

The Importance of Fire-Resistant Hydraulic Fluids in High-Pressure Die Casting

BY: RONALD KNECHT, GLOBAL PRODUCT MANAGER

Executive Summary

The high-pressure die casting (HPDC) industry is evolving at an unprecedented pace. As components grow larger and more complex, and as giga casting reshapes automotive manufacturing, equipment is being pushed harder than ever before.

Amid these advances, one critical factor is often underestimated: hydraulic fluid. No longer just a safety requirement, modern fire-resistant hydraulic fluids play a central role in process control, equipment reliability, and overall operational efficiency.

This paper explores how selecting and managing the right hydraulic fluid – particularly HFC (water glycol) and HFDu (synthetic ester) technologies – can directly influence part quality, overall equipment effectiveness (OEE), and total cost of ownership (TCO).

Industry Evolution and Emerging Pressures

Die casting has moved well beyond producing small housings and brackets. Today, manufacturers are creating large, structurally critical components, especially in the automotive sector where light weighting and giga casting are transforming design and production.

This shift brings a combination of challenges. Components are larger and more geometrically complex. Operating pressures continue to rise, while cycle times are shrinking in response to

global demand. At the same time, expectations around quality, reliability, and safety have never been higher.

Machine design has advanced significantly, but these demands place increasing pressure on hydraulic systems. In practice, the performance of the hydraulic fluid itself has become a defining factor in whether operations run smoothly or struggle with variability.



Every die casting cycle depends on a sequence of hydraulic actions that must occur at precisely the right force, speed, and timing to avoid defects.

Why Hydraulic Fluid Performance Matters

Every die casting cycle is a tightly controlled sequence: clamping the mold, injecting molten metal, applying intensification pressure, and ejecting the finished part. For consistent production, each step must occur at precisely the right force, speed, and timing. Even small variations can result in defects such as porosity, dimensional inaccuracies, or inconsistent surface finish.



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To maintain control, the hydraulic fluid has to perform reliably under difficult conditions.

- **Thermal and oxidative stability** is a key consideration. In demanding environments, lower-quality fluids can degrade and form deposits such as varnish. These deposits interfere with valves and actuators, making it harder to maintain consistent cycle timing.
- **Lubricity** plays a quieter but equally important role. Without it, systems can suffer from uneven or jerky movement, and components like pumps and valves wear faster. Over time, this affects both performance and maintenance requirements.
- **Viscosity stability** is fundamental. A high viscosity index helps the fluid behave consistently even as temperatures rise during long production runs, which in turn keeps pressure and flow predictable.
- **Air release** is another critical factor. When air becomes trapped in the fluid, it increases compressibility and affects the pressure profile. That can disrupt injection and intensification, especially when producing large or thin-walled parts.
- Finally, there is the question of **shear stability and cleanliness**. Fluids need to maintain their characteristics under pressures that can exceed 200 bar, while staying clean enough to protect sensitive components and ensure consistent machine response.

Warning Signs Worth Investigating

Operators often see early signals before a failure occurs. Common indicators include:

- Slower response during injection or intensification
- Increased operating temperatures without process changes
- Pressure fluctuations
- Visible deposits or darkening of the fluid
- Jerky or uneven cylinder movement

Addressing these early can help avoid larger performance issues later.

Fire Resistance: More Than a Safety Requirement

Fire risk is inherent in die casting. Molten metal, high temperatures, and pressurized systems create conditions where even a small leak can quickly escalate.

Fire-resistant fluids are essential for protecting operators and equipment, but their role goes further than that. They also support operational stability by reducing the risk of incidents that interrupt production.

In that sense, fire resistance is not just about compliance. It is about maintaining confidence in the process.



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Fire-resistant hydraulic fluid is essential in die casting, due to the high temperatures and molten metal.

Technology Choices: HFC vs. HFDu

Choosing a fire-resistant hydraulic fluid means balancing safety, performance, and operational complexity. The two main technologies used in die casting are HFC and HFDu.

HFC (Water Glycol Fluids)

HFC fluids remain the most widely used option in high-pressure die casting, particularly in Europe and North America. Their high water content provides strong fire resistance, which is why they have been the default choice for many years.

That same water content, however, requires careful management. Concentration levels need to be monitored to maintain lubrication and corrosion protection. Without that attention, performance can decline.

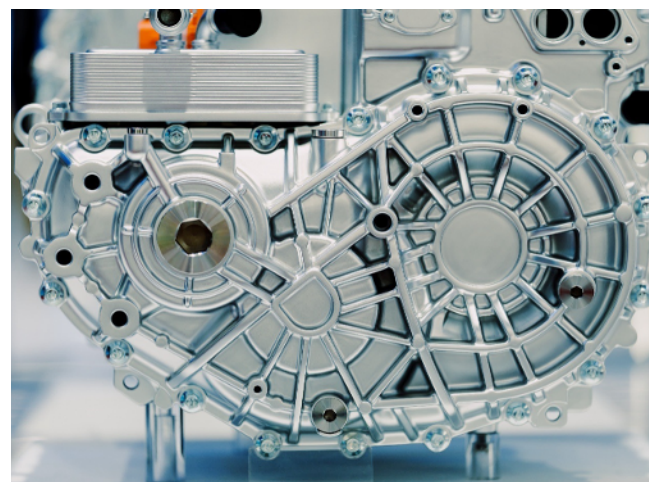
Even so, well-formulated HFC fluids can deliver reliable performance, especially in older systems or in operations where leakage is more likely.

HFDu (Synthetic Ester Fluids)

HFDu fluids take a different approach. These are water-free synthetic esters, designed to combine fire resistance with the performance characteristics of traditional hydraulic oil.

They offer better lubricity, which helps reduce wear and support smoother operation. Their thermal stability also allows for longer fluid life and more consistent performance over time. In addition, their high fire point and self-extinguishing properties provide a strong safety profile that is often recognized by insurers.

For newer, high-performance equipment – particularly in giga casting – these advantages can make a noticeable difference. While the upfront cost is higher, the operational benefits tend to show up quickly in reduced downtime and improved consistency.



With trends for more complex geometries and larger parts, many die casters are turning to HFDu fluids to improve process stability and quality.



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HFC or HFDu? A Practical Decision Guide

When reviewing your current setup, a few simple questions can help guide fluid selection:

- **Are you managing frequent leaks or operating older equipment?** HFC may offer a more forgiving and cost-effective solution
- **Are you running high-value parts or large structural castings?** HFDu can help improve consistency and reduce wear-related variability
- **Is maintenance time or fluid monitoring a constraint?** HFDu typically requires less ongoing intervention
- **Are you looking to reduce long-term operating costs rather than upfront spend?** HFDu fluids can deliver energy savings and extend pump life through better wear protection.

Looking Beyond Cost: Total Cost of Ownership

Hydraulic fluid is often treated as a consumable, but that view misses the bigger picture.

In reality, fluid choice affects equipment life, maintenance needs, downtime, and product quality. A stable, well-performing fluid reduces wear, helps avoid unplanned stoppages, and supports consistent output.

When these factors are taken into account, the lowest-cost option is not always the most economical. Fluids that perform better over time can significantly reduce total cost of ownership across the life of the equipment.

Enhancing Overall Equipment Effectiveness

Hydraulic fluid management has a direct impact on overall equipment effectiveness (OEE). In many cases, small improvements in stability and reliability translate into meaningful gains in productivity.

Routine fluid analysis is an important part of this. Monitoring viscosity, contamination, and fluid condition helps operators spot trends early and act before problems develop. As a general rule, HFC fluids are tested more frequently than HFDu fluids due to their water content.

Cleanliness is equally important. Maintaining appropriate ISO cleanliness levels helps protect critical components and ensures the system continues to respond as expected.

Seal compatibility is another factor that tends to be overlooked. Ensuring the fluid works well with system materials helps prevent leakage and improves long-term reliability.

What matters most is acting on the data. Whether it's adjusting concentration or improving filtration, timely intervention is what keeps systems performing as intended.



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Quick Wins for Improving OEE

Improving overall equipment effectiveness often comes down to consistency.

- Review fluid analysis results regularly, not just when issues arise
- Act early on contamination trends rather than waiting for threshold limits
- Confirm seal compatibility during fluid changes or system upgrades
- Align fluid maintenance schedules with production cycles to avoid disruption

Even small improvements in hydraulic consistency can translate into fewer defects and less downtime.

From Consumable to Competitive Advantage

In modern high-pressure die casting, hydraulic fluid is no longer just an operational input. It plays a direct role in performance, safety, and cost control.

When the right fluid is selected and properly maintained, it supports stable processes, consistent part quality, and reliable equipment operation. It also helps reduce risk, both in terms of safety and unplanned downtime.

As the industry continues to move toward larger castings and tighter tolerances, the margin for error is shrinking. The operations that perform best will be the ones that treat hydraulic fluid not as a background detail, but as a deliberate and strategic choice.

