National Marine Manufacturers Association

February 8, 2017

Senate Committee on Environment and Natural Resources
Oregon State Capitol
900 Court St. NE
Room 347
Salem, Oregon 97301

RE: Senate Bill 19, updates descriptions and allowed quantities of oxygenates in gasoline for sale at wholesale or retail in this state.

Dear Committee Members,

The National Marine Manufacturers Association (NMMA) appreciates the opportunity to express our members strong opposition for Senate Bill 19 which updates descriptions and allowed quantities of oxygenates in gasoline for sale at wholesale or retail in Oregon.

NMMA is the leading recreational marine industry trade association in North America, representing 1,400 boat, engine, and accessory manufacturers. NMMA members collectively produce more than 80 percent of the recreational marine products sold in the United States. Recreational boating is a popular pastime in Oregon with over 166,000 registered recreational boats. The recreational boating industry contributes $1.7 billion and over 8,800 jobs to the state's economy.

The proposed changes in Senate Bill 19 will stifle emerging biofuel technologies. NMMA specifically opposes language that would ban butanol, isobutanol and all structural isomers into the market. For the past five years the recreational boating industry has been working with the Department of Energy (DOE), the USEPA, US Coast Guard and Argonne National Labs to evaluate the benefits of isobutanol in marine engines. Through this extensive government sponsored evaluation, NMMA has industry and government supported data that confirms not only the safe, but the beneficial use of isobutanol at 16.1% in both non-road and marine applications. Ethanol at 16.1% by volume is documented in DOE sponsored studies to destroy non-road and marine engines. Isobutanol at this concentration has greater energy value than ethanol, it does not absorb moisture like ethanol, it has a lower vapor pressure than ethanol a major contributor to evaporative emissions and most significant; isobutanol in blended concentrations as high as 16.1 percent (B16) by volume is approved by the EPA for non-road and marine fuels. Senate Bill 19 would ban this beneficial, commercially available EPA-approved advanced biofuel.

NMMA appreciates the opportunity to provide written comment on this important issue. NMMA recognizes that the intent of this bill is to simplify Oregon's gasoline blending requirements, in reality

650 Massachusetts Avenue, NW, Suite 520
Washington, D.C. 20001
202.737.9750 Fax 202.737.9755
nmma.org

it is banning EPA approved oxygenates and stifling technology that can deliver better biofuels to Oregon. NMMA is available to discuss our work on advanced biofuels and we have attached a summary of our test programs.

If you should have any questions, please contact State Government Relations Manager, Libby Yranski at lyranski@nmma.org.

Sincerely,

John McKnight
Vice-President Government Affairs

fueled by Biobutanol

FACT SHEET

EMISSIONS AND OPERABILITY OF GASOLINE, ETHANOL, AND BUTANOL BLENDS IN RECREATIONAL MARINE APPLICATIONS

The National Marine Manufacturers Association (NMMA) and the American Boat and Yacht Council (ABYC) under the direction and guidance of the US Department of Energy and Argonne National Laboratory have been engaged in a four-year program to evaluate the performance of recreational marine engines and vessels operated on biologically produced butanol fuel[1]. With known issues associated with ethanol fuels and the ongoing push toward higher quantities of ethanol such as E15, the marine industry has come together to evaluate an advanced biofuel with properties more suited for the marine environment than ethanol.

Biobutanol contains nearly 90% of the energy content of gasoline compared to 67% for ethanol. A higher energy content means that 16.1 vol% biobutanol (Bu16) is equivalent to the energy content of 10 vol% ethanol (E10). Both Bu16 and E10 contain the same oxygen by weight, and both raise octane when blended into gasoline. **Biobutanol is particularly interesting to the marine industry as it is significantly more resistant to phase separation than ethanol. It is also less corrosive to fuel system component materials such as fuel tanks, fuel hoses, primer bulbs, gaskets and o-rings when compared to ethanol[2].**
Lack of phase separation and low solvency means that biobutanol could be transported in the existing pipeline distribution infrastructure, minimizing the need for truck and rail transportation, which is required for ethanol[3]. When added to gasoline, biobutanol lowers the Reid Vapor Pressure (RVP) of the finished gasoline blend which results in lower evaporative emissions and allows for a less costly gasoline blend stock.

Several years of engine and vessel testing performed through a collaborative industry effort conducted on many different engine technologies and boats, along with US Coast Guard testing have confirmed the compatibility of biobutanol fuel blends with marine engines and vessels. The major tests performed during this testing program and conclusions are highlighted in this fact sheet.

TEST PERFORMED

- Gaseous and particulate engine exhaust emissions (regulated and non-regulated)
- Green house gas emissions (GHG)
- Combustion analysis
- Cold start
- Power and performance
- Runability
- Winter storage
- Oil tribology and lubricity
- Exhaust gas temperature
- Stoichiometric air/fuel ratio (Lambda)
- Field engine and vessel performance
- Full useful life endurance/durability
- Engine tear down and component inspection

TYPES OF FUELS TESTED

- E10 (10 vol% ethanol – control fuel)
- Bu16 (16.1 vol% biobutanol)
- Tri-fuel blend (8 vol% isobutanol, 5 vol% ethanol and 87 vol% gasoline)
- Indolene (non-oxygenated certification fuel)

ENGINE TECHNOLOGIES TESTED

- Electronic fuel injection four-stroke outboards
- Carbureted four-stroke outboards
- Open-loop (CARB 3-star) SD/I and PWC engine
- Closed-loop (CARB 4-star) SD/I engines
- Conventional carbureted two-stroke outboard
- Direct fuel injection two-stroke outboards

ENGINE BRANDS TESTED

- BRP – Evinrude and SeaDoo
- Mercury
- Volvo-Penta
- Yamaha
- Tohatsu
- Indmar
- OMC – Johnson
- Honda

MAJOR CONCLUSONS

Laboratory, endurance, and field testing results on boats and engines indicate no discernable difference in power, performance, runability, emissions or durability between E10 and biobutanol test fuels (Bu16/Trifuel blends).

All test engines remained below EPA and CARB emissions standards for HC+NOx and CO. Exhaust emissions comparisons between E10 and biobutanol test fuels were virtually the same on all engines tested. No significant emissions differences between E10 and biobutanol test fuels were found regardless of engine technology.

Full useful life engine tear-down and inspection on pistons, cylinder heads, cylinder bores, intake/exhaust valves, intake/exhaust ports, connecting rods and rod bearings indicate similar wear between the E10 control engines and Bu16 test engines. No unusual wear, carbon build-up or durability issues were observed with either fuel during the 350 hour (equivalent 10 year useful life) testing.

No engine runability, engine durability, or engine/boat performance issues were experienced during the test program. All engines and boats performed well throughout the test program.

Engine startability performed at two different temperatures indicates similar seconds to start and pulls to start at 75°F between E10 and Bu16 test fuels. At 30°F, data indicates a slight advantage in startability for biobutanol fuels.

Friction, wear and scuffing tests performed on engine oils suggest that E10 and Bu16 fuels present in the oil result in a slight friction reduction but a noticeable reduction in scuffing load compared to a non-oxygenated test fuel. There were no major differences between the load carrying capacity of the oil with either E10 or Bu16 fuels.

The comprehensive data collected during this multi-year test program suggests that biobutanol blends up to 16.1 vol% can be used in recreational marine engines and boats without deterioration of engine/boat performance, emissions characteristics, durability or runability. Moreover, butanol blends up to 16.1 vol% may mitigate many fuel related issues experienced with ethanol fuels, primarily related to phase-separation and corrosion.

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[1]DOE Annual Progress Reports - Emissions and Operability of Gasoline, Ethanol, and Butanol Blends in Recreational Marine Applications – marinebiobutanol.net

[2]Kass, M., Theiss, T., Janke, C., Pawel, S., et al "Compatibility Study for Plastic, Elastomeric, and Metallic Fueling Infrastructure Materials Exposed to Aggressive Formulations of Isobutanol-blended Gasoline" Oak Ridge National Laboratory, 2014

[3]Wasil, J., McKnight, J., Kolb, R., Munz, D. et al., "In-Use Performance Testing of Butanol-Extended Fuel in Recreational Marine Engines and Vessels," SAE Technical Paper 2012-23-0011,2012, doi:10.4271/2012-32-0011.

Biobutanol FAQ

Q: What is biobutanol and how is it made?
Biobutanol is a four-carbon alcohol produced from renewable, plant-derived energy sources in a fermentation process similar to beer and wine production. Biobutanol can be produced using existing ethanol feedstocks, such as corn and sugar beets, or advanced feedstocks (cellulosic biomass) such as crop residues, wood residues, dedicated energy crops, and industrial and other wastes. Biobutanol delivers more renewable energy content than ethanol while remaining compatible with current vehicles, boats, and infrastructure.

Q: Why interest in biobutanol for recreational marine engines?
The congressionally-mandated US Renewable Fuels Standard (RFS) requires 36 billion gallons of renewable fuel to be blended into the gasoline supply by 2022. Methods to increase renewable fuels in the gasoline supply have primarily focused on ethanol and higher ethanol blends such as E15. Recreational marine industry reports show significant damage to marine engines using ethanol E15 fuels. Recognizing the issues associated with higher ethanol blends such as E15, the recreational marine industry has explored biobutanol fuel blends with very promising results. The approval of biobutanol fuel blends up to 16.1 vol percent (Bu16) for marine engines and boats positions the industry as a proactive leader in identifying renewable fuels that are more compatible with recreational marine engines and boats.

Q: How is biobutanol different from bioethanol?
Biobutanol has several characteristics which distinguish it from ethanol, making biobutanol an attractive gasoline bio component. For example:

- Biobutanol is compatible with existing recreational boats and refueling infrastructure at levels significantly higher than ethanol, overcoming the impending ethanol blendwall.
- Biobutanol is substantially less susceptible to phase separation in the presence of water than ethanol which means biobutanol behaves similarly to conventional non-ethanol gasoline when water is introduced to the boat fuel tank.
- Biobutanol has an energy content that is closer to gasoline, so consumers face less of a compromise on fuel economy at higher blend ratios. At 16.1 vol% in gasoline (Bu16), biobutanol has the exact same energy content of 10 vol% ethanol fuels (E10).
- Biobutanol is well-suited for current boat and engine technologies. It does not require boat builders or engine manufacturers to compromise on performance to meet environmental regulations.

Q: Has biobutanol caused any damage to recreational boats or engines?
No. Based on thousands of engine and boat test hours, extensive industry testing and published research reports, biobutanol fuel blends up to 16.1 vol percent (Bu16) resulted in no engine failures, no engine runability issues and no boat performance issues.

Q: Does an engine have to be altered to use biobutanol?
No. Biobutanol fuel blends up to 16.1 vol percent (Bu16) were rigorously tested in standard marine engines and boats with no alterations to the engine or fuel system.

Q: Can biobutanol be used in an old engine?
Yes. Biobutanol fuel blends up to 16.1 vol percent (Bu16) have been tested in a variety of recreational boats powered by many different engine technologies including fuel injected four-stroke outboards, two-stroke direct fuel injection outboards, catalyst based stern-drive and inboards, non-catalyzed inboards, carbureted four-strokes, and conventional carbureted two-stroke engines.

Q: Will my boat perform differently with biobutanol?
Based on thousands of hours of testing both in the laboratory and on water, boat and engine performance is transparent between fuels such as E10 and biobutanol fuel blends up to 16.1 vol percent (Bu16). Biobutanol fuel blends behave more similarly to conventional non-ethanol gasoline, particularly when water is introduced into the boat fuel tank.

Q: Is there any significant difference in fuel economy or other operating factors that I should expect when running my boat with biobutanol fuel blends?
Thousands of hours of testing on marine engines operated both in the laboratory and operated in boats on the water indicate no negative impact on fuel economy as compared to E10. More importantly, Biobutanol does not phase separate in the presence of water which is a very desirable property, particularly when used as a biofuel blend for recreational boats. Fuel phase separation with ethanol fuel blends such as E10 is a very common source of boat and engine related issues. Phase separated fuels can quickly deteriorate fuel system components and can lead to catastrophic engine failure. Biobutanol fuel blends up to 16.1 vol percent (Bu16) behave similarly to conventional non-ethanol gasoline, in its resistance to phase separation, making biobutanol an excellent biofuel for recreational boats when compared to E10.

Q: Are there any different maintenance requirements in a boat using biobutanol fuel blends?
No. Comprehensive material compatibility studies indicate that biobutanol fuel blends up to 16.1 vol% (Bu16) are compatible with a variety of fuel system components typical of recreational boats. In fact, research has shown biobutanol fuel blends to be more compatible with fuel system components than ethanol. Coupled together with desirable properties including resistance to phase-separation in the presence of water and thousands of hours of successful marine industry testing means that biobutanol (Bu16) is a biofuel better suited for recreational marine engines and boats.

Q: What is the difference between biobutanol, isobutanol and n-butanol?
Biobutanol is a description for biologically produced butanol which can include Isobutanol and n-butanol. Isobutanol and n-butanol are similar (same energy content and resistant to phase separation) but isobutanol has a higher octane rating than n-butanol making it more attractive for blending with gasoline. Both n-butanol and isobutanol have been evaluated in internal combustion engines.

Q: Who is involved in the recreational marine biobutanol testing program?
Biobutanol research is supported by the US Department of Energy, Office of Energy Efficiency and Renewable Energy coordinated through Argonne National Laboratory. There is participation across the industry from engine manufacturers as well as the National Marine Manufacturers Association (NMMA), the American Boat and Yacht Council (ABYC) and the United States Coast Guard (USCG).

Q: How many companies are working on commercializing biobutanol?
There are many companies currently working on commercializing and developing biobutanol as a building block for renewable chemicals and/or for use as a biofuel in internal combustion engines. The marine industry does not endorse any specific biofuel company, but rather is focused on biofuels that indicate compatibility with recreational marine engines.

Q: Where can I purchase this fuel?
Large scale availability of biobutanol fuel blends will take some time. However, marine industry approval of biobutanol fuel blends up to 16.1 vol percent (Bu16) for marine engines and boats as an alternative to ethanol will encourage its market expansion by providing marine fuel distributors, retailers and consumers with the confidence that this is not only a suitable, but a more compatible fuel for boats. Approval for the use of Bu16 blends is an important first step in securing a biofuel that is compatible with recreational boats and engines, particularly when the damaging effects of higher ethanol blends such as E15 are widely known.

Q: Will biobutanol fuel blends up to 16.1 vol percent (Bu16) be available in different octane ratings?
Yes, the existing fuel grade structure will remain applicable to biobutanol fuel blends.

Q: What is (or what will be) the relative price of biobutanol fuel blends vs. conventional gasoline?
Biobutanol production technology is being developed to compete against current market gasoline fuel costs

Q: With today's lower gas prices, why are we interested in biofuel alternatives like biobutanol?
Gasoline blended with oxygenated compounds like biobutanol is required in many parts of the US by EPA regulations in the Clean Air Act for reducing air pollution. In addition, a biofuel that is more compatible with recreational boats and engines such as biobutanol is key to realizing important goals of the Renewable Fuels Standard such as US energy security, rural and agricultural job growth, and greenhouse gas reduction.

Q: Are there any other aspects of Bu16 that need further investigation?
Long term fuel storage, in the marine environment, has been an issue both in boats and in fuel storage tanks. As we have seen, E10 created even more storage issues as compared to E0. The marine engine manufacturers will continue to work with the Biobutanol suppliers to determine the long range storage characteristics of Bu16 and work to develop best practices for storage of this fuel with the suppliers.

Q: How can I learn more?
More information can be found on the following websites -- US Department of Energy Alternative Fuels Data Center and the Marine Biobutanol Research webpage:

http://www.afdc.energy.gov/fuels/emerging_biobutanol.html
http://marinebiobutanol.net