BioBlend White Paper:

Sewer Line Plugging Reductions with BioBlend Technologies

Abstract

The devastating impact of inadvertent lubricant discharges into the environment, including storm drain and sewer drainage systems, can be mitigated by using properly formulated bio-lubes versus conventional petroleum and/or synthetic lubricants.

Statistics suggest that approximately 2.5 billion gallons of finished lubricants are sold annually in NA. Some studies suggest that up to 60% of this fluid, approximately 1.5 billion gallons, is not accounted for meaning it is either burned as an alternative energy source or is ending up in ground water, rivers, lakes and on the ground, causing untold harm to the environment, fish and wildlife. **(1)** It also exposes the people and companies responsible for these discharges to potential litigation.

Petroleum oil is toxic for most life forms and episodic and chronic pollution of the environment by oil causes major ecological impacts. Marine environments are especially vulnerable, since oil spills of coastal regions and the open sea are poorly containable and mitigation is difficult. In addition to significant pollution through human activities, millions of tons of petroleum enter the marine environment every year from natural seepages**. (2)**

Marine, forestry, agriculture, refuse & construction industries in particular, along with citizen groups and governments, are becoming more and more concerned about our responsibility to the protection of the environment. Inadvertent lubricant discharges can be introduced directly into aquatic environments; oceans, lakes, rivers, streams as well as directly onto the soil. In both cases these discharges have a devastating impact on aquatic and soil microbes, which carries right on up the food chain. Waste lubricant discharges have a direct impact on the environment we all live and work within, as well impacting even our basic quality of life, including; drinking water quality, agricultural soil impacts, etc.

An often overlooked aspect of lubricant discharges, yet equally as devastating, is related to the signifcant volumes of used lubricants introduced into the underground storm and waste water discharge infrastructure. Sewer and storm drainage systems exist within, and often under, every developed town and city. Because these subterranean systems are 'out-of-sight', the impact used lubricants can have on proper system functionality often goes unnoticed … until a problem occurs. It's recognized that even with controls, a certain amount of used lubricant is going to end up in these systems. This paper examines the advantages of using bio-lubes versus conventional petroleum or synthetic lubricants to aid in mitigating the known and devastating impact used oil discharges have on the environment, and the systems mankind has developed to control storm water discharge and sewage.

Storm Drain Discharges – Unintended Environmental Stewardship

Ever since finished lubricants were first introduced, there has been an issue with inadvertent discharges of used lubricants into the environment. There are millions of automobiles and trucks of all shapes and sizes utilizing the North American transportation infrastructure. This is augmented by the fact that there are literally millions of pieces of off-road equipment working directly in the dirt and/or near and around water systems. The net impact is around the clock used oil discharges. While the impact of leakage from a single piece of rolling stock may be small, the cumulative impact suggests that an undesirable volume of used oil is entering our environment. As interstate and rural highways see rain – vehicular lubricant discharges end up directly in soil and water environments. As cities clean their streets, or when it rains, storm drains are the final destination for much of this ‘spilled oil’ with many storm drains discharging directly into water systems; storm drain canals, streams, rivers, lakes, etc..

Sewer Discharges – Unintended Environmental Stewardship

One of the beauties of a civilized industrial society is the subterranean sewage systems prevalent throughout North America. Too many people the sewer system is where everything ‘disappears’, but nothing could be further from the truth. All sewer systems lead somewhere, typically to a waste water treatment facility that is funded by taxpayer dollars. This means every taxpayer, and every person, has a stake on what is/is not introduced into our sewer infrastructure.

The introduction of refined oils and greases into sewer lines can have a devastating impact on waste discharge efficiencies. Used lubricants can accumulate and build up on the inside of sewer lines. This not only impedes the overall flow of the sewage effluent, but can result in obstructions that are signifcant enough to result in complete blockage. Such blockages can have devastating impacts on the businesses and homes connected to the impacted sewage system with back-ups resulting in signifcant clean-up and remediation costs – to say nothing of the potential health risks associated with exposure to raw sewage. This is very much akin to the build-up of plaque and deposits within our arteries, which slows blood flow to your heart, and can eventually result in a heart attack.

A clogged sewer   A clogged artery

Just because one doesn’t see sewage doesn’t mean the challenges lubricant discharges bring to sewer line maintenance and efficient waste water treatment should go unnoticed, nor unaddressed.

Regulatory Impact

Concerns related to lubricant discharges into the environment, be it directly into aquatic or soil environments, or indirectly through the storm and/or waste water treatment infrastructure, have driven the creation of multiple discharge standards at the city, county, state and federal levels. Heavy manufacturing and industrial facilities frequently monitor used oil discharge levels to manage and control, and to minimize used lubricant introduction into the environment.

Quick lube service centers are often monitored for environmental discharges due to the very nature of their business and the volume of used oil they regularly contend with. Food and beverage facilities, even those that have implemented the use of NSF H1 rated lubricant technologies that are safe for incidental contact with food and beverage products, experience frequent plant wash downs and operational challenges that may result in used lubricant discharges into the sewer system. Perhaps most prolifically refuse, construction and logging operations, as well as vehicular and/or trucking operations of all types, to include municipal government vehicle fleets, offer visual reminders of the impact inadvertent lubricant discharges can have on the environment. After all, who wants their local refuse hauler to accidentally dump 5, 10 or more gallons of hydraulic fluid on the street in front of their home?

This problem is further exasperated by commercial, industrial, and/or institutional facilities, which engage in, among other things, the preparation, processing, packaging, and/or manufacturing of commodities of all types. They too are challenged to manage and control the introduction of used oils and greases into sewage lines where they can accumulate in sewer lines and directly affect operation and treatment, to include direct environmental discharges.

FOG's … A 'very real' Sewer Problem

FOGs *(fats, oils & greases)* … which includes lube oils … Re known to accumulate and build up inside sewer lines which:

- Impedes overall flow of sewage effluent.
- Results in obstructions & possibly complete blockage.

Back-ups & blockages have devastating impacts on businesses & homes connected to impacted sewage systems creating:

- Significant clean-up and remediation costs.
- Potential health risks associated to raw sewage exposure.

Just because you don't see sewage doesn't mean FOG discharge issues should go unnoticed … nor unaddressed. And, it's important to recognize that the type oil you're using does make a difference – both in reducing FOG agglomeration as well as minimizing the environmental impact should these lube oils be introduced into the environment, to include sewer lines.

Conventional Petroleum and Synthetic Lubricants ... they're a problem!

Petroleum oil is toxic for most life forms causing chronic pollution of the environment resulting in major ecological impacts. Marine environments are especially vulnerable, since oil discharges are poorly containable and mitigation is difficult. Waste lube discharges have a direct impact on the environment we all live and work within … impacting even our basic quality of life, including;

Drinking water quality
Water quality in lakes & rivers
Agricultural soil impacts / etc.

Petroleum oil is only <u>inherently biodegradable</u> *(typically <20%)* while BioBlend bio-lube technologies are <u>readily biodegradable</u> *(>60%)* … thus offering a notable environmental advantage.

- Using BioBlend *(readily biodegradable bio-lubes)* vs. conventional petroleum/synthetic lubes helps mitigate the known & devastating impact of used oil discharges:
  - ✓ On the systems mankind has developed to control sewage & storm water discharges.
  - ✓ On the environment.
- Used lubes aren't the only problem … so too are FOG discharges from food facilities, restaurants & homes.
  - ✓ That's why there are regulations tied to FOG discharges enforced at most city and/or county and/or state levels.

This drives one to ask the question; ***"Why evaluate the sewer clogging tendency of 'lube oils'?"***

- If it could be demonstrated that BioBlend bio-lubes could measurably reduce sewer plugging tendency vs. conventional petroleum and synthetic lube oils … municipal sewer maintenance & operational costs would be dramatically reduced - especially if:
  - ✓ It did so consistently - even with variations in water concentrations.
  - ✓ It did so consistently – even with variations in temperature *(i.e. cold plugs).*
- The need for oil/water separators could be over:
  - ✓ Separators are used because lube oil has clogging tendencies … so the oil must be removed prior to discharge into sewer systems.
  - ✓ Separator installation & operational costs are known to be high.
  - ✓ Eliminating the need for oil/water separators would reduce costs & save municipal tax dollars.

Generalized Analytical Test Considerations

Since there is not a recognized test to differentiate clog tendencies of FOGs, the following clog tendency factors were considered:

- ***Water Concentration Fluctuations … the Water Impact***
  - Water is a primary component in sewers, and aids in flow
- ***Temperature Variations … the Temperature Impact***
  - The colder it gets, the greater the tendency for FOGs to solidify on the inside of sewer walls … creating blockage, and requiring signifcant tax-payer dollars to manage & remove.
- ***Microbial Oxygen Demand … The Oxygen Impact***
  - Air containing oxygen resides within sewer lines.
  - Oxygen is needed for the microbial breakdown of organic materials
  - Oils that inhibit microbial oxygen uptake inhibit raw sewage breakdown.

Performance Measurements … on FOGs that clog sewer lines

- ***Why all the testing?***
  - Again – the ability of BioBlend bio-lubes to reduce sewer line clogging vs. other FOGs … has massive and positive cost saving ramifications:
  - Sewer lines will not clog as frequently … Costly sewer back-ups are minimized.
  - Health risks associated with exposure to raw sewage are significantly reduced.
- ***The Water Impact:***
  - Representative samples of *BioBlend BioFlo Biodegradable Hydraulic Fluid* and other FOGs were mixed 50:50 with water.
  - Simulates the presence of water in an active sewer system.
- ***The Temperature Impact:***
  - Representative samples of *BioBlend BioFlo Biodegradable Hydraulic Fluid* & other FOGs were evaluated for the impact on their *solidification potential* as temperatures were reduced.
  - Simulates real life ambient temp swings … and the derogatory impact cold temp has on FOGs propagating sewer line clogging.
- ***The Oxygen Impact:***
  - Representative samples of a BioBlend biodegradable hydraulic fluid technology *(enviromax)* & other FOGs were submitted for BOD & COD analysis.
  - BOD *(Biochemical Oxygen Demand)* and COD *(Chemical Oxygen Demand)* are known tests used to evaluate the impact a substance might have on minimizing the oxygen availability necessary for the microbial breakdown of sewage *(we anticipated governing entities might ask about it).*

We tested several well known FOGs known to end up in sewers, where they accelerate sewer clogging:

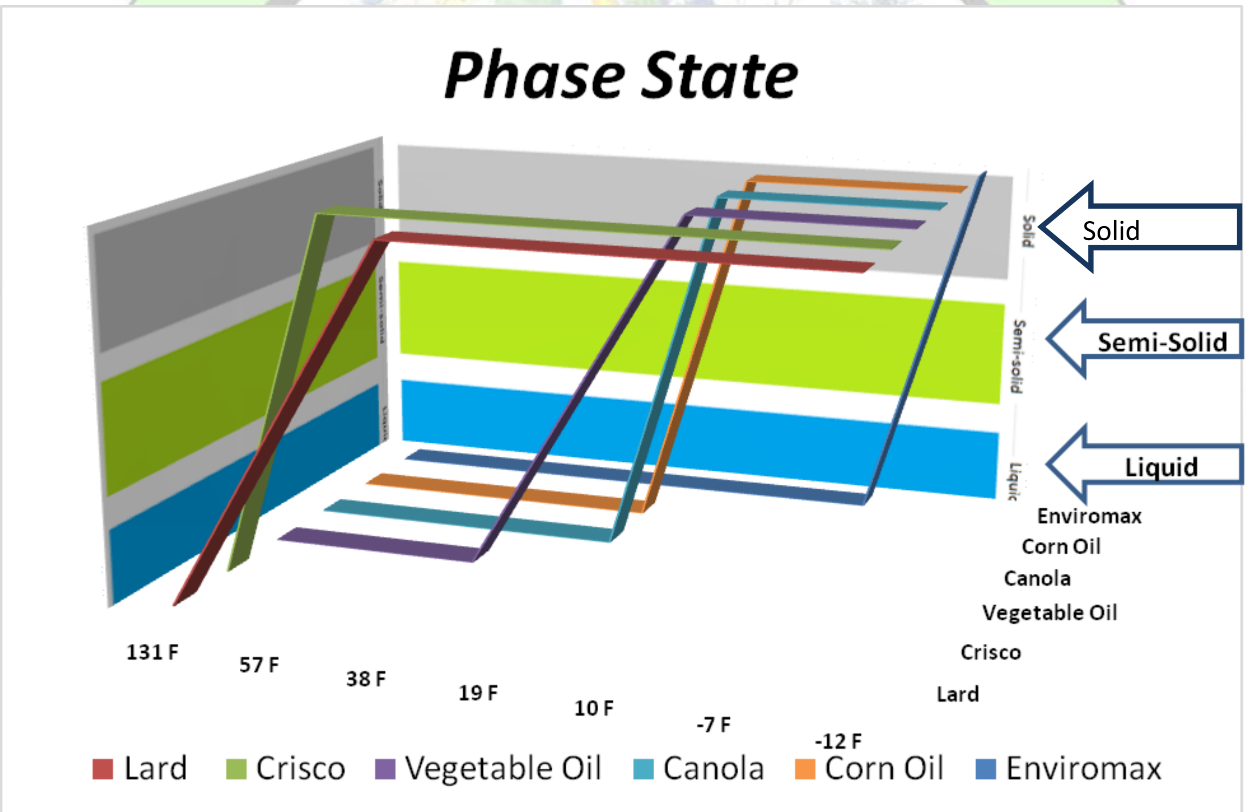
- ✓ Lard
- ✓ Crisco

- ✓ Wesson Vegetable Oil
- ✓ Canola
- ✓ Mazola Corn Oil
- ✓ BioBlend biodegradable hydraulic fluid *(specifically 'enviromax' - a biodegradable hydraulic fluid developed in conjunction with ThyssenKrupp with technology akin to the standard BioBlend hydraulic fluid product series)*

Analysis Results

The Water Impact: The referenced FOGs were mixed 50:50 with water to simulate the conditions they'd encounter if released into a sewer, which uses water for flow.

The Temperature Impact: The 50:50 FOG blends (oil + water) were placed in a freezer and monitored at steadily decreasing temperatures to determine the FOG/Water mixture solidification potential. The following chart shares the results of this investigation since FOG solidification increases sewer clog tendency:



FOG Solidification Clogging Potential Test Photos

FOG Solidification Clogging Potential - Testing

(Room Temp to 131°F to 50% Water Contamination)

Start of Test:

- **FOGs @ room temp**
- **Before heating**
- **Neat** *(no water)*

Heat Impact:

- **FOGs heated to target temp of 131°F** *(lard melted)*
- **Neat** *(no water)*

Water Impact:

- **Add 50% water**
- **Reheat to 131°F**

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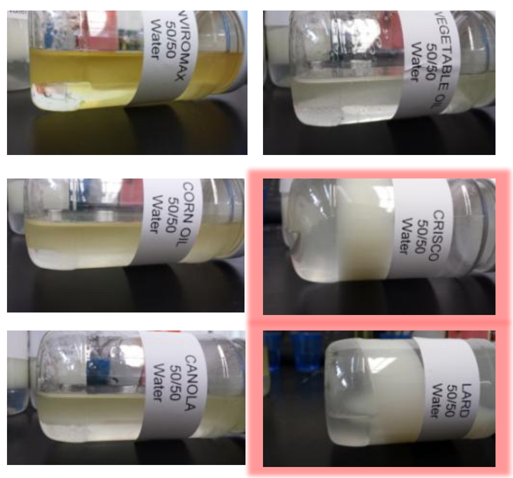
FOG Solidification Clogging Potential - Testing

(Phase 1 Temp: Cooled from 131°F to 57°F)

FOGs @ 57°F … tilted



Phase 1: FOGs Solidification:

- **Started @ 131°F**
- **50% FOG / 50% Water**
- **Cooled to 57°F**

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FOG Solidification Clogging Potential - Testing

(Phase 2 Temp: Cooled from 57°F to 38°F)

FOGs @ 38°F … tilted

Phase 2: FOGs Solidification:

- Started @ 131°F
- 50% FOG / 50% Water
- Cooled to 38°F

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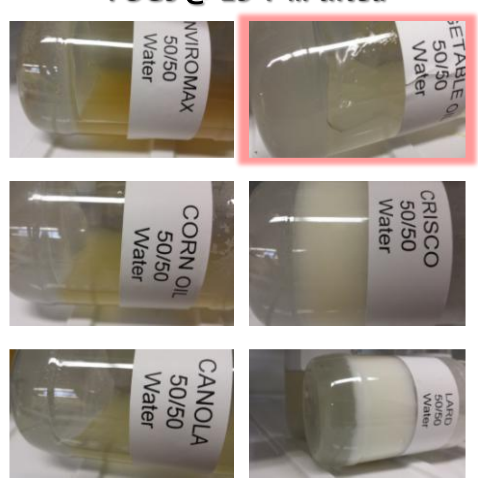
FOG Solidification Clogging Potential - Testing

(Phase 3 Temp: Cooled from 38°F to 19°F)

FOGs @ 19°F … tilted

Phase 3: FOGs Solidification:

- Started @ 131°F
- 50% FOG / 50% Water
- Cooled to 19°F
- All FOGs … 4 hours in freezer



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BioBlend/enviromax

- ✓ All samples were placed in a low temp freezer & reduced to -7°F.
- ✓ All FOGs m were solid … except the BioBlend bio-lube technology!
- ✓ The BioBlend technology stays liquid longer …minimizing solidification clog tendency as temperatures in sewers drop!

Another way to view the solidification potential is to view results in a chart:

FOG Solidification Results with 50% Water							
FOGs	***Temperature, °F***						
	131	***57***	***38***	***19***	***10***	***-7***	***-12***
Lard	Liquid	Semi-Solid	**Solid**	**Solid**	**Solid**	**Solid**	**Solid**
Crisco	Liquid	**Solid**	**Solid**	**Solid**	**Solid**	**Solid**	**Solid**
Wesson Veg. Oil	Liquid	Liquid	Liquid	Semi-Solid	**Solid**	**Solid**	**Solid**
Canola	Liquid	Liquid	Liquid	Liquid	**Solid**	**Solid**	**Solid**
Mazola Corn Oil	Liquid	Liquid	Liquid	Liquid	**Solid**	**Solid**	**Solid**
BioBlend technology	Liquid	Liquid	Liquid	Liquid	Liquid	Liquid	**Solid**

The Oxygen Impact: Microbes are essential life forms found in water and soil that serve a vital role in eco-system functionality … with most requiring oxygen to survive. Fluid and/or solid contaminants that negatively impact the ability for these essential microbes to get the oxygen they need to do their work can have a negative environmental consequence.

- <u>In sewers</u> … digestive microbes need oxygen to start and maintain the breakdown and digestion of raw sewage.
- <u>In rivers and streams</u> … microbes need oxygen to survive and serve their role in marine eco-system functionality.

Because of this - measurement of a fluids oxygen limiting impact is an important and recognized environmental impact screening tool. Two commonly used tests recognized as tools to measure the impact a fluid may have oxygen availability include:

1. ***<u>Biochemical Oxygen Demand</u> (BOD):***
   - ✓ BOD is the amount of oxygen required for microbial metabolism of organic compounds in water. *(an aerobic process).* Demand occurs over a variable period of time depending on temp., nutrient concentrations & enzymes available to indigenous microbial populations.
   - ✓ <u>BOD can be used as a gauge of the effectiveness of WWTP's</u>. Products with BOD's are listed as conventional pollutants in the U.S. Clean Water Act.
2. ***<u>Chemical Oxygen Demand</u> (COD):***
   - ✓ Measurement of the amount of material that can be oxidized *(combined with oxygen)* in the presence of a strong chemical oxidizing agent.
   - ✓ Most applications of COD determine the amount of organic pollutants found in surface water *(i.e. lakes & rivers)* or wastewater, making <u>COD a useful measure of water quality</u>.
   - ✓ Expressed in milligrams per liter *(mg/L) …* also referred to as ppm *(parts per million),* which indicates the mass of oxygen consumed per liter of solution.

BOD/COD analysis is recognized testing that quantifies the impact a test fluid will have on the oxygen uptake of select microbes in an aqueous *(water prevalent)* environment.

- BOD is commonly used as a gauge of the effectiveness of WWTP's. *(i.e. oxygen uptake for digestive microbes for sewage breakdown).*
- COD is commonly used as a useful measure of water quality *(i.e. oxygen uptake for microbes commonly found in rivers and lakes)*

<u>The fluid being evaluated</u> + <u>water</u> + <u>select microbes or enzymes</u> are all added to the COD/BOD test vials. Dissolved oxygen is measured before and after a 5 day ***'at-rest'*** test vial incubation period … there is no agitation of the mixture. The idea is to measure whether or not the fluid being tested has a negative impact and inhibits the oxygen required for microbial digestion of the fluid being tested.

Here's the problem: Because COD/BOD tests are designed to run with water *(it's an aqueous solution in the test vial)*, fluids being tested must be miscible in water so they can ***'go into solution'*** to determine their impact on microbial digestion of the product being tested. Typical FOGs are oils. Typical FOGs have a specific gravity lighter than water … typical FOGs will float on the surface of water. You can **NOT** gain a viable BOD/COD value for FOGs under current BOD/COD test parameters.

Summary – Sewer Line Plugging

There were three areas evaluated to compare the sewer clogging tendency of FOGs … including the biodegradable BioBlend bio-lube technologies

- The Water Impact
- The Temperature Impact
- The Oxygen Impact

The objective in studying these specific impacts is to determine:

1. Solidification Potential
2. Toxicity / Safety
3. Oxygen Barriers to Microbial Decomposition

Results from this evaluation, when analyzed together, demonstrate there are signifcant environmental advantages and a minimal impact on sewer line plugging when using biodegradable BioBlend bio-lube technologies when compared to other common FOGs, and when contrasted to conventional petroleum and synthetic fluids.

Solidification Potential

- Clog-inducing FOG agglomeration occurs over time … with solidification rates increasing as temps decrease.
  - ✓ FOGs - such as Lard and Crisco - solidify between 38-57°F.
  - ✓ FOGs - such as Wesson Vegetable Oil, Canola Oil and Mazola Corn Oil - solidify between 10-19°F.
  - ✓ FOGs – such as BioBlend bio-lubes (enviromax) - doesn't solidify until -12°F.
- The BioBlend bio-lube technology remains a flowable liquid at significantly lower temps than the common FOGs it was tested against … resulting in a lower sewer clog tendency.

Toxicity / Safety Impact

- While it's anticipated that conventional petroleum/synthetic lube oils would also have good cold temp flowability … the *environmental advantages* of BioBlend bio-lube technologies are far superior to conventional petroleum/synthetic lubes:

FOG Environmental Toxicity Comparison		***Meets EPA def. to be classified as an EAL per the 2013 VGP***		
FOG	***Inherently Biodegradable (<20%)***	***Readily Biodegradable (>60%)***	***Minimally Toxic***	***Not Bioaccumulative***
Conventional Petroleum Oils	**YES**	**NO**	**NO**	**NO**
Conventional Synthetic Oils	**YES**	**NO**	**NO**	**NO**
BioBlend bio-lube Technologies	**YES**	**YES**	**YES**	**YES**

Oxygen Barriers to Microbial Decomposition

1. Many FOGs are oils … have a specific gravity lighter than water … are not miscible with water … and float to the water's surface.
   - ✓ The digestive microbes whose job it is to digest the product whose COD/BOD impact is being measured … can only eat at the edges of the oils since they float on the waters surface *(there is not any agitation of the test vials over the course of the typical 5-day incubation period).*
   - ✓ COD/BOD test data results on any oil floating on water are inconclusive.
2. BioBlend bio-lube technologies would have no more impact on the oxygen requirements of digestive microbes than would common and well-known FOGs such as; Lard, Crisco or common vegetable oils *(corn, peanut, soy, sunflower, canola, etc.)*

The use of BioBlend bio-lube technologies have no more of a negative impact on COD/BOD as the very oils people and businesses cook with - and consume.

Assessing the Environmental Impact of Oils Entering the Environment

Aquatic vs. Soil Lubricant Discharges

A strong argument can be made that it doesn't really matter whether used lubricants end up on the soil or directly in water – both scenarios can have a devastating impact on the environment. Further, even when used lubricants are introduced to soil environments, the various geological watershed infrastructures throughout North America could very well introduce these same used lubricants directly into the marine environment. The fact remains that many navigable and even smaller rivers and ports have been identified as Environmental Protection Agency (EPA) Superfund Clean-up Sites. Therefore, it stands to reason that the EPA would eventually have to step in and provide some level of used lubricant risk mitigation to minimize the debilitating impact used lubricants have on marine environments. Such is the case and the EPA took action on December 19th, 2013 when the EPA's 2013 Vessel General Permit went into effect. **(3)**

EPA's 2013 Vessel General Permit (VGP)

While a complete discussion on the VGP permitting regulation is beyond the scope of this paper, and while it currently only applies to non-recreational vessels >79' in length operating in U.S. waters, defined as within 3 miles of a U.S. salt water coast and any navigable freshwater river, this regulation is significant because for the first time the EPA has 'mandated' … ,meaning it's no longer an option … that Environmentally Acceptable Lubricants (EALs) must be used in all applications with the potential for an oil-to-water interface unless its deemed technically infeasible to do so.

> **NOTE:** It should be noted that on December 19th, 2017 the sVGP (small Vessel General Permit) is scheduled to go into play. The sVGP applies to all non-recreational vessels <79 ' in length with the same general guiding principles as the 2013 VGP. While the sVGP was actually scheduled to go into effect December 19th, 2014, on December 18th, 2014 President Obama signed into law a 3-year moratorium on this regulation. This regulation isn't going away … instead the timing of implementation has simply been delayed three years thereby giving vessels operators falling into this class more time to get into compliance.

Further, the 2013 VGP provides regulatory environmental testing criteria whereas lubricant manufacturers now have a series of benchmark tests to use as a guideline in designating a lubricant as an EAL. Why is this significant? Simply put the EPA has created a standard of sorts that helps lubricant users select lubricants that have the least environmental impact by 'mandating' the use of EALs that meet EPA definitions for being readily biodegradable, minimally toxic, and not bioaccumulative as per the following guidelines:

EPA's VGP Criteria for Lubricant Classification as an EAL As defined in Appendix A of the EPA's 2013 VGP, the three criteria for a finished lubricant product to be classified as an EAL by the EPA.	
EPA's EAL Criteria	***EPA Recognized Testing Protocols*** *(an EAL must pass one of these tests, test series or calculations)*
Readily Biodegradable	✓ OECD 301 A-F, 306, and 310 ✓ ASTM 5864 ✓ ASTM D-7373 ✓ OCSPP Harmonized Guideline 835.3110 ✓ ISO 14593:1999
Minimally Toxic	✓ OECD 201, 202, and 203 for acute toxicity testing *(ISO/DIS 10253 for algae, ISO TC147/SC5/W62 for crustacean, and OSPAR 2005 for fish, may be substituted)* ✓ OECD 210 and 211 for chronic toxicity testing

Not Bioaccumulative	✓ 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%

Equipment Operator Impacts - Relevancy of the EPA's 2013 VGP

Virtually every piece of mechanical equipment uses one or more finished lubricants to accomplish its work. The reason for this is obvious … mechanical wear and friction are an identified reality of equipment operation. The following short list provides evidence of just how many different types of equipment are currently in play around the clock throughout North America, and globally:

- ✓ **On-Road Rolling Stock:** automobiles, light trucks, semi-trucks, delivery trucks, refuse haulers, snow removal vehicles
- ✓ **Off-Road Rolling Stock:** dozers, backhoes, graders, scrapers, logging equipment, mining equipment, refuse trucks, drill trucks, pump trucks, etc.
- ✓ **Plant Equipment:** hydraulic systems, bearings, gearboxes, pumps, compressors, chains, cables, slides, motors, etc., mechanical componentry of all types.
- ✓ **Facility Equipment:** elevators, escalators, airport walkways/turnstiles and the hydraulic systems, gearboxes, pumps, chains, cables, compressors, chillers, refrigeration equipment, etc. required to operate facility equipment.
- ✓ **Marine Equipment:** ships, tugs, barges, ferries, dredges, etc.

Regardless of the specific type equipment utilizing a finished lubricant, inadvertent lubricant discharges from any piece of equipment may eventually have a toxicity or bioaccumulation impact on aquatic environments making the EPA's 2013 VGP relevant to all lubricant consumers regardless of the nature of their equipment operation. Thus the applicability of the environmental stewardship benchmarks tied to EALs as outlined by the EPA's 2013 VGP make is equally signifcant to lubricant discharges from any type of equipment, in any or all operating environments.

Storm Water and Sewage System Operator Impacts - Relevancy of the EPA's 2013 VGP

Whether formulated with natural esters , like canola, or synthetic esters, bio-lubes that are formulated to meet the environmental stewardship requirements to be classified as an EAL as per the EPA's 2013 VGP must be used. While storm drains and sewage systems are 'out-of-sight', the benefits of bio-lube usage offers every equipment operator significant environmental advantages while minimizing a company's litigation exposure should inadvertent lubricant discharges occur into these critical infrastructure systems. Further, when a company recognizes the long-term negative consequences spilled lubricant discharges can have on their brand and reputation, the decision to use bio-lubes in all equipment applications simply makes sense, especially considering that the performance of many of today's bio-lubes are equal or better than the performance that can be achieved when using conventional petroleum lubricants. Consider this:

- ✓ **Lubricant Biodegradation:** Lubricant biodegradation is the chemical breakdown of oil products into CO_2 and H_2O in the presence of sunlight, water & microbial activity. In simple terms biodegradation doesn't occur when the finished lubricant is inside the piece of equipment because the finished lubricant, of any type, is not subjected to sunlight and microbial activity. Certainly over time the lubricant may be exposed to air-borne water ingestion - which is harmful to all lubricants - but you need microbial activity to stimulate the lubricant biodegradation process.

- ✓ **Inherently Biodegradable Lubricants:** Conventional petroleum and synthetic lubricants are inherently biodegradable … and have been for years. Inherently biodegradable means 'eventually' the products will biodegrade, typically 20-40% within 28 days when subjected to the biodegradation process.
- ✓ **Readily Biodegradable Lubricants:** Most bio-lube products are readily biodegradable. Being readily biodegradable means that >60% of the lubricant will biodegrade within 28 days when subjected to the biodegradation process. For example, all but a few BioBlend lubricants are readily biodegradable and fit in this category, with many being >80% biodegradable.
- ✓ **Storm Drains:** Storm drain systems often discharge their effluent directly into streams, rivers or lakes … many of which serve as sources for a community's fresh water drinking supply. Thus bio-lube usage offers a singularly unique environmental advantage versus continuing to use conventional petroleum and/or synthetic lubricants.
- ✓ **Sewer Systems:** The chronic build-up of lubricant-related deposits in sewage systems is decidedly favorable to bio-lubes when compared to conventional petroleum and/or synthetic lubricants. Sewage is naturally fraught with intense microbial activity, the very same mechanism that activates the biodegradation process. In fact, waste water treatment plants treating sewage have become masters of utilizing microbial activity as part of their planned process to break down sewage in the treatment facility prior to discharges into fresh water streams, rivers and lakes.

Lubricants that are 'readily biodegradable' will have less of an impact on sewer line build-up than 'inherently biodegradable' conventional petroleum and/or synthetic lubricants because … simply put … they biodegrade at a significantly faster rate. Add to this the important factoid that bio-lubes meeting the EPA definition to be classified as 'minimally toxic' will have less of an impact … if they have any impact at all … on the very microorganisms responsible for catalyzing the biodegradation process. Inherently biodegradable lubricants not offering minimal toxicity as per recognized and accepted EPA test protocols kill the very same microorganisms needed in the biodegradation process that keeps sludge and sewer line build-up from occurring. Therefore, bio-lubes that meet the EPA definitions to be classified as readily biodegradable and minimally toxic offer equipment operators of all types the decided advantage of reducing or eliminating build-up in sewer lines, plus they lend themselves more readily to the process of microbial decomposition should such products actually adhere to a sewer line or reach the sewage treatment facility.

> **Referential Note:** Consider this … the majority of products sold for the purpose of cleaning sewer lines and septic system lines introduce enzymatic microbes to catalyze the biodegradation process, which catalyzes the biodegradation process thereby allowing sludge and build-ups associated with finished lubricant introductions into sewer lines removes the build-up.

Summary

The bio-lube technologies in the marketplace today are significantly more advanced than their predecessors of only a few years ago. The EPA has enacted legislation tied to lubricants and related to the marine environment which is aimed at minimizing the known negative consequences inadvertent used lubricant discharges have on the environment we all live and work within. The net conclusions one can thus deduce include, but are not limited to:

- ✓ Lubricant users have alternative bio-based lubricant alternatives to conventional petroleum and/or synthetic lubricants that offer specific and unique environmental performance advantages. (3)
- ✓ The EPA, through the 2013 VGP, has shown the significant environmental impact differences between conventional petroleum and synthetic finished lubricants when contrasted to EAL lubricants. Bio-lubes meeting the EPA requirements to be classified as EALs offer significantly reduced environmental impacts when entering aquatic environments. (3)
- ✓ The EPA is NOT done … with plans to enact additional legislation applicable to the marine industry *'mandating'* the use of EALs that meet EPA definitions as being readily biodegradable, minimally toxic, and not bioaccumulative when the EPA's revision to the 2014 small Vessel General Permit (sVGP) goes into affect December 19th, 2017. **(3)**

- ✓ Whether a used oil enters an aquatic environment through direct discharge, or migrates to an aquatic environment through natural soil ingress mechanisms, the fact remains that used lubricants have a direct an immediate impact on the environment, and that such impacts can be mitigated through the use of bio-lube technologies.
- ✓ The very nature of the EPA-recognized test protocols related to classifying a lubricant as Readily Biodegradable and Minimally Toxic and Not Bioaccumulative lend themselves to demonstrating that equipment operators of all types can not only significantly reduce the environmental impacts associated with inadvertent finished lubricant discharges into the environment, but minimize or even eliminate the impact lubricant discharges have on storm drainage effluent and proper sewer line operation.
- ✓ The use of bio-lube technologies, with their significantly reduced environmental impacts, lend themselves to additional and significant cost-saving actions such as eliminating the need to utilize costly water-oil separators prior to lubricant discharge thanks to bio-lubes being readily biodegradable and minimally toxic, and in many cases, being not bioaccumulative.
- ✓ Bio-lubes offering enviro-advantages are gaining *'significant'* traction throughout North America, and the global lubes marketplace, with growth in the bio-lubes market being primarily driven by increased market sector penetration in: **(1)**
  - Construction / Earth Moving / Rock-Drilling / Logging
  - Fresh & Waste Water Treatment / Landfill Operations / Refuse Hauling
  - Agricultural / Municipal / Government Equipment
  - Commercial Elevators / Escalators / Hydraulic Lifts
  - Push Tugs / Dredges / Ferries / Barges / Commercial Fishing / Diving
  - Hydro Facilities / Power Plants
  - Oil Fracing / Oil Drilling
  - Cold Climate Machinery *(snow-tracks, plows, snowmobiles, etc.)*
  - Railway *(curves and gears)*
  - Motorboats / Jet Skis
- ✓ Petroleum lube sales have hit a plateau and are declining … being replaced by synthetic and biodegradable lubricants. **(1)**
- ✓ Bio-lubes are witnessing strong market acceptance given the numerous benefits offered, and the significant progress made over the years … now in the 6th or 7th generation of bio-lube performance offering attributes such as: **(1)**
  - Biodegradability WITHOUT a Performance Sacrifice
  - Superior Natural & Enhanced Lubricity
  - High VI's for 'All-Weather' Performance
  - Better Anti-Corrosion & Oxidation Stability Properties
  - Lower Flammability … Toxicity … Volatility *(they're safer)*
- ✓ Favorable macro factors are expected to play a prominent role in market expansion in the long term, including: **(1)**
  - Government Regulations / Legislations / Incentives
  - Fluctuating Global Petroleum Prices … to include supply & demand
  - Depletion of Global Oil Reserves
  - Renewability of Bio-Lubes
- ✓ Other drivers poised to benefit future bio-lube market prospects include: **(1)**
  - Improved Availability of Bio-Lubes & Bio-Products
  - Rising Consumer Awareness
  - Consumer / Industry Demand for Favorable Environmental Options
  - Bio-Lube Technology Improvements
  - Bio-Technology Innovations
  - Increasing Acceptance by OEMs
  - Amongst others …

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Companies like BioBlend Renewable Resources, LLC are taking the manufacturing and marketing of bio-lubes to an entirely new level, with many lubricant technologies that meet the requirements to be classified as an EAL as per current EPA definitions for being readily biodegradable, minimally toxic and not bioaccumulative.

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

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