial respiration, or if the heart has stopped, cardiopulmonary resuscitation (CPR) immediately.