California Coastal Nonpoint Source Program
Water Quality Fact Sheet

Non-Petroleum Hydraulic Fluids and Biodiesel Fuel for Construction Equipment

Note: This factsheet is a summary of information compiled by the Coastal Commission's water quality staff. It is not a finding by the Coastal Commission, and this factsheet may be superseded by site-specific information.

Introduction

Hydraulic fluids are used in several types of heavy equipment that may be used on a construction site, such as excavators and backhoes. These fluids function to transfer power from one location to another in the machinery, and also serve to lubricate moving parts and transfer heat. Hydraulic lines are under pressure, and breaks in hydraulic lines are a commonplace occurrence in construction equipment. Standard hydraulic fluids are based on petroleum products (such as mineral oils), and due to their high aquatic toxicity they pose a risk if leaked or spilled in or near sensitive aquatic habitats. There are alternative non-petroleum hydraulic fluids available for use in construction equipment that have lower aquatic toxicity than do petroleum products. Non-petroleum hydraulic fluids choices include vegetable oil-based (canola oil or other crop-based oils) or synthetic (polyglycols or synthetic esters) hydraulic fluids.

Diesel fuel may also leak or spill from heavy equipment and vehicles used in construction, and where construction takes place in or adjacent to waterways and the ocean, diesel poses a risk of aquatic toxicity. Biodiesel is a non-petroleum alternative fuel that is less toxic, and can be used in construction equipment and vehicles operating in or near sensitive aquatic habitats.

In addition to having lower aquatic toxicity than petroleum products, vegetable-oil based hydraulic fluid and biodiesel are biodegradable, and break down more rapidly in the environment than petroleum products. Using biodegradable hydraulic fluid and biodiesel instead of petroleum products thus can reduce the contamination of soil, groundwater, and surface waters from hydraulic fluid and fuel spills from construction equipment.

Synthetic Hydraulic Fluids

Polyglycols: Polyglycols (sometimes labeled HEPG) include polyalkylene glycols, polyglycol ethers, and polyalkylene glycol ethers. Polyglycols have good viscosity, lubricity, anti-wear performance, and resistance to aging. Polyglycols are incompatible with petroleum-based fluids, so most manufacturers recommend completely evacuating the system when switching to or from petroleum-based to polyglycol hydraulic fluids, which adds to the expense. Polyglycol hydraulic fluids may also not be compatible with the lining, seal, filter, and gasket materials used with petroleum-based hydraulic fluids. Polyglycol hydraulic fluids cost two to three times more than petroleum-based hydraulic fluids.

Synthetic Esters: Synthetic esters (sometimes labeled HEES) are derived from vegetable oil or animal fat, and have very good viscosity, lubricity, anti-wear performance, and resistance to aging. They are also more thermally stable than vegetable oil-based hydraulic fluids. Some

synthetic esters may oxidize quickly, however, leading to deposits in the system. They are compatible with most seals, and can be mixed with petroleum-based hydraulic fluids, so the system does not need to be evacuated when switching to or from petroleum-based products. Synthetic esters cost three to six times more than petroleum-based fluids, but are longer-wearing and might need to be changed less often

Maintenance Considerations: Both polyglycols and synthetic esters tend to dissolve deposits in the system left by petroleum-based fluids, so filters will need to be checked more frequently after switching from petroleum-based to synthetic hydraulic fluid.

Vegetable Oil-Based Hydraulic Fluid

Vegetable oil-based hydraulic fluids are commonly made from canola oil, and may also be made from oils of other crops such as soybean, sunflower, or castor beans. In general they function well, with good viscosity and lubricity, but do not flow as well at low temperatures (less than 22° F) as do petroleum-based fluids.

Most vegetable oil-based hydraulic fluids tend to age rapidly and oxidize more quickly than petroleum-based products, especially at high temperatures, leading to formation of sludge. They are usually compatible with the seals and other components of engines used with petroleum-based fluids.

Vegetable-oil based hydraulic fluids cost two to three times more than petroleum-based fluids. However, the cost of spill cleanup is much less with vegetable-based fluids.

Environmental Impacts of Hydraulic Oils

The aquatic toxicity, potential for bioaccumulation, and biodegradability of hydraulic fluid are important considerations in determining the potential environmental impacts of spills of these products from construction equipment. The U.S. Environmental Protection Agency addressed these considerations in a report on "Environmentally Acceptable Lubricants,"[1] from which the following information is summarized.

Aquatic toxicity: Aquatic toxicity is the ability of a substance to cause harmful effects on an aquatic organism, ranging from physiological and behavioral effects to mortality. Petroleum-based hydraulic fluids have high aquatic toxicity; non-petroleum alternatives (vegetable oils, polyglycols, and synthetic esters) all have low aquatic toxicity.

Biodegradation: Biodegradation is defined by the American Society for Testing Materials (ASTM) as "the process of chemical breakdown or transformation of a material caused by organisms or their enzymes." [2] Biodegradable hydraulic fluids do not persist as long in the environment as non-biodegradable products, which is likely to lessen the environmental impacts of spills. Petroleum-based hydraulic oils are not readily biodegradable. In contrast, vegetable-oil based hydraulic fluids are readily biodegradable, as are some synthetic hydraulic fluids. Some polyglycols are biodegradable, and synthetic esters are up to 80% biodegradable.

[1] Environmentally Acceptable Lubricants. EPA 800-R-11-002. November 2011. U.S. EPA Office of Wastewater Management. See Table 7, Comparative Environmental Behavior of Lubricants by Base Oil Type.

[2] ATSM standards ASTM-D-6006, *Guide for Assessing Biodegradability of Hydraulic Fluids*, and ASTM-D-6046, *Standard Classification of Hydraulic Fluids for Environmental Impact*, are relevant.

Potential for Bioaccumulation: Bioaccumulation is the tendency of a substance to accumulate in an organism. Petroleum-based hydraulic fluids have a potential for bioaccumulation, but non-petroleum hydraulic fluids (vegetable oils, polyglycols, and synthetic esters) do not.

Additives: Hydraulic fluids contain a variety of additives, such as anti-corrosion or anti-wear additives. Some of these additives, such as anti-wear additives containing zinc, also affect the fluid's biodegradability and toxicity.

Recommendation: Vegetable oil-based hydraulic fluids are formulated for rapid biodegradability and low aquatic toxicity, and do not bioaccumulate in aquatic organisms. They are thus the best choice for use in heavy equipment for construction in or near sensitive aquatic habitats. Synthetic hydraulic fluids also have low aquatic toxicity and do not bioaccumulate, but synthetic esters are less biodegradable than vegetable oil-based hydraulic fluids, and only some polyglycols are biodegradable. Therefore, although the synthetic hydraulic fluids are a better choice than petroleum-based hydraulic fluids, vegetable oil-based hydraulic fluids are the best choice for this situation.

Biodiesel

Types of Biodiesel: Biodiesel fuel is produced from vegetable oil, such as used cooking oil. Note that it is sold as 100% biodiesel, and also in mixtures with various percentages of petroleum-based diesel.

Availability: Biodiesel may not always be readily available in some locations, as the demand may be more than the supply. For larger and/or longer duration construction projects, it should be possible to plan ahead to purchase the biodiesel needed for the project.

Environmental Impact: Biodiesel is classified as readily biodegradable, does not bioaccumulate in aquatic organisms, and has low aquatic toxicity.

Compatibility with engines: Any diesel engine will run on biodiesel, but the fuel filters may clog at first if switched over from petroleum diesel, as the biodiesel dissolves the deposits left by the petroleum diesel. Biodiesel can rot rubber parts in the fuel system, but any engine constructed after the mid-1990s has resistant rubber parts.

Spills: Fuel lines don't break as commonly as hydraulic fluid lines do, as hydraulic lines are under pressure but fuel lines are not. Diesel volatilizes quickly, and most diesel from small spills will dissipate or evaporate so quickly that response agencies do not conduct active clean-up operations.

Maintenance and Fueling Practices: Construction equipment should be inspected daily for fuel leaks. Equipment fueling should not be allowed within 100 feet of the top-of-bank of a waterway, or of the high-tide line. Fueling should take place off-site if possible; when fueling is necessary on-site, it should be conducted on an impervious surface surrounded by a containment berm.

Recommendation: Because biodiesel has a much lower acute aquatic toxicity than petroleum diesel does, an environmentally-friendly practice would be to use biodiesel for large and/or long duration construction projects taking place near or over sensitive aquatic habitats.