How to Choose a Hydraulic Oil

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Just because a machine will run with a particular lubricating oil doesn't mean that it's the best selection for that application. In most cases, using a less-than-optimal lubricant doesn't mean that your machine will experience a sudden and catastrophic failure. Instead, it will shorten the average life of the machine components, decreasing their efficiency over time. In this case, it is not uncommon for warning signs to go unnoticed.

The importance of selecting a quality hydraulic oil cannot be overstated. This choice will have a lasting effect not only on your machine life, but also on your bottom line. In this article, we'll discuss hydraulic oils and how to pick the right one for the job, as well as how they interact with your hydraulic equipment. By understanding the fundamentals and how they all work together, you can positively impact the working environment for you, your employees, and your machines.

Types of Fluids

Hydraulic fluids play an important part in the smooth operation of a well-balanced and well-designed system. There are many roles that the hydraulic fluid can take on, including heat transfer, power transfer, and lubrication. The actual makeup of the fluid can vary greatly; there are three prevalent types of fluid — synthetic, mineral, and water-based.

Synthetic fluids are manmade fluids that are comprised of chains of molecules. These molecules are specifically arranged to provide excellent fluid stability, lubrication, and other performance-enhanced characteristics. Synthetic fluids are valued for their ability to handle drastic temperature and pressure changes. Potential disadvantages include their higher price tag and their potential incompatibility with certain seal materials.

Petroleum fluid (also referred to as mineral fluid) is the most common type of hydraulic fluid and is made by refining crude oil to a specific level to help increase the lubricant performance. Once the crude has been refined, a blending facility will include a package of additives. Additives can enhance properties, suppress undesirable properties, and can even impart new properties. Common additives include anti-wear, rust and oxidation inhibitors, and viscosity index improvers. These fluids are often a lower-cost alternative to synthetic fluids and can be very comparable to synthetics with the right additive package.

Water-based fluids are the least common type of fluids available. These fluids are most commonly found in applications where there is a risk of fire. They tend to be more expensive than petroleum fluids but less expensive than synthetic fluids. A potential drawback of this fluid is its lack of wear protection.

Fluid Selection

Viscosity is one of the most important factors to consider when selecting a hydraulic fluid. Viscosity is a fluid's ability to resist flow and shear. At lower temperatures, excessive viscosity can result in poor mechanical efficiency, start difficulties, and wear damage. At higher temperatures, a lack of viscosity will cause the fluid to become too liquid, preventing it from providing the protection required for the different components. The result is lower volumetric efficiency, overheating, and wear damage. Pump manufacturers will often include hydraulic fluid recommendations that cover aspects such as:

- The maximum startup viscosity when under load
- The range of optimum operating viscosity
- The maximum and minimum operating viscosity
- Normal viscosity requirements for multiple operating temperature ranges

Selecting the right fluid viscosity grade for your specific needs will provide the most efficient pump performance, minimizing loss due to downtime, personnel costs, and fuel/energy. To help navigate this area of hydraulic pump health, a performance standard was developed, described as Maximum Efficiency Hydraulic Fluid (MEHF).

MEHF fluids are formulated to provide a combination of high viscosity indexes with good sheer stability at standard and peak operating conditions, which enables all types of hydraulic pumps to deliver increased power at a lower level of energy consumption. MEHFs are designed to offer both improved low-temperature flow and excellent air release properties. The result is an improved ability to meet the Original Equipment Manufacturer's viscosity requirements over a wider range of temperature and pressure conditions, thus maintaining higher pump efficiency.

Multigrade Fluid Improvements

Multigrade hydraulic fluids are often recommended for equipment where the operating temperatures vary widely. High viscosity index MEHFs enable efficient equipment operation over a wider temperature range than standard grade mineral oils. Because of this wide temperature operating range, MEHF products can also eliminate the need for seasonal oil changes since it is formulated to perform in both winter and summer conditions. While improved flow characteristics provide smoother operation and improved productivity, the primary performance advantage of an MEHF is its effectiveness in maintaining pumping efficiency at high temperatures.

One of the challenges that professionals must contend with is how to reduce operating costs while simultaneously improving productivity. One way of overcoming this challenge is by selecting hydraulic fluids to help improve pump efficiency and lower their overall costs.

Proven Advantage

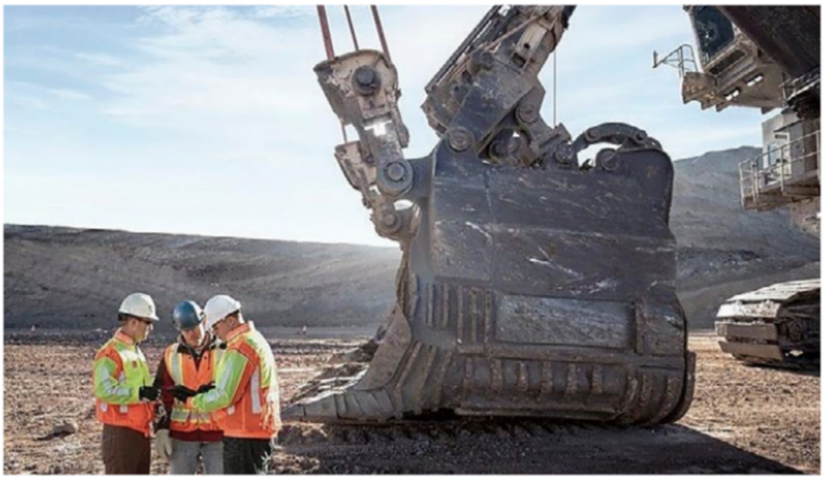
With up to 5% greater energy efficiency and 21% less energy loss, Shell Tellus S4 VE is a real competitor in the energy-efficiency lubrication market. This oil helps create an environment that quickly releases air to prevent fluid aeration, which can significantly reduce the efficiency and responsiveness of your lubrication. This can lead to an 8% increase in volumetric efficiency and a 50% reduction in sound. Shell Tellus S4 VE provides extra-long oil life, comprehensive system efficiency, and premium wear protection.

Application-Based Selection

To ensure that systems function properly, the application should be the most critical attribute to consider when selecting a hydraulic fluid. When selecting a hydraulic fluid, it is critical to determine the system's needs, such as viscosity, additives, reliability goals, and operation.

The fluid's viscosity should be determined by the pump type, operating temperature, and pressure achieved. Not having the correct viscosity will drastically reduce the average life of the pump and the system, directly reducing its reliability and production capabilities. When selecting the appropriate viscosity grade, look for the optimum viscosity required by the pump. This can be determined by collecting data from the pump's Original Equipment Manufacturer (OEM) actual operating temperature of the pump, and the lubricant properties referenced in the ISO grading system.

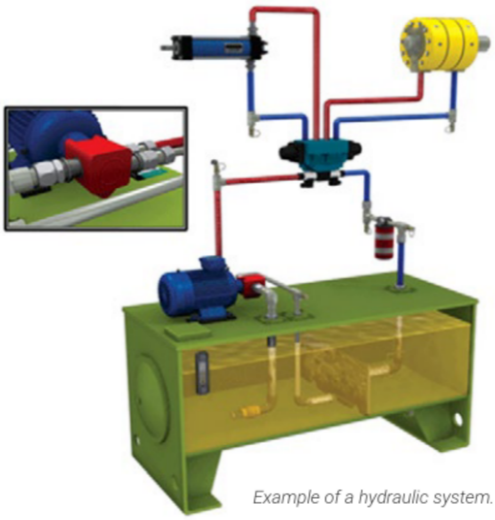
Selecting the proper hydraulic fluid for the application is not a hard task, but it does require time to research the application, determine the resulting cost, and decide which fluid type is best. You can spend more money than is needed simply by not including these criteria in your proper lubricant selection techniques. Practicing good lubricant selection facilitates great machine performance.



Pumps and Viscosity Requirements

There are three major design types of pumps used in hydraulic systems — vane, piston, and gear. Each of these pumps is designed and deployed for certain performance tasks and operations, and each pump type must be treated on a case-by-case basis for lubricant selection.

- Vane: The design of the pump is exactly what the name depicts; inside the pump, rotors with slots are mounted to a shaft that spins to a cam ring. As the rotors and vanes spin within the ring, the vanes become worn due to the internal contact between the two touching surfaces.
- Piston: Piston pumps are the typical middle-of-the-road hydraulic pump, and they are more durable in design and operation than a vane pump. These are the most complicated of pump designs.
- Gear: Gear pumps are typically the more inefficient of the three pump types, but they are more agreeable with larger amounts of contamination. Gear pumps operate by pressurizing the fluid between the trapped air volume of the meshing teeth of a gear set and the inside wall of the gear housing, then expelling that fluid. There are two main types of gear pumps — internal and external. Internal gear pumps offer a wide range of viscosity choices, while external pumps offer easy maintenance, steady flow, and decreased costs when buying or repairing the machine.



Example of a hydraulic system.

Case Study: Shell Tellus

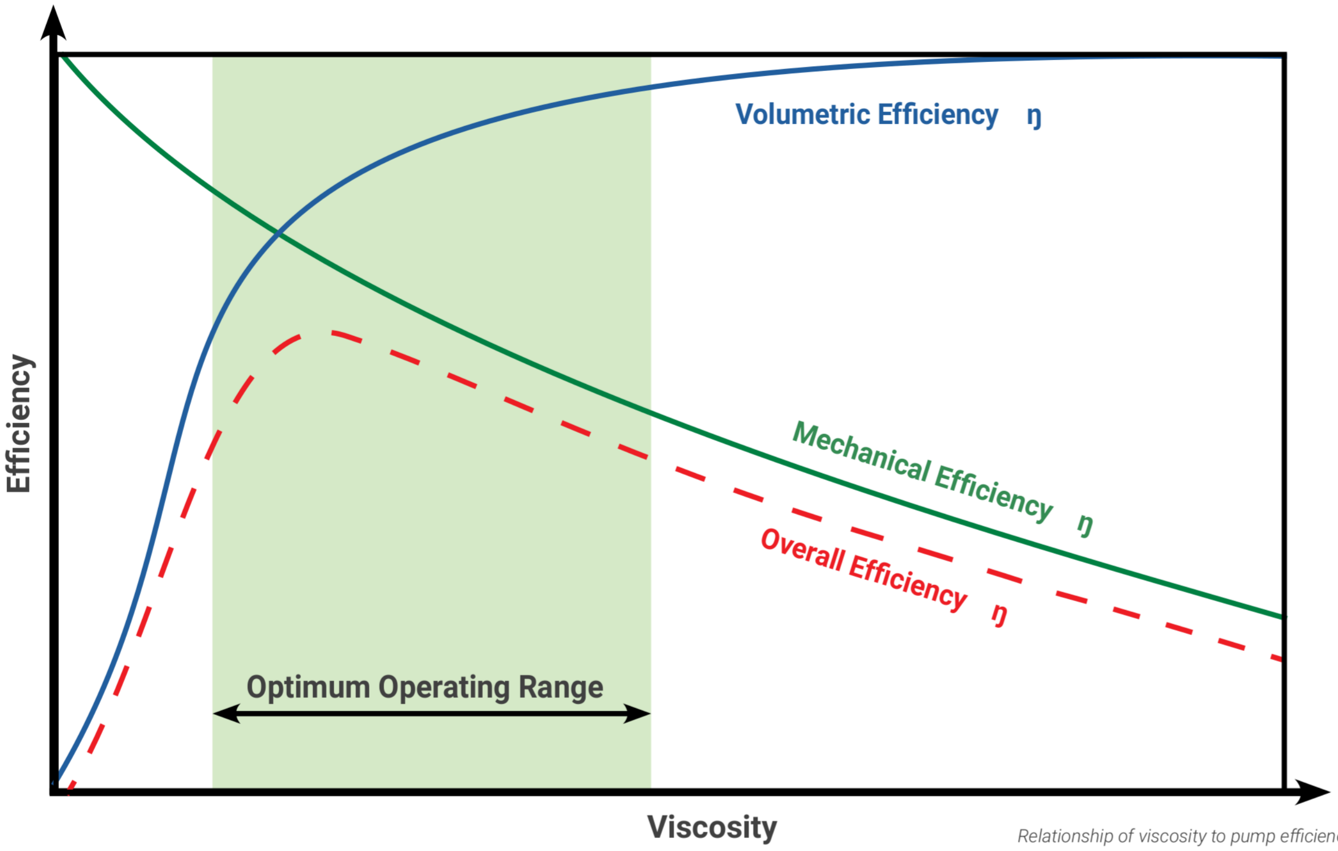
Golden Queen Mining, LLC commissioned a study assessing the efficiency benefits and longevity of hydraulic oils, looking specifically at their 800 loaders located at a California mine. The Shell Lubricants team supplied the mining group with Shell Tellus S4 ME 46 for a 3000-hour harsh-condition trial.

The used oil was analyzed to measure energy efficiency, oil life and production levels and was found to have performed well in every parameter. Golden Queen Mining switched to the new oil and has since noticed improved fuel consumption and productivity, leading to increased oil drain intervals. After the switch, the company reported an annual savings of $278,000.

Pump Efficiency

The performance of the hydraulic pump is a critical factor in determining the hydraulic system's reliability. There are two main aspects to consider when looking at hydraulic efficiency — volumetric efficiency and hydromechanical efficiency.

Volumetric efficiency relates to the flow within a hydraulic component and the degree to which internal leaking occurs. Hydromechanical efficiency relates to the frictional losses within a hydraulic component and the amount of energy required to generate fluid flow. Both properties are highly dependent on viscosity. For example, volumetric efficiency increases as fluid viscosity increases due to the reduction of internal leakage. On the other hand, hydromechanical efficiency decreases as the fluid viscosity increases due to its higher resistance to flow.



Relationship of viscosity to pump efficiency.

Loss of volumetric efficiency causes the pump to work harder and longer to produce the required flow to hydraulic actuators. At the same time, high temperatures compromise volumetric efficiency as the result of low-viscosity fluid bypassing critical pump clearances. Thus, inadequate viscosity due to high temperatures creates a destructive cycle of rising temperatures, accelerated wear, and increased internal leakage. All pump manufacturers publish the maximum and minimum oil viscosity requirements for their pumps, and it is advised to consult the pump manufacturer directly for specific guidance on the fluid viscosity requirements.

Every type of hydraulic pump is designed to have a small amount of internal fluid leakage. This fluid is essential because it helps form a film of lubrication on the moving parts, effectively preventing wear damage. If the pump is operating with optimum temperature and pressure conditions, the amount of leakage is minimal, and the pump can operate with greater than 90 percent efficiency. However, hard-working pieces of equipment, like those typically seen at mining or construction sites, are often placed under significant stress, contributing to higher operating temperatures. As the temperature increases, the oil's viscosity drops, and higher levels of internal leakage occur. This is why it pays to have a quality lubricating oil that can sustain these types of temperatures while operating at peak performance.

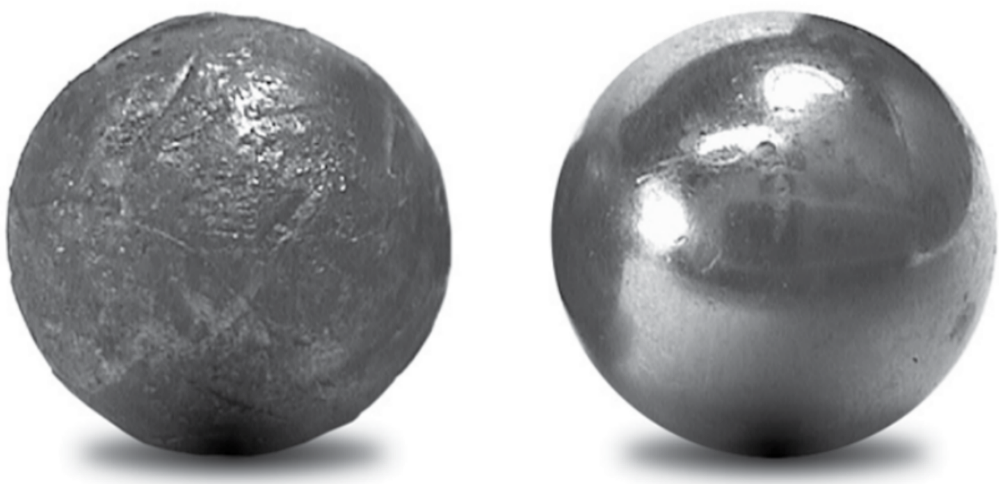
Shell Tellus S4 VE Makes the Difference

This advanced, energy-efficient synthetic hydraulic fluid meets and beats OEM approvals for mobile and stationary applications. Not only does it beat the standard, but it is also proven to extend oil life, provide wear protection, and is designed to operate at a wider range of temperatures. Shell Tellus S4 VE even exceeds the 10,000-hour maximum duration that can be measured in industry-standard turbine oil stability tests (TOST).

Cavitation, Wear, and System Overheating

At low operating temperatures, high viscosity negatively affects the mechanical efficiency of the hydraulic system, resulting in reduced system performance, lubricant starvation, and cavitation.

Cavitation causes metal fatigue and spalling, which reduces the pump life and generates abrasive metal particles in the fluid. Viscosity influences cavitation because high-viscosity fluids can create excessive pressure drops at the pump inlet. Excessive viscosity from low-temperature conditions leads to pump starvation, which may result in pump failure. Pump manufacturers specify a maximum fluid viscosity limit for a startup to ensure cavitation is avoided. Improperly designed or undersized inlets and strainers can aggravate the problems associated with high viscosity.



Damaged ball bearing compared to a healthy ball bearing.

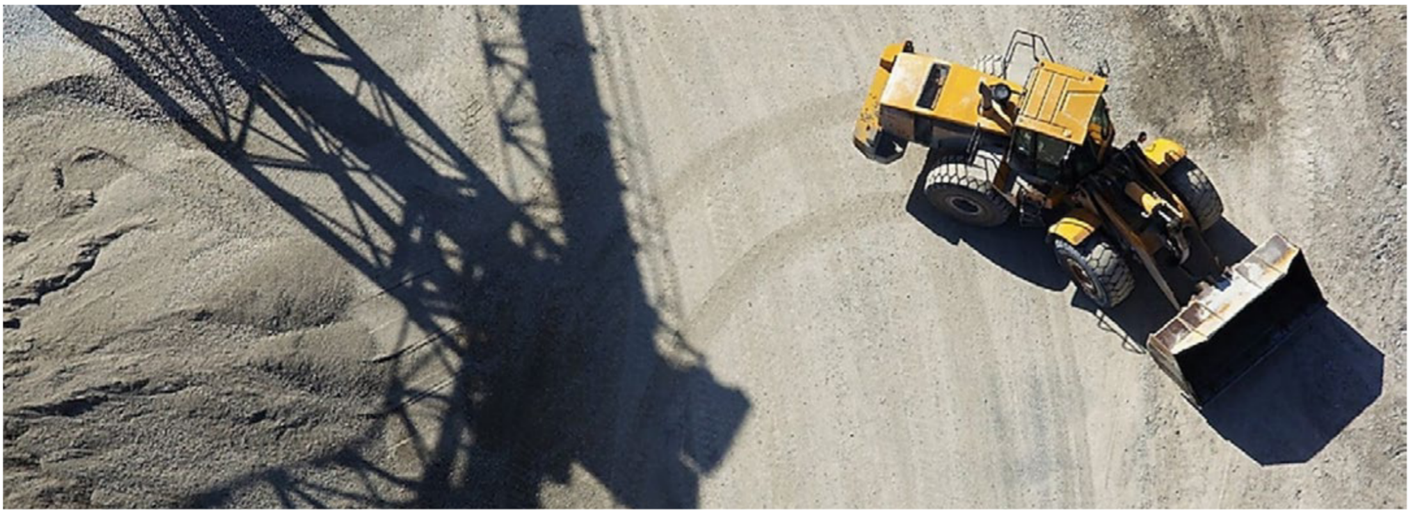
An essential function of hydraulic fluid is to provide a lubricating film that reduces wear on moving pump parts. Film effectiveness depends upon a balance between viscosity, sliding speeds and loads, and fluid stability within a hydraulic pump. As temperatures increase and the film thins, the lubricant film ruptures, allowing for metal-on-metal contact. Wear predominantly occurs within the pumps that are critical in terms of volumetric efficiency. Loss of volumetric efficiency causes the pump to work harder to produce the required flow needed.

At the same time, high temperatures can compromise volumetric efficiency because of the low-viscosity fluids that are able to bypass critical pump clearances. This inadequate viscosity is due to high temperatures, which in turn creates a destructive cycle of rising temperatures, accelerated wear, and increased internal leakage.

Mobile Hydraulic Equipment

The total space and weight of a machine can become an issue when force comes into play. Larger machines add extra pressure and force, with potentially costly consequences. When space and weight become a machine issue, a more compact hydraulic system with a higher power-to-weight ratio may be necessary. Mobile hydraulic equipment has a harder operating life than industrial hydraulic equipment. There are four key reasons for this:

1. **Operating environment —** They are typically operating in conditions that are dirty, dusty, and experience extreme temperatures.
2. **Tank size —** Due to space and weight restrictions, the reservoir capacity is less than industrial equipment. This means that there is less oil circulating in the system and a shorter tank dwell time. This can allow for contaminants, like particles, water, and air, to enter your system more easily.
3. **Cooling capacity —** Mobile hydraulic equipment has a limited cooling capacity. The aspect that will have the biggest impact on the equipment's operating temperature is the temperature of the machine's location.
4. **Operating pressure —** While there are many high-pressure industrial hydraulic systems, the mobile systems are the ones pushing the envelope on what is possible, even with operating pressure.



How Much Can I Save?

Extensive testing has demonstrated that high-viscosity index fluids provide better pump efficiency at operating conditions. However, these high-performing fluids cost more than standard fluids, so what is the benefit? While nearly any hydraulic application can take advantage of MEHFs, heavy-duty equipment, such as those seen in construction and agriculture, see the most significant benefits. On average, you can expect to see a five to ten percent savings on energy and an improvement in productivity. This can mean saving hundreds of dollars per pump every year.

Choosing the right fluid can also help reduce environmental impact. Shell Naturelle is a biodegradable lubricant designed specifically to keep equipment operating efficiently while being conscientious of its biodegradability and ecotoxicity.

Conclusion

Just because a machine will run with a particular lubricating oil doesn't mean that it's the best selection for that application. By properly reviewing your machine's specific needs, you can begin to find the best lubrication for the job. With careful consideration and planning, you can not only positively affect the total useful life of your machines but also your bottom line.

Shell Tellus System Efficiency

To help your equipment perform to its design standards, the hydraulic fluid needs to protect, lubricate, and help transmit power in the most effective way possible. Shell Tellus® hydraulic fluids can help maintain or even improve the efficiency of hydraulic systems. From Shell Tellus® S4 ME, which can help improve the energy efficiency of many hydraulic systems, to Shell Tellus® S2 MX and Shell Tellus® S2 VX that provide reliable air release, water separation, filterability, cleanliness and stick-slip performance, there is a choice that can help to optimize your system's efficiency and costs of operation.

Learn more about Shell at shell.us or shell.com.