

BioBlend White Paper:

Are NSF H1 certified lubricants environmentally sensitive?

Abstract

In a lubricants world subjected to heightened environmental scrutiny there is often a misunderstanding on the actual differences between lubricants labeled as H1 by the National Safety Foundation (*NSF*) and bio-based lubricants meeting the Environmental Protection Agency (*EPA*) definitions for biodegradability and minimal toxicity to the environment. Companies that consume lubricants and want to support their own or their customers corporate ‘*green*’ or ‘*sustainability*’ objectives need a veritable road-map to understand which lubricants actually align with their goals and objectives, and what management controls need to be implemented so that the lubricants they use truly support stated corporate goals and objectives. This paper will explain fundamental differences between H1 rated lubricants and bio-based biodegradable lubricants, and demonstrate that just because a lubricant is certified H1 does not make it a suitable replacement for bio-based biodegradable lubricants in environmentally sensitive applications ... and vice versa.

Executive Summary

Tribology, the science of lubrication, continues to delve deeper into all aspects of effective and efficient equipment lubrication. The new game-changer is the impact performance-oriented renewable bio-lubes that are biodegradable and minimally toxic per EPA definitions are having on all aspects of lubrication. Companies face a quagmire of uncertainty when it comes to environmental definition interpretation. The lubricants marketplace has not made it easy for consumers or companies to understand what is safe to use in environmentally sensitive applications, and what isn’t. Lubricant manufacturers make a variety of environmental claims related to their technologies that are often misunderstood, or even potentially misleading. The net result is end-user confusion with many questions on which lubricants actually support their objectives, and which do not. Some important distinctions to make include:

- Use of NSF H1 lubricants in environmentally sensitive equipment applications does not represent or suggest that the lubricant user has implemented effective environmental sustainability stewardship.
- NSF H1 certified lubricants lubes do not automatically take the place of bio-based lubricants, especially as it relates to their being biodegradable and minimally toxic as defined by the EPA for use in environmentally sensitive applications. Lubricant claims of biodegradability and toxicity should be supported by recognized and accepted EPA test protocols defining biodegradability and toxicity.
- Bio-based biodegradable lubricants should not automatically be used in applications requiring the use of H1 certified lubricants ‘*unless*’ they possess NSF H1 certification credentials.
- H2 biodegradable lubricants do not automatically take the place of NSF H1 certified lubricants, especially as it relates to their ability to come in incidental contact with food and beverage products.
- There are H2 rated bio-based lubricants in the market that do NOT carry NSF H1 credentials. These H2 bio-based lubricants may claim they are biodegradable and/or minimally toxic to the environment, but without the NSF H1 certification they cannot be used in applications within the food and beverage industry with potential for incidental contact with food and beverage products.
- All too often companies use an H1 product in an environmentally sensitive application because they assume that it is safer than using an H2 lubricant. In reality, applications in environmentally sensitive environments should use products that meet the EPA definition of biodegradability and toxicity for environmentally acceptable lubricants.

- NSF H1 bio-based renewable lubricants based on renewable, biodegradable base oils (*canola, etc.*) do not lose any of their natural lubricity during the refining process like conventional white mineral oils. And, when properly formulated, will offer more natural lubricity than H1 white mineral oils.
- In USDA inspected facilities maximum safety and performance can be achieved by using lubricants that are *'both'* NSF H1 rated and certifiably biodegradable with minimal toxicity as per EPA definitions. In this fashion the lubricant meets applicable legal requirements should it come in incidental contact with food or beverage products, while concurrently having minimal environmental impact should the lubricant be introduced into the environment – such as frequently occurs during equipment wash downs.

Equipment operators making the assumption it's safe to use H1 lubes in environmentally sensitive markets expose their organizations to potential fines and/or litigation if they are using H1 certified lubes where they should be using lubricants that are certifiably biodegradable and minimally toxic to the environment as per EPA definitions. Equipment operators making this assumption in USDA-inspected food and beverage facilities expose their organizations to potential fines and litigation if they are found to be using products other than NSF H1 lubricants in applications where the potential for incidental contact with food or beverage products exists.

The EPA 2013 Vessel General Permit (VGP) mandates that an *Environmentally Acceptable Lubricant (EAL)* must be used in all non-recreational vessels 79 ft. or greater operating within 3 miles of a U.S. coast (*salt water or fresh water*) unless it is deemed *Technically Infeasible* to do so, as per the guidelines. There is a strong likelihood this trend will continue in other environmentally sensitive markets beyond the marine industry.

Making Sense of NSF Category Codes

The NSF site provides category codes to aid in substance identification accessible through the following link: <http://info.nsf.org/USDA/categories.html#A7>. *Table II. Category Codes – Nonfood Compounds* provides three primary category codes for Lubricants:

- **H1 (General - incidental contact):** True food-grade NSF H1 certified lubricants are permitted for use on food/beverage equipment in locations in which there is potential exposure of the lubricated part to food or beverage products, i.e. incidental contact.
- **H2 (General - no contact):** H2 authorized lubricants may be used in food/beverage processing plants on equipment in locations in which there is no possibility of the lubricant or lubricated part contacting edible products.
- **H3 (Soluble Oils):** The USDA H3 category refers to water-soluble oils. The machined part has to be cleaned and free of the emulsion before re-use.

Food, beverage and even pharmaceutical plant lubricant applications typically use both H1 and H2 lubes. USDA-inspected food and beverage facilities have a general requirement to use NSF H1 certified lubricants at and above the food/beverage processing level where the potential for incidental contact with food and beverage products may occur. Conversely, based on the plant layout or design, in many cases H2 rated lubricants are safe for use below the food/beverage processing level where the chance for incidental contact with food/beverage products is minimal. The objective has never been for H1 lubricants to be inadvertently dumped into food and beverage products in large volumes. However it's acceptable for food and beverage products destined for human consumption to have 'incidental' lubricant contamination, but only from H1 certified lubricants.

NSF Certified H1 Lubricants

The NSF program is guided by Title 21 of the FDA's Code of Federal Regulations using a formal procedure to review and certify lubricants as being in compliance with the various FDA Title 21 regulations. H1 lubes are formulated

with FDA Title 21-approved ingredients, making them safe for incidental contact with food and beverage products. A listing of NSF H1 certified lubricants can be found on their website at www.nsf.org/usda/listings.asp.

NSF H1 Lubricant Base Oils/Formulations

Lubricating fluids and greases can be formulated with a variety of base oils and still be classified as NSF H1.

Typical Base Oil Biodegradability Levels		
H1 Lubricant Type	Base Oil Type	% Biodegradability
H1 Bio-based Renewable Oil	Natural & Vegetable Oil	70-100%
H1 Bio-based Synthetic Oil	Polyol, Diester, Polyalkylene Glycol (PAG) Synthetic	55-100%
H1 White Mineral Oil	White Mineral Oil ... <i>your typical H1</i> <i>(non-biodegradable petroleum-based white oils)</i>	25-45%
(H2-rated)	Mineral Oil <i>(non-biodegradable conventional petroleum oils)</i>	15-35%
H1 Synthetic Oil	Polyalphaolefin (PAO) Synthetic	5-30%
	Polyisobutylene (PIB) Synthetic <i>(non-biodegradable conventional synthetic oils)</i>	0-25%

This insight suggests that one understand recognized definitions relevant to this paper. A **Renewable Resource** is any natural resource (*as in plants or solar energy*) that can be replenished naturally within a period of 10 years. A **Sustainable Resource** is an available supply that can be drawn on when needed and is capable of being continued with minimal long-term effect on the environment. **BioBased Products** are defined by the U.S. Secretary of Agriculture in the *Farm Security and Rural Investment Act of 2002*, as any manufactured, commercial, or industrial good (*non-food*) that is made up of biological materials or agricultural resources within the United States. And, **Biodegradation** is the chemical breakdown of the base oil and additives into carbon dioxide and water, in the presence of organisms, air, and water. Biodegradability has many different 'names' or 'classifications' and is the most frequently misunderstood definition, making it important to understand lubricant manufacturer claims.

Defining Biodegradability		
Nomenclature	% Biodegradation (28 days or less)	EPA OPPTS 835.3110 and OECD Guidelines Biodegradability Definitions
Inherently Biodegradable	20-60%	A classification of chemicals for which there is unequivocal evidence of biodegradation (primary or ultimate) in any test of biodegradability.
Readily Biodegradable	60% or more	Arbitrary classification of chemicals which have passed certain specified screening tests for ultimate biodegradability; these tests are so stringent that it is assumed that such compounds will rapidly and completely biodegrade in aquatic environments under aerobic conditions.
Ultimately Biodegradable	60% or more	The level of degradation achieved when the test compound is totally utilized by microorganisms resulting in the production of carbon dioxide, water, mineral salts, and new microbial cellular constituents
Non Biodegradable	-	Negligible biotic removal of material under test conditions

This clearly illustrates why conventional white mineral oil based NSF H1 lubricants are NOT suitable replacements for lubricants that truly possess biodegradability characteristics. While the lubricant manufacturer's claims may not be intentionally misleading, these typical biodegradability results leave room for misinterpretation unless one understands the definitions for biodegradability. For example, literature may state an H1 lubricant is '**inherently biodegradable**' so the end user believes that product meets the EPA definition for biodegradability and

subsequently uses that lubricant in an environmentally sensitive application that actually requires a **‘readily biodegradable’** lubricant. There is actually a big difference.

An EPA-supported Case for Bio-based Biodegradable Lubricants

Recent legislation by the U.S. EPA puts a spotlight on the biodegradability issue, and correctly ties to biodegradability measurement the toxic impact that lubricant has on the environment and all soil and water-borne microorganisms and higher life forms it encounters as it biodegrades. This legislation mandates that lubricants be measured to determine whether or not they bioaccumulate (*build-up*) in specific eco-sensitive aquatic and soil species during the biodegradation process. While biodegradability and toxicity have long been a part of professional sanctioning of bio-based lube technologies, this addition of bioaccumulation testing is relatively new.

On December 19th, 2013 the U.S. EPA issued a mandate via their *Vessel General Permit (VGP)* that all non-recreational vessels 79 ft. or greater in length operating within 3 miles of a U.S. coastline must use an *Environmentally Acceptable Lubricant (EAL)* in all lube applications with the potential for an oil-to-sea interface unless it is *Technically Infeasible* to do so. The VGP is tied to the *Clean Water Act* and applies to all vessels operating in salt or fresh water. The inclusion of fresh-water makes the VGP applicable to qualifying vessels operating on the St. Lawrence Seaway, the Great Lakes, and large rivers with tug and barge activity – and means that use of an EAL must occur wherever oil-to-water interface potential exists. The 2013 VGP provides a statement to the marketplace on the expanding & important role of bio-lubes, demonstrating a forward step is being made to back environmental claims with scientific testing. The final 2013 VGP is a complex document with one significant revision tied directly to lubricants: The 2008 VGP revision said EAL’s **‘should’** be used, while the 2013 VGP revision says EAL’s **‘must’** be used. The VGP is also very specific regarding whether or not a lube can be classified as an EAL.

2013 VGP Criteria for Lubricant Classification as an EAL		
<i>As defined in Appendix A of the 2013 VGP, there are three criteria for a product to be classified as an Environmentally Acceptable Lubricant (EAL)</i>		
EAL Criteria	Recognized Testing	Comment
Biodegradable	<ul style="list-style-type: none"> - OECD 301 A-F, 306, and 310 - ASTM 5864 - ASTM D-7373 - OCSPP Harmonized Guideline 835.3110 - ISO 14593:1999 	> 60% means ‘biodegradable’ under this standard (<i>28 day test</i>)
Minimally Toxic	<ul style="list-style-type: none"> - OECD 201, 202, and 203 for acute toxicity testing (<i>ISO/DIS 10253 for algae, ISO TC147/SC5/W62 for crustacean, and OSPAR 2005 for fish, may be substituted</i>) - OECD 210 and 211 for chronic toxicity testing 	Safe for contact with skin, non-carcinogenic
Not Bioaccumulative	<ul style="list-style-type: none"> - The partition coefficient in the marine environment is log KOW <3 or >7 using test methods OECD 117 and 107 - Molecular mass > 800 Daltons - Molecular diameter >1.5 nanometer - BCF or BAF is <100 L/kg using OECD 305, OCSPP 850.1710 or OCSPP 850.1730 - Field-measured BAF - Polymer with MW fraction below 1,000 g/mol is <1% 	Typically a calculated value

There are significant differences between H1 rated lubes and the EAL lubes meeting the 2013 VGP, especially as it relates to non-recreational vessels operating in salt/fresh water in port areas and on navigable rivers.

Enviro-Sensitive Markets

Many enviro-sensitive applications are not marine related and thus not directly impacted by the EPA’s 2013 VGP. In these instances use of bio-based renewable lubricants that are **‘readily biodegradable’** and **‘minimally toxic’** are

good environmental choices for companies interested in supporting their own and/or their customers sustainability or green goals and objectives. Some of the markets fitting this category include, but aren't limited to:

- Agriculture/Farming
- Concrete Work
- Construction
- Drilling (water/oil/gas)
- Forestry/Logging
- Government Ops.
- Landscaping
- Metalworking
- Sand & Gravel Ops.
- Mining
- Municipality Ops.
- Oilfield Services
- Parks & Recreation
- Skiing/Outdoor Recr.
- Vineyards

Performance Differences: H1 Biodegradable Lubricants vs. H1 White Mineral Oil Lubricants

One critical performance attribute differentiating bio-based H1 lubes from white mineral oil H1 lubes is lubricity. Lubricant manufacturers rarely talk about how the conventional petroleum oil refining process used to create the white mineral oils used in the production of conventional H1 lubricants removes some of the natural lubricity from those white oils. The net result is they frequently require significant additive treatment to bolster the desired performance properties required for effective service. Further, the additives used to bolster specific performance attributes can directly impact both the biodegradability and toxicity of the finished H1 lubes.

Conversely, renewable bio-based lubricants have naturally great lubricity and naturally high *Viscosity Indexes (VI's)* making them very resilient to changes in viscosity with changes in temperature. H1 certified bio-based lubricants, especially those based on canola or other high oleic acid based bio-tech, are tremendous natural lubricants that require no additional finishing to prepare them to be classified as H1 lubes. The net result when coupled with bio-sensitive performance-enhancing additive treatments is the end-user does not have to accept a lubricity performance deficiency. End users get the best of both worlds; an H1 certified product that meets applicable legal requirements should it come in incidental contact with food or beverage products, combined with a lubricant that meets the EPA definitions for biodegradability and toxicity with minimal impact should the lubricant be introduced into the environment – such as frequently occurs during equipment wash downs.

Summary

Every person on this planet is directly impacted by both soil and water contamination issues. In fact, concerns over global warming pale in comparison to the impact hydrocarbon (*oil and grease*) contamination can have on the quality of human water and food sources. To put this in visual perspective, think of the daunting task involved with the proper disposal of used engine oil for your automobile(s), and those of every automobile on this planet. And this is just the tip of the iceberg.

As the marketplace moves towards heightened environmental awareness, advanced lubricant stewardship and enhanced corporate sustainability the trend of using performance-oriented bio-based renewable lubricants will continue to increase. The advent of the EPA's revised 2013 VGP with its mandate to incorporate the use of an EAL in all applications where the potential for an oil-to-sea or oil-to-water interface exists is proof of just how serious hydrocarbon contamination of water and soil has become. The revised VGP also suggests a pattern has now been established whereas biodegradable lubricant marketers must back up their environmental claims with technical test data.

Marine Impact: It is a fact that over 706 million gallons of oil spills into the ocean each year. However, the ocean isn't the only negatively impacted environment on our planet due to petroleum based oil spills. Land, sea, plants, birds and animals, food sources can all be impacted by a spill; small or large, that occurs in a salt or freshwater environment. That's why it is of critical importance to understand the options available and how different products work. Utilization of renewable bio-based lubricants that are readily biodegradable within 28 days (*as per applicable tests*) leaving waterways and marine environments safer, cleaner and without a telltale sheen on the water's surface are critical to basic aquatic and human sustainability.

Soil Impact: The volume of lubricants of all types, NSF H1, H2, mineral-based, synthetic or bio-based that end up in our soils is almost impossible to determine, but is known to be significant. Experts generally agree that the most common land/soil pollution chemicals are petroleum hydrocarbons, solvents, pesticides, lead and other heavy metals. Concerns over soil contamination stem primarily from health risks, from direct contact with the contaminated soil, vapors from the contaminants, and from secondary contamination of water supplies within and underlying the soil. Hydrocarbon contamination can and does reach groundwater aquifers used for human consumption, sometimes in areas far removed from any apparent source of above ground contamination. Health consequences from exposure to soil contamination vary greatly depending on pollutant type, pathway of attack and vulnerability of the exposed population. Mapping of contaminated soil sites and the resulting cleanup are time consuming and expensive tasks, requiring extensive amounts of geology, hydrology, chemistry and computer modeling skills. Having a legal framework to identify and deal with environmental soil contamination is the precise reason why regulations pertaining to lubricant usage and contamination continue to escalate.

Not unexpectedly, soil contaminants can have significant deleterious consequences for ecosystems. There are radical soil chemistry changes which can arise from the presence of many hazardous chemicals even at low concentration of the contaminant species. These changes can manifest in the alteration of metabolism of endemic microorganisms and arthropods resident in a given soil environment. The result can be virtual eradication of some of the primary food chain, which in turn could have major consequences for predator or consumer species (*like humans*). Even if the chemical effect on lower life forms is small, the lower pyramid levels of the food chain may ingest alien chemicals, which normally become more concentrated for each consuming rung of the food chain. Many of these effects are now well known. Here also utilization of renewable bio-based lubricants that are readily biodegrade within 28 days (*per applicable tests*) leaving soil environments safe and clean are critical to basic microbial and crop-based soil integrity, as well as human sustainability.

Conclusion: There was a lubricant quality and performance evolution experienced over the time the first petroleum lubricants were introduced to the marketplace, to where they are today. The same can be said about the evolution of synthetic lubricants, their quality and performance today far exceeds their quality and performance when they were first introduced. The renewable bio-based lubricants in the marketplace today represent the most modern tribological evolution in lubricant technology. There is a strong case for using renewable biodegradable lubricants that are minimally toxic in all facets of the marketplace, and manufacturers have responded with revolutionary performance-driven technologies. Businesses engaged in the food and beverage industry can now utilize a NSF H1 rated biodegradable lubricants that are minimally toxic. This solution allows this class of lubricants to come in incidental contact with food and beverage products, and be biodegradable and minimally toxic to the environment should it inadvertently end up in soil or water. Not only is our water quality at risk, but the sanctity of our food-chain is at risk as well. BioBlend Renewable Resources encourages the use of performance oriented renewable lubricants in all applications, not just environmentally sensitive applications.

BioBlend Renewable Resources, LLC made their lubricant debut in the field in 2001. Since then, we've continued our bio-lubes innovation quest expanding our product line to include not only the most advanced biobased lubricant technologies available, but also food grade and synthetic lubricants. BioBlend's goal is to provide environmentally responsible products and solutions to a wide range of industries. Our customers come to us from every corner of the earth and in every industry: drilling, mining, construction, agriculture, marine, food processing, government, and many more. The BioBlend team has a wealth of experience in lubricants, manufacturing, and distribution. The company also has the venture capital backing of Archer Daniels Midland (NYSE: ADM) and Quest Technology Ventures.

- ✓ ***Made in the United States of America***
- ✓ ***Renewable***
- ✓ ***Readily Biodegradable***

- ✓ **Minimally Toxic**
- ✓ **Sustainable**
- ✓ **Performance Driven**
- ✓ **Cost Competitive**

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REFERENCES:

Environmental Protection Agency, "VESSEL GENERAL PERMIT FOR DISCHARGES INCIDENTAL TO THE NORMAL OPERATION OF VESSELS (VGP), AUTHORIZATION TO DISCHARGE UNDER THE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM", In compliance with the provisions of the Clean Water Act (CWA), as amended (33 USC 1251 et seq.), Dec 19, 2013.

Panagos, P., Van Liedekerke, M., Yigini, Y., Montanarella, L. (2013) Contaminated Sites in Europe: Review of the Current Situation Based on Data Collected through a European Network. *Journal of Environmental and Public Health* In Press. doi:10.1155/2013/158764

Risk Assessment Guidance for Superfund, Human Health Evaluation Manual, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington D.C. 20450.

Snyder C (2005). "The dirty work of promoting "recycling" of America's sewage sludge". *Int J Occup Environ Health* **11** (4): 415–27. PMID 16350476. Free full-text (registration required).

R. Olawoyin, S. A. Oyewole, R. L. Grayson, (2012). Potential risk effect from elevated levels of soil heavy metals on human health in the Niger delta, *Ecotoxicol. Environ. Saf.*, Volume 85, 1 November 2012, Pages 120–130
<http://yosemite.epa.gov/water/owrcCatalog.nsf/065ca07e299b464685256ce50075c11a/383316fae0e9065285256cfd0048e1d2!OpenDocument>.

Michael Hogan, Leda Patmore, Gary Latshaw and Harry Seidman *Computer modeling of pesticide transport in soil for five instrumented watersheds*, prepared for the U.S. Environmental Protection Agency Southeast Water laboratory, Athens, Ga. by ESL Inc., Sunnyvale, California (1973).

S.K. Gupta, C.T. Kincaid, P.R. Mayer, C.A. Newbill and C.R. Cole, "A multidimensional finite element code for the analysis of coupled fluid, energy and solute transport", Battelle Pacific Northwest Laboratory PNL-2939, EPA contract 68-03-3116 (1982).

Facing up to "invisible pollution"

Martin Williamson, "Understanding Food Grade lubricants", *Machinery Lubrication*, A Noria Publication, Jan. 2013.

David Turner, "Food-grade Greases", *Machinery Lubrication*, A Noria Publication, Nov 2007.

Sabin Gebarin, "the Basics of Food-grade Lubricants", *Machinery Lubrication*, A Noria Publication, Jan. 2009.

Tocci, Lisa, "Brouhaha in Food-grade Lubes". *Lubes N' Greases*, July 2004.

Judge, Diana, Shell Lubricants, "Switching to Food-grade Lubricants Provides Safety Solution". *Machinery Lubrication* magazine. 2005.

Williamson, M., Noria UK Ltd., "Understanding Food-Grade Lubricants". *Machinery Lubrication* magazine. 2003.

Lloyd Leugner, Maintenance technology International, Inc., "Biodegradable Oils – How to Apply and Maintain", *Machinery Lubrication*, A Noria Publication, Jul. 2003.

NSF International Registration Guidelines (July 2003) version 3.3, retrieved October 2004 from http://www.nsf.org/business/nonfood_compounds/guidelines.pdf.

Hodson, D., Shell Cassida, "Food-Grade Lubricants Reduce Contamination Threats for Food and Beverage Manufacturers". *Machinery Lubrication* magazine. 2004.

S.Z. Erhan B.K. Sharma K.M. Doll, "Improving Vegetable Oil Properties for Lubrication Methods" Machinery Lubrication, A Noria Publication, 2009.

Girard, J. Lubriplate Lubricants Division, Fiske Brothers Refining Company, "The Continuing Evolution of Food-Grade Lubricants". *Machinery Lubrication* magazine. 2002.

21 CFR 178.3570 – Lubricants with Incidental Food Contact. Retrieved November 2004 at <http://www.gpoaccess.gov/cfr/index.html>.

Mackwood, W., Muir, R., "Calcium Sulfonate Complex Grease: The Next-generation Food Machinery Grease". NLGI Spokesman, 17, 2003.

Noria Corporation, "Switching to H1 Food-grade Lubricants", Machinery Lubrication

Saurabh Lawate, The Lubrizol Corporation, "What You Need to Know About Food-grade Lubricants", Machinery Lubrication, A Noria Publication, Jul. 2007.

Loren Green, Noria Corporation, "What You Should Know About Food-grade Lubricants", Machinery Lubrication, Apr. 2014.