



NOAA GREEN SHIP INITIATIVE

Development of Biodiesel and Bio-Products in Marine Applications

The National Oceanic and Atmospheric Administration (NOAA) operates a fleet of research vessels and small boats on the Great Lakes through its Great Lakes Environmental Research Laboratory (GLERL). As part of its larger stewardship mission in the marine environment, NOAA, over the past 7 years, has been exploring options to convert its research vessels (age 30-50 years) from petroleum-based fuels and lubricants to full use of renewable and environmentally friendly products.

GLERL's Green Ship Initiative has led the Nation by successfully converting all shipboard systems to biofuels and bio-lubricants. This effort produced the first federal vessel to run completely on non-petroleum products. The marine diesel-powered vessels in the Great Lakes are now fueled by B100 (100%) soy biodiesel, a true alternative energy source for propulsion and electric generation. This is a significant advancement beyond the use of B20 petroleum blends (20% biodiesel and 80% petroleum diesel). All other shipboard

mechanical and hydraulic systems have been converted to bio-oils and lubricants (rapeseed and canola) to complete the objective of totally petroleum-free vessels.

The B100 operational benefits include lower emissions, higher lubricity, cleaner injectors, and cost savings while also improving the work environment of the ship's crew and scientists, who face long-term exposure to emissions. The biodegradable vegetable oils used in crankcase, gear box and hydraulics offer an additional level of environmental protection in the event of a spill or accidental leak. The extensive application of bio-based products demonstrates cost-effective alternatives to the increasing demand on oil. GLERL's Green Ship Initiative is based upon field experience over a broad spectrum of engine, equipment, and vessel designs and will be used to advance bio-product usage on other government and scientific vessels well into the future.



Leadership - You Have the Power

The NOAA R/V *Huron Explorer*, the first modern U.S. research vessel to operate free of petroleum products, was given an award by the Department of Energy's Federal Energy Management Program during an Earth Day Week event on the shores of Lake Michigan in 2006. It was part of the DOE's "You Have the Power" campaign.

The campaign helps federal agencies reach their energy-saving goals by raising awareness about energy efficiency at federal facilities. The federal government strives to encourage wise energy use while simultaneously protecting the environment and conserving natural resources.



SPECIAL POINTS OF INTEREST

- ◆ Ethanol and biodiesel, the primary biofuels today, can be blended with or substituted for gasoline and diesel for use in unmodified automobiles, trucks, and in this case – ships.
- ◆ Biodiesel which is used in diesel-powered vehicles is made from oil of soybeans and used cooking oil.
- ◆ Rapeseed and Canola oils are part of the mustard or cabbage family and can be used for motor oils and hydraulic fluid.



R/V *Huron Explorer*



R/V *Laurentian*

www.glerl.noaa.gov

Advantages of Biofuels

Biodiesel has a higher lubricity, make injectors cleaner, has a detergent effect, and saves on the cost of regular diesel. As of 2006, B100 is 20-50 cents less per gallon compared to #2 diesel fuel. Use of biofuels also reduces air pollution, greenhouse gas buildup, dependence on imported oil, and supports agriculture and the U.S. economy. The U.S. Department of Energy reports that the amount of used cooking oil now disposed of in the U.S. exceeds the current potential demand for biodiesel fuel, making it an abundant resource. Another advantage of biodiesel is its high lubricity which helps the moving parts of engines last longer. Experts estimate that about 1/3 of our transportation fuel needs can be met by domestically produced biofuels.

What's Ahead?

Although the key Green Ship goal of petroleum-free operation of all three GLERL vessels has been reached, much work remains in follow-up evaluation of the conversion and future exploration of opportunities to further expand use of renewable fuels in other aspects of GLERL research operations. Key future activities will include:

- ◆ Monitor and document long-term effects of B100 use on engine components.
- ◆ Complete field tests and continue the evaluation of use of bio-crankcase oils.
- ◆ Identify and implement measures to reduce nitrogen oxide (NOx) emissions associated with biodiesel use.
- ◆ Explore opportunities for use of ethanol as fuel for propulsion in small boats.



Green Ship Project Timeline

1999 – Diesel exhaust filter test and after-treatment test on R/V *Shenehon*. The 67-foot vessel built in 1953 has served as GLERL's primary research vessel throughout most of GLERL's 32-year history and is one of the oldest vessels in the NOAA fleet.

2000 – *Shenehon* converted to B100 and showed immediate reductions in visible emissions, smoke, and offensive odor with unchanged performance in main engine or generator. This was the first federal vessel in the nation to operate on 100% biodiesel.

2001 – *Shenehon* and *Laurentian* started on bio hydraulic oil.

2005 – R/V *Huron Explorer* converted to the first petroleum-free vessel through use of B100 and bio-motor, hydraulic, steering, and transmission oils.

2006 – April Dept. of Energy Award in recognition of GLERL leadership in Green Ship Initiative. In May, all three GLERL vessels transitioned to total petroleum-free operation.

Petroleum-Free Goal Reached in 2006!

The complete conversion of all three GLERL vessels in May 2006 was a key milestone, and follow-up evaluation showed that all systems using the bio-hydraulic oil performed satisfactorily without change to pump or equipment performance, while contributing to improved onboard storage and reduced inventory.

For more information:

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Environmental Research That's Environmentally Friendly

There were many motivating factors for undertaking the Green Ships project. These include:

- ◆ Reducing ecosystem impact of ship-based research activities.
- ◆ Reducing workplace health and safety hazards.
- ◆ Advancing renewable technologies.
- ◆ Lessening dependence on fossil fuels.

