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WHY HYDRAULIC OIL IS DIFFERENT

AND HOW YOUR OIL CHOICE CAN SAVE YOU MONEY

Hydraulic oil is different than other lubes. Not only is it a lubricant, it's also the means by which power is transferred throughout the hydraulic system. So, it's a lube and a power transfer device. This dual role makes it unique.

To be an effective and reliable lubricant, hydraulic oil must possess properties similar to most other lubes. These include: foaming resistance and air release; thermal, oxidation and hydrolytic stability; anti-wear performance; filterability; demulsibility; rust and corrosion inhibition; and viscosity in respect of its influence on film thickness.

To be most efficient in its role as a power transfer device, hydraulic oil needs high bulk modulus (high resistance to reduction in volume under pressure) and high viscosity index (low rate of change in viscosity with temperature).

As an analogy, consider the tension on a V-belt. If it is out of adjustment, the belt will slip. The result is a higher percentage of input power wasted to heat. This means less power is available at the output to do useful work. In other words, the drive becomes less efficient.

A similar situation can occur with hydraulic oil. Change in its bulk modulus and/or viscosity can affect the efficiency with which power is transferred in the hydraulic system.

As I have explained in previous columns, the perfect hydraulic fluid for transmission of power would be infinitely stiff (incompressible) and exhibit a constant viscosity of around 25 centistokes regardless of its temperature. Such a fluid does not exist.

Compact Excavator	Units	142 IV	200 VI	Benefit
Hours of work per drain	Hours	1,000	1,000	
Hydraulic fluid volume	Gallons	11	11	
Hydraulic fluid price	$/gallon	9.00	18.00	
Hydraulic fluid cost	$	99.00	198.00	-$99.00
Trench length in 1,000 hours	Yards	19,970	22,830	2,860
Time to dig 20,000 yards	Hours	1001.5	876.0	125.5
Labor/rental cost per hour	$/hour	75.00	75.00	
Labor/rental cost for 20,000 yards	$	75,112.67	65,703.02	$9,409.65
Fuel consumed for 20,000 yards		1,836.5	1,591.1	245.5
Fuel price	$/gallon	3.15	3.15	
Fuel price	$	5,785.12	5,011.93	$773.19
Overall costs/savings	**Total $**	80,996.79	70,912.96	$10,083.84

Figure 1. Cost/Benefit Analysis of Changing to 200 VI Shear-stable Oil[1]

Bulk modulus is an inherent property of the base oil and can't be improved with additives. But viscosity index (VI) can be improved by using high VI basestocks such as synthetics and/or by adding polymers called Viscosity Index Improvers to the formulation.

Viscosity Index Improvers were first used to make multi-grade engine oils in the 1940s. These days, this common and well-tested technology is used to make high VI oils for other applications, including automotive transmission fluids and manual transmission gear oils. However, the VI improvers used in oils for the aforementioned applications are not typically shear stable when used in modern hydraulic systems.

But, recent advances in VI improver technology mean that mineral hydraulic oils with a shear-stable viscosity index in the 150 to 200 range are now commercially available.

While this may be good to know, what does it really mean to a hydraulic equipment owner? Well, within the allowable extremes of viscosity required to maintain adequate lubricating film thickness for hydraulic components, there's a narrower viscosity range where power losses are minimized and, therefore, power transfer is maximized.

By maintaining the oil's viscosity in this optimum range, machine cycle times are faster (productivity is increased) and power consumption (diesel or electricity) is reduced.

So, using a higher VI oil means the hydraulic system will remain in its power transmission "sweet spot" across a wider operating temperature range. You could think of this as similar to installing an automatic tensioner on the V-belt drive we talked about earlier in order to maintain optimum power transfer conditions.

However, based on simple cost/benefit analysis, if the cost to install the auto-tensioner was $200, we wouldn't spend this money unless we were satisfied we can recover this investment - plus an acceptable return - through savings attributable to more efficient power transfer and/or reduced maintenance costs.

The same approach should be applied when evaluating the cost and benefits of using a higher VI hydraulic oil. But unlike the relatively simple V-belt drive, savings accruing from increased hydraulic machine performance can be more difficult to quantify. The results, though, of field trials conducted by a manufacturer of shear-stable VI improvers[1] have demonstrated real economic benefit to the equipment end-user. In one trial, the performance of a 40-horsepower compact excavator was evaluated using an all-season 142 VI "baseline" oil and compared to the performance of the same machine using a 200 VI "test" oil.

The test procedure was as follows:

Run baseline data with 142 VI oil.

1. Start with a new air filter and fuel filter.
2. Top off fuel to fill the neck at start of test.
3. Put trenching blade width to normal depth.
4. Dig trench for seven hours.
5. After seven hours, record fuel to refill.
6. Measure trench width, depth and length.
7. Repeat steps 2-6 with a second operator.
8. After baseline is established, change oil and filter, run for two hours, and repeat oil and filter change with 200 VI oil (due to some dilution of the 200 VI oil with the 142 VI baseline oil after changeover, the actual VI of the "test" oil was less than 200).
9. Repeat steps 2 through 7.

The higher VI test oil demonstrated the following advantages over the baseline fluid:

- 15.4 percent improvement in "fuel economy" - cubic yards of dirt moved per gallon of fuel consumed.
- 14.3 percent improvement in "productivity" - cubic yards of dirt moved per hour.

To assign a value to these performance gains, a spreadsheet was developed to calculate an owner's variable costs over the 1,000-hour drain interval recommended by the excavator OEM. The following assumptions were made:

- All-season baseline oil cost $9 per gallon and the 200 VI test oil cost $18 per gallon.
- Labor and equipment rental cost was $75 per hour.
- Diesel cost was $3.15 per gallon.

From extrapolating the results of the trial, it was determined that with the baseline oil, the excavator could dig approximately 20,000 yards of trench in 1,000 hours. And, the same amount of trench could be dug in 874 hours with the 200 VI test oil. No value was assigned to the additional 126 hours the machine owner would have to undertake additional work.

Based on the field test results and the assumptions stated previously, replacing the 142 VI all-season oil with 200 VI oil would save the machine owner $10,000 for every 1,000-hour drain interval (see Figure 1).

As the figure shows, while the fuel cost savings are not insignificant, the greatest potential benefit from switching to higher VI oil is likely to accrue from machine productivity improvement. ML

Reference

1. Gregg, D., Herzog, S.N., "Improving Fuel Economy and Productivity of Mobile Equipment through Hydraulic Fluid Selection: A Case Study" NCFP 08 - 2.4, IFPE March 2008, Las Vegas, NV, USA

About the Author

Brendan Casey has more than 20 years experience in the maintenance, repair and overhaul of mobile and industrial hydraulic equipment. For more information on reducing the operating cost and increasing the uptime of your hydraulic equipment, visit his Web site, www.InsiderSecretsToHydraulics.com