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SAVANT LABS

On the Horizon

A World of Lubrication Understanding®

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Today's Topics:

- **Understanding Hydraulic Fluids**
- **Get It Fast: Choose from 24-Hour, 3-Day, or 5-Day Turnaround Plus, Enjoy No Wait with Our Standard 10-Day Turnaround Service!**
- **ASTM D02 Ballot Approval Paves the Way for CDT Testing in EV Fluids**

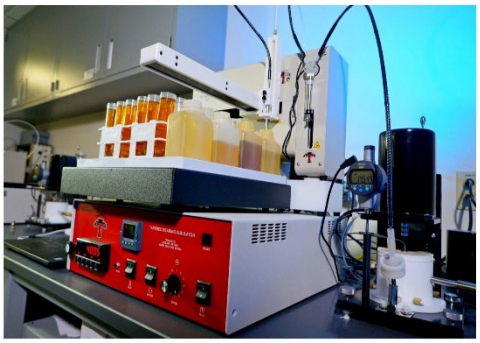
Understanding Hydraulic Fluids: Properties, Testing, and Maintenance Considerations

Hydraulic fluid is essential for a range of applications, including automotive braking systems, industrial machinery like forklifts and construction equipment, and hydraulic lifts. It serves to transmit force and mechanical power throughout machines by responding to applied pressure. Viscosity, which affects flow efficiency, is crucial. Viscosities being too high can lead to frictional losses, while too low may cause leaks. Maintaining incompressibility is vital to prevent issues like sponginess in hydraulic systems, often caused by air bubbles or foam.

Moreover, hydraulic fluids provide lubrication and protection against wear for system components like pumps and pistons. They contain anti-wear additives to safeguard surfaces under high pressure. However, fluids must also avoid reacting with system materials and causing corrosion or seal damage. Contaminants such as water and oxidation byproducts pose significant risks, leading to corrosion, sticky varnishes, or abrasive particles that wear down components. Effective filtration is necessary to remove contaminants while preserving beneficial additives.

Practical considerations include minimizing costs, safety hazards, and environmental impact. Longer service life and the use of non-toxic, environmentally friendly additives are essential for sustainability and safety. Additionally, fire resistance is crucial in certain applications to prevent accidents. Overall, hydraulic fluids play a critical role in various industries, and their proper selection and maintenance are essential for efficient and safe operation.

Testing Hydraulic Fluids for Flow Properties



Many hydraulic fluid tests examine viscosity and fluid flow. ASTM D445 measures kinematic viscosity. When determined at two temperatures, this test shows how the fluid flows as it warms and cools. As it cools and becomes more resistant to flow, pumpability is a concern. The Scanning Brookfield Test (ASTM D5133) examines whether a change in structure (viscosity and/or gelation tendency) may prevent effective pumping at cold temperatures. Low-temperature pumpability might be especially important for hydraulics in a refrigerated warehouse. Other tests measure viscosity loss under shearing conditions. That loss may last only as long as the fluid is under shear forces or may be permanent. Combining tests for high-temperature, low-shear viscosity (SAVLAB TBR) and high-temperature, high-shear viscosity (ASTM D4683 or D6616) at the same temperature reveals both temporary and permanent viscosity loss from shearing. KRL shear loss (CEC L-45-99) or sonic shear (ASTM D2603) tests also show permanent viscosity loss.

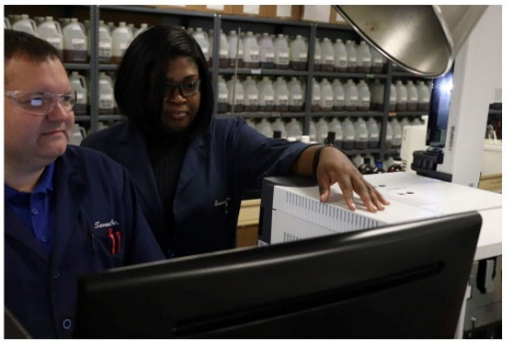
Testing for Incompressibility

The Foaming Characteristics (ASTM D892) and Air Release (ASTM D3427) tests relate to keeping air out of the hydraulic fluid so it remains incompressible. In the foaming characteristics tests, air is introduced into the fluid, creating foam. Fluids with desirable anti-foaming characteristics will create minimal foam volumes. The faster the foam dissipates, the more quickly air problems will resolve. Air Release also times a fluid's return to an acceptable minimum level after air is added.

Testing for Protection

Many tests measure a fluid's ability to protect machine components from damage. Rust Prevention Test (ASTM D665) determines protection against rust, Copper Strip Corrosion (ASTM D130) against corrosion of yellow metals, and a higher acid number found using Acid Number (ASTM D664 or D974) generally indicates a more corrosive fluid. Several Elastomer Compatibility Tests (ASTM D471, ASTM D7216, or CEC L-112-16) examine how the fluid impacts the elastomer seals, Differences between these Elastomer Compatibility Tests generally involve the specific reference material tested with the fluid, and modifications may be appropriate for application-specific seal materials. Many tests measure protection against wear. A few of these include the FZG Scuffing Test (ASTM D5182), the Four-Ball Wear Test (ASTM D4172), and the Falex Pin and Vee Test (ASTM D2670). These tests use different mechanisms to create wear and may be listed in different specifications. For instance, ASTM D6158-18 specification requires the scuffing test, while FED-STD-791 requires the four-ball test. Consideration of the type of wear likely in a particular system and discussion with a testing expert at Savant Labs may help select a wear test.

Testing for Resistance to Fluid Degradation



Many different hydraulic fluid tests assess fluid degradation. These tests predict how long a fluid will retain its critical properties or measure the actual degradation of an in-service fluid. Oxidation tests, such as Oxidation Characteristics/TOST (ASTM D943), Oxidation Characteristics/Dry TOST (ASTM D4310), and Oxidation by RPVOT (ASTM D2272), artificially apply conditions with increased oxygen and high temperatures to stress the fluid. The measurements determine how long the fluid resists breakdown from these stressors. While results may not predict a specific number of service hours, a better result in an oxidative test indicates a longer expected service life. The Thermal Stability Test (ASTM D2070) is similar but focuses on elevated temperature, not oxygen exposure. When applied to a fresh and in-service fluid, some oxidation tests, such as ASTM D2272 or Oxidation by FTIR (ASTM D7214), measure whether antioxidant additives are depleted. The Hydrolytic Stability Test (ASTM D2619) also focuses on predicting service life. It tests how well fluid can resist changes in the presence of water. Better results imply a longer service life and better suitability for applications where water contamination is likely. Tests for the presence of water, such as the Water Content by Karl Fischer Test (ASTM D6304), and tests to determine the Particle Count (ISO 4406) reveal contamination of in-service fluids. The Water Separability Test (ASTM D1401) evaluates the ease of separating water from samples when they are contaminated. Filterability tests verify that only contaminants, not fluid components, are removed during filtration. Both tests indicate the possibility of extending service life by removing contaminants. Testing for volatility (ASTM D6417) can indicate whether a fluid could lose some of its critical properties as the lightest components evaporate. When applied to an in-service fluid, changes in volatility can indicate contamination. Changes in fluid composition by elemental analysis (ASTM D5185), density (ASTM D1298), or color (ASTM D1500) also indicate contamination or other fluid degradation.

Property	Test	Benefit
Viscosity and Flow Properties	ASTM D445 Kinematic Viscosity (100 °C and 40 °C)	Find viscosity, stability of viscosity with temperature
	SAVLAB High-Temperature, Low-Shear Viscosity (TBR)	Find dynamic viscosity, stability of viscosity with shear
	ASTM D6616 or D4683 High-Temperature, High-Shear Viscosity (TBS)	Stability of viscosity with shear
	ASTM D2983 Brookfield Viscosity	Find dynamic viscosity, low-temperature flow behavior
	ASTM D5133 Scanning Brookfield (-5 °C to -40 °C)	Find viscosity at many temperatures, pumpability characteristics (gelation index)
	CEC L-45-99 KRL Shear Loss	Stability of viscosity with shear (permanent loss)
	ASTM D2603 Sonic Shear	Stability of viscosity with shear (permanent loss)
	ASTM D97 Pour Point	Low-temperature flow properties
Compressibility	ASTM D892 Foaming Characteristics	Resistance to foaming
	ASTM D3427 Air Release	Resistance to holding air
Component Protection	ASTM D5182 FZG Scuffing	Wear protection
	ASTM D4172 Four-Ball Wear	Wear protection

	ASTM D2670 Falex Pin and Vee	Wear protection and friction
	ASTM D665 Rust Prevention	Corrosiveness to ferrous metals
	ASTM D130 Copper Strip Corrosion	Corrosiveness to yellow metals
	ASTM D471 Effects of Liquids on Rubber	Damage to seals
	ASTM D7216 or CEC L-112-16 Elastomer Compatibility	Damage to seals
Fluid Degradation	ASTM D664 or D974 Acid Number	Corrosiveness, fluid remaining life
	ASTM D943 Oxidation Characteristics (TOST)	Estimate fluid life
	ASTM D4310 Oxidation Characteristics (dry TOST)	Estimate fluid life
	ASTM D2272 Oxidation by RPVOT	Estimate fluid life, remaining life
	ASTM D7214 Oxidation by FTIR	Estimate remaining life
	ASTM D2070 Thermal Stability	Resistance to changes from heat
	ASTM D1401 Water Separability	Ability to remove water
	ASTM D2619 Hydrolytic Stability	Resistance to changes from water
	ISO 4406 Particle Count	Fluid contamination
	ASTM D6417 Volatility by GC	Identify fluid, contamination, predict stability
	ASTM D5185 Elemental Analysis by ICP	Identify fluid, additives, changes
	ASTM D6304 Water Content by Karl Fischer	Determine water in fluid, changes
	ASTM D1298 Density SAVLAB Density by Pycnometer	Needed to track density over time to find potential contamination issues
	ASTM D1500 Color	Identify fluid contamination or changes
Safety	ASTM D92 Flash Point	Fire hazard identification

Savant's Hydraulic Fluid Testing Capabilities

Savant Labs has extensive experience with all of these hydraulic fluid tests. In addition to testing new fluids for specifications, we offer customized projects to address particular problems. In one case study, the customer was evaluating new fluids for their company-wide hydraulic systems. As part of the project, we tested some of the customer's in-service fluids. Clues like wear metals revealed during elemental analysis, poor oxidation resistance, and permanent viscosity loss due to shearing helped the client identify unmet lubricant needs to be addressed with their new fluid choice. Our analysts also tested several proposed fluids and recommended which would perform best under the customer's service conditions. Whether you need to confirm your newly developed fluid is meeting specification limits, verify that a fluid is the right one for your application, or monitor your in-service hydraulic fluids, Savant Labs can meet your needs. Contact Savant Labs for a quote on standard hydraulic fluid testing or to learn more about our custom testing capabilities.

Request Quote

References

ASTM D6158-18. Standard Specification for Mineral Hydraulic Oils. ASTM International.

BioBlend Renewable Resources, LLC. What is hydraulic fluid for and why is it important. *BioBlend Sustainable Performance*. Accessed Feb 12, 2024. https://www.bioblend.com/what-is-hydraulic-fluid-for/

FED-STD-791E. (2021, June 22). Testing Method of Lubricants, Liquid Fuels, and Related Products.

The Lubrizol Corporation. (2015, November 30). Characteristics of a Good Hydraulic Fluid. *Lubrizol 360*. Accessed Feb 12, 2024. https://360.lubrizol.com/2015/Characteristics-of-a-Good-Hydraulic-Fluid
MAC Hydraulics. (2021, May 11). *The Roles and Characteristics of Hydraulic Fluid*. Accessed Feb 12, 2024. https://mac-hyd.com/blog/the-roles-and-characteristics-of-hydraulic-fluid/
Meiji Corporation. (2023). Slash Costs, Eliminate Downtime and Go Green with Precision Filtration. *Machinery Lubrication*, Noria. Accessed Feb 12, 2024. https://www.machinerylubrication.com/Read/32553/slash-costs-eliminate-downtime-go-green-with-precision-filtration

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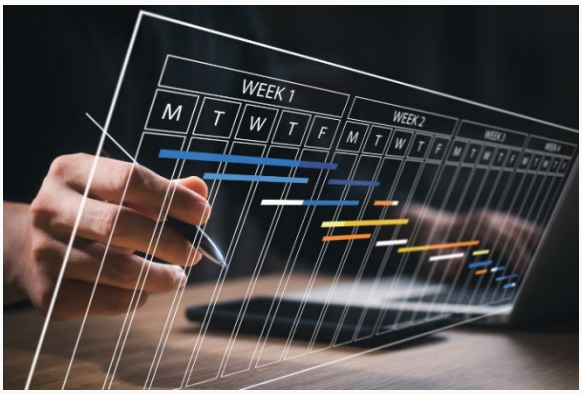

It's no secret that many labs offering lubricant oil testing services have a backlog of tests, causing long wait times and frustrations for customers. **Savant Labs is different.**

At Savant Labs, we are dedicated to helping companies overcome their testing challenges so they can focus on what matters most - delivering top-quality products to their customers. Savant offers a **24-hour, 3-day, and 5-day turnaround for most testing services** for lubricant oils.

We have invested in renovations to increase capacity, added additional resources, and built an expert team to deliver fast and accurate results. Quality is not sacrificed for efficiency. Savant Labs uses international methods and industry-standard equipment for comprehensive testing, and we are ready to meet your testing needs.

Contact us to learn how we can accommodate your immediate testing requirements. Thank you for considering Savant Labs. We look forward to the opportunity to collaborate with you in the near future.

ASTM D02 Ballot Approval Paves the Way for CDT Testing in EV Fluids

The ASTM D02 ballot for the Conductive Deposit Test (CDT) test has received a green light and has been assigned the official ASTM method number D8544-24. It is expected to be published by the middle of March.

CDT testing assesses fluids for electric vehicle (EV) use by exposing a copper trace circuit board to test fluids under controlled conditions, simulating EV environments where components are exposed to minimal circulation or lubricant vapors. The test detects conductive copper deposits formed from corrosion that can cause short circuits by bridging unconnected components. Results are measured in resistance

drops and the Conductive Deposit Factor (CDF), indicating fluid suitability and performance. Each manufacturer sets their limits, although industry-wide standards are in the works. Released in October 2022, the SAE J3200 guideline documents new performance properties and suggested test methods for fluids used in electrified automotive drivetrains. The CDT test is included in this document for measuring conductive deposit properties and thermal characteristics.

At Savant Labs, we are proud to offer ASTM D8544 CDT testing services. Our ongoing efforts have positioned us as knowledgeable professionals in these emerging fields, ready to support our customers' testing requirements. To learn more about our services and to request a quote, please contact us to request a quote.

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