



PENN STATE and “GREEN” HYDRAULIC FLUIDS – A Fact Sheet

The College of Agricultural Sciences began converting some 200 pieces of farm equipment including trucks, tractors, and attachments to biodegradable hydraulic fluids in 2003. This was done in an effort to begin the “greening” of Penn State, with environmental stewardship, the conservation of petroleum, and advancing the agricultural economy as goals. Presently, Penn State is in the process of converting vehicles, machinery, and building elevators throughout the entire University, including the Commonwealth Campuses.

What Are Hydraulic Fluids?

These are fluids that are used in machines that perform work through the transfer of power from one location to another. The science of hydraulics dates back thousands of years, to the use of water wheels, sluice gates and dams by farmers to control the flow of water to irrigate their crops. Today’s hydraulic systems are more complicated and involve motors, actuators, gear, vane, and piston pumps to convert hydraulic power into useful work. Hydraulic systems are used in tractors, farm implements, vehicles, industrial factory machines, elevators, aircraft, and other mechanical devices. In addition to transferring power, hydraulic fluids must lubricate, transfer heat, and be compatible with other materials such as gaskets, seals, and metal components in the system. Today most hydraulic fluids are petroleum-based, and perform well.

What Is A Biodegradable Hydraulic Fluid?

The American Society for Testing Materials (ASTM) defines biodegradation as “the process of chemical breakdown or transformation of a material caused by organisms or their enzymes.” To be classified biodegradable, lubricants such as hydraulic fluids, gear oils, engine oils, and other industrial oils must pass one or more tests currently used to assess biodegradability.

If Petroleum-Based Hydraulic Fluids Are Working Well, Why Change?

1. The United States and the world are facing a future crisis due to the depletion of world oil resources. The availability of oil may be peaking, and over the next several decades will be declining, while alternative sources of fuels and lubricants increase. The U.S. currently uses over 20 million barrels of oil per day, of which about 60 percent is imported. A barrel of crude oil contains 42 gallons of oil. At the refinery, this oil is processed to produce 44.2 gallons of products. Over 60% of the barrel is used as fuel and only 1.2% (0.5 gallons/bbl) goes to make lubricants. Hydraulic fluids make up a major portion of the lubricant fraction. Even though the numbers appear small, we can reduce the amount of imported oil by over 15 million barrels per year by using vegetable oils as lubricant base fluids. More importantly, we are replacing this imported oil with a renewable resource.

2. There are a number of advantages to using biodegradable hydraulic fluid, but the most important factor is that it will prevent pollutants from getting into the soil and ground water. It has been reported that over 60% of all lubricants end up in our soil and water. Hydraulic line breaks are extremely common. If not attended to, these releases can cause contamination of the soil, ground and surface water. Many equipment operators do not clean up spills, thereby introducing pollutants to the environment. Using a fluid that is biodegradable reduces the cost of cleanup as well as the potential for polluting the environment.
3. Conversion to vegetable base hydraulic fluid expands the market for soybeans and other vegetable oils. The use of biodegradable hydraulic fluids adds jobs and dollars to the agricultural industry.
4. Penn State believes it is important to be a leader for the state of Pennsylvania with this green initiative. We are continuing to collect information on the long-term performance and analysis of these fluids.

What Have We Learned To Date?

The biodegradable hydraulic fluids have performed well, with no performance problems related to their use. No additional maintenance, such as filter changes, has been required. Analysis has shown a decrease in friction and wear compared to petroleum-based hydraulic fluids, no change in viscosity, and no oxidation. We are continuing to conduct periodic analysis of selected units.

In addition, it has been found in laboratory composting experiments that the biodegradable hydraulic fluids are decomposing more rapidly than petroleum hydraulic fluids. In fact they break down in less than two weeks, enabling a possible alternative method of disposal for soil affected by spills and releases.

What Do We Still Need To Learn?

We are satisfied with short term (2 years) performance of these fluids. Long-term performance will continue to be evaluated.

Now that we know that these fluids break down rapidly in a laboratory compost setting, we will be analyzing the compostability of these fluids in field scale composting sites.

We need to increase public awareness of the benefits of using environmentally friendly fluids. The reduced environmental impact of these fluids is significant, and needs to be communicated to the public. The effects of spills and releases of petroleum-base and biodegradable fluids needs to be further understood.

Are Biodegradable Hydraulic Fluids More Expensive Than Petroleum-Based Fluids?

Yes. It costs about \$12-14 per gallon for vegetable-based hydraulic fluid. This compares to about \$9 per gallon for a good petroleum fluid and \$25 per gallon for a synthetic biodegradable hydraulic fluid. However, the cost of spill cleanup is less with vegetable-based fluid. In our initial field test, Cargill, Inc. cooperated with Penn State by supplying

over half of the 6,000 gallons of hydraulic fluid required. Some pieces of equipment in the study were purchased new with OEM biodegradable hydraulic fluid in them. The study contains a total of 4 different fluids.

What Do I Have To Do To Changeover To Biodegradable Hydraulic Fluids?

One approach is to simply add fluid as needed. The vegetable-based oils are compatible with petroleum fluids. Because they are a better solvent for some contaminants in the system, the filter should be checked and replaced as needed. However, a mixture of the two types of fluid still presents an environmental risk, albeit lower than 100% petroleum-based fluids. While mixing fluids is an option, it is recommended that the used petroleum hydraulic fluid be drained prior to addition of the biodegradable fluid, and a new filter installed. In most cases, this should maintain a high level of biodegradability in the case of spills.



Fluid and filter change.

At Farm Operations at Penn State, we drained and flushed the systems to remove the petroleum fluid, so that when we have a spill, the cleanup can be handled as totally biodegradable, without any traces of petroleum. This also enabled us to conduct a more scientific evaluation of the fluid's performance. The system was flushed until a clean sample was obtained. In most cases this was done with one change of fluid. In larger, more complicated hydraulic systems, two or more flushes were required. The filter was also changed before the final fill (see photos).



Hydraulic fluid installation.

Summary

- Reduces our dependency of foreign oil
- Improves environmental quality and public health
- Increased lubricity improves system durability
- Supports our agricultural industry with value-added opportunities for crops

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