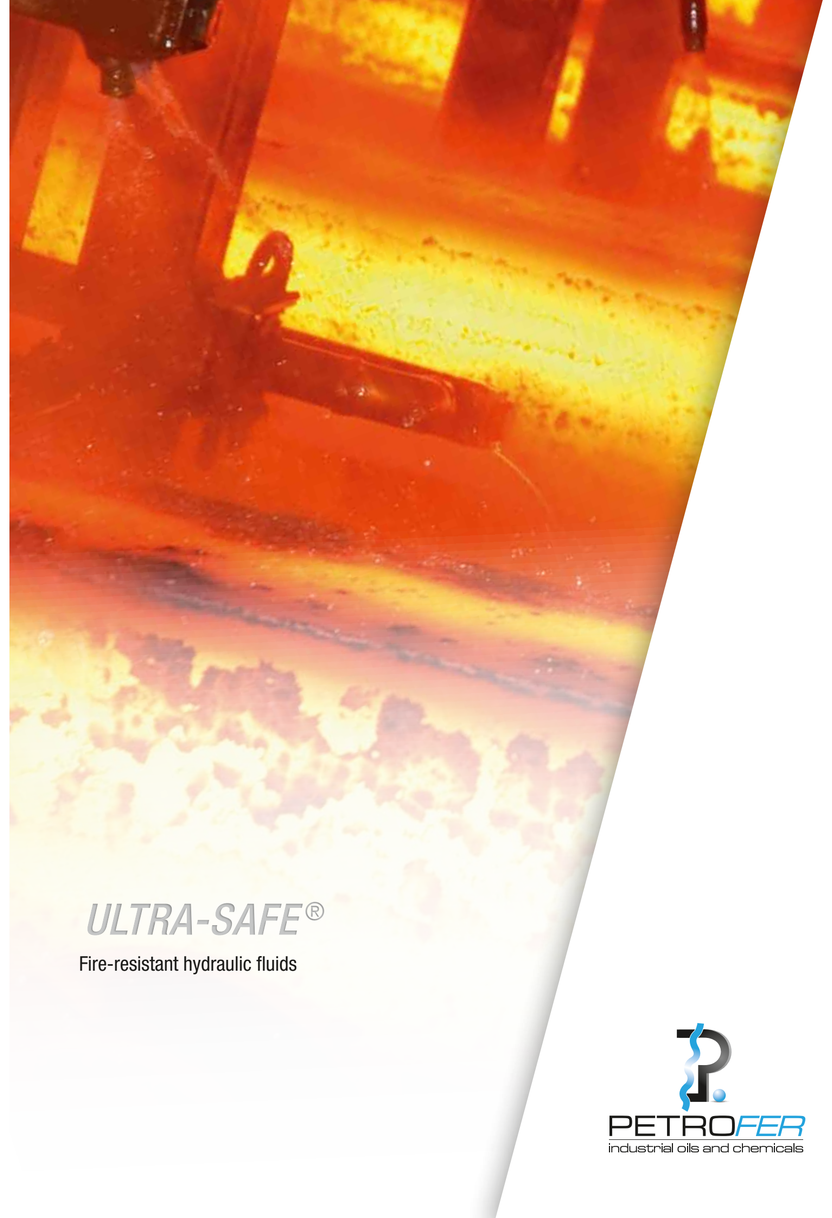
PetroFer Chemie

H. R. Fischer GmbH + Co. KG
P. O. Box 10 06 45
31106 Hildesheim
Germany
Telephone: +49 51 21 / 76 27- 0
Fax: +49 51 21 / 5 44 38
www.petrofer.com I info@petrofer.com

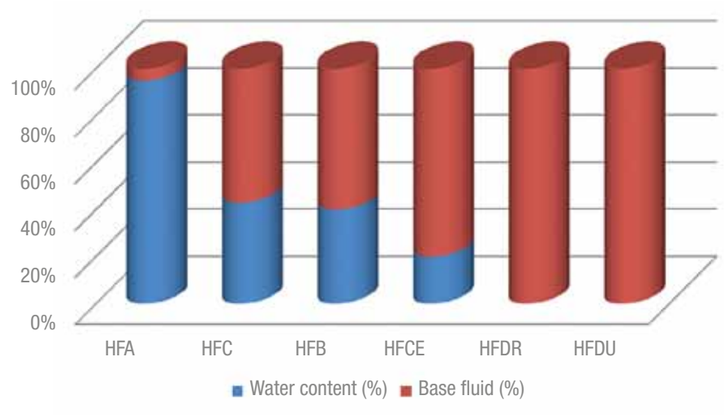


ULTRA-SAFE®

Fire-resistant hydraulic fluids

Product	Description	Typical applications
ULTRA-SAFE® 620	HFC aqueous polymer solution	Die-casting machines
ENVOLUBRIC HE 46	HFDU water-free fluid based on synthetic polyol ester fluids	Stage and theatre hydraulics
ENVOLUBRIC PE 46	HFDR water-free fluid based on phosphoric acid esters	Hydraulic steam-turbine control gear

Typical water content of fire-resistant hydraulic fluids



Performance requirements for fire-resistant hydraulic fluids

Many of Europe's coal-producing countries base their performance requirements for fire-resistant hydraulic fluids on the Luxembourg Report, published by the European Coal and Steel Community's High Authority. This report, which contains guidance on health and safety in the coal-mining industry, was originally prepared following a major accident and fire in a mine in Marcinelle, Belgium, in 1956. The most recent edition, the 7th Luxembourg Report issued in 1994, covers the following:

- Test procedures for rating fire-resistance
- Test procedures for assessing health risks
- Essential technological tests
- Recommended inspection procedures for assessing environmental compatibility
- Recommended technological inspection procedures

FM Certificate of Compliance:


FM APPROVED

Certificate of Compliance

This certificate is issued for the following:

PETROFER ENVOLUBRIC HE 46, HESAFE DU 46,
ENVOLUBRIC HE 68 and HESAFE DU 68
Hydraulic Fluids

Prepared for:

Petrofer Chemie HR Fischer GmbH + Co KG
Ramsering 12 - 16
PO Box 100645
Hildesheim, 31137
Germany

FM Approvals Class: 6930

Approval Identification: 3039972 Approval Granted: 4 March 2011

Said Approval is subject to satisfactory field performance, continuing follow-up Facilities and Procedures Audits, and strict conformity to the construction as shown in the Approval Guide, an online resource of FM Approvals.

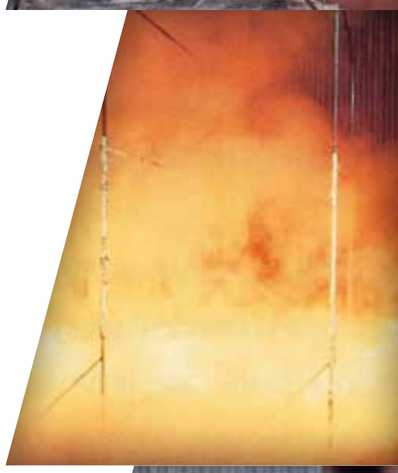
For more than 160 years FM Approvals has partnered with business and industry to reduce property losses

Richard Fortin
Group Manager - Materials -
FM Approvals
1151 Boston-Providence Turnpike
Norwood, MA 02062

FM Approvals

In addition to the Luxembourg Report's fire risk assessment and analysis methods widely recognised in European countries, other methods and certification programs for fire-resistant hydraulic fluids, developed by FM Approvals, have now become established. FM Approvals, part of the FM Global Group, a leading global insurance provider, offers international certification and testing services in the field of loss prevention for industrial and commercial products. Through globalisation, the organisation's approvals are now recognised worldwide and have become a de facto standard for assessing the quality and fire resistance of hydraulic fluids."

PETROFER



Choosing the right fire-resistant hydraulic fluid

In addition to the fire-resistance requirements, the design of a hydraulic system is the primary criterion when choosing which hydraulic fluid to use. The operating pressure and temperature ranges, material and component compatibility as well as wear and corrosion protection are all factors that determine the choice of pressure medium.

Under the DIN EN ISO 6743-4 standard, fire-resistant hydraulic fluids are labeled HF: the “H” stands for “hydraulic,”and the “F” for “fire-resistant.” The Luxembourg Report further subdivides these fluids into groups A, B, C and D.

Groups A, B and C – comprising HFA, HFB and HFC fluids – are water-based, whereas group D fluids are water-free. The HFD group is subdivided into additional categories, of which just two are still common today:

- R = phosphoric acid esters
- U = other substance combinations (polyol esters, carboxylic acid esters and polyglycols)

HFA hydraulic fluids

HFAs are highly aqueous hydraulic fluids intended for use at operating temperatures from +5° C to +50° C. Under the ISO 12922 standard, these fluids are divided into the groups HFAE and HFAS. HFAE fluids are oil and water emulsions with a water content of at least 95%, whereas HFAS solutions are chemical solutions in water, also with a water content of at least 95%. Not only do they offer exceptional fire resistance, but their concentrates are also readily biodegradable.

HFA fluids generally afford good to excellent corrosion protection but they can be frost-sensitive. Given their high water content, these fluids also have a limited ability to lubricate – something that needs to be taken into account, particularly when choosing hydraulic components and materials during system design and engineering. If contacted, manufacturers of hydraulic pumps and components can provide information on which parts and assemblies are suitable for use with HFA fluids.

With HFA fluids, it is important to ensure that they are used in their prescribed concentrations and to monitor carefully the quality of the water. If the proper checks are not carried out and the pressure medium and system are not maintained correctly, a bacterial or fungal infestation may be the result, leading to unpleasant odours, the accumulation of deposits, blocked filters as well as fouled valves and control elements. Problems like these can cause hydraulic systems to malfunction or even fail completely. HFA products are available for various water types (hardness grades, additives and other conditions).

HFAs are the fluids of choice for face-work equipment in underground mining, for overground pipe-laying and tunnel-boring equipment, as well as a pressurised water additive in tyre manufacture and in hydroforming systems.

HFA fluids offer:

- good resistance to microbial infestation
- excellent elastomer/material compatibility
- exceptional corrosion protection
- high emulsion stability (HFAE)
- outstanding solution durability (HFAS)
- good biodegradability

PETROFER

HFC hydraulic fluids

HFCs are aqueous polymer solutions that contain at least 35% water by volume. These hydraulic fluids have excellent viscosity / temperature properties and are capable of functioning reliably at temperatures from -20° C to +60° C. Like all pressure media that contain water, HFC fluids only offer limited protection against wear compared to HLP oils. The water content means that the viscosity increase under pressure – an important requirement for the proper lubrication of antifriction bearings – is less pronounced with HFCs than it is with mineral oils. In spite of this constraint, the exceptionally long operating lives seen in pumps and machinery have proven over a period of decades that HFC fluids like ULTRA-SAFE® 620 can protect hydraulic systems reliably against wear. Generally the use of HFC fluids is limited to a maximum operating pressure of 250 bar, but for some special applications high performance HFC fluids such as ULTRA-SAFE® 620 are approved for running / operating at higher pressure. HFCs generally offer good material compatibility, but they are incompatible with zinc and their compatibility with other non-ferrous metals needs to be verified. However, they are compatible with many seal materials that are suitable for mineral oils, including NBR, PTFE and SBR.

To maintain the requisite viscosity and fire-resistance, the water content should be monitored carefully and adjusted if necessary.

HFC hydraulic fluids are used in mining equipment such as hydraulic cylinders, winches, belt loaders and impact rippers. In industry, they are used widely in die-casting machines, furnace hydraulics and a variety of presses.

The advantages offered by HFC hydraulic fluids such as ULTRA-SAFE® 620 are:

- high pressure absorption capacity
- good wear protection
- high viscosity index
- low pour point
- optimised corrosion protection
- high heat conductivity
- high resistance to bacteria, fungi and yeasts
- good filterability
- high biodegradability

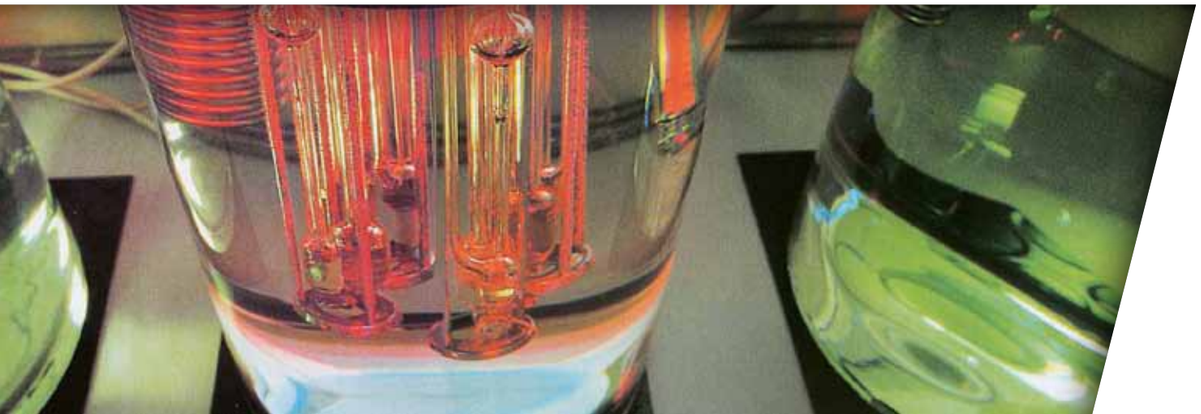


table 1	ULTRA-SAFE® 620	
Appearance	light-pale liqiud	
Density at 20 °C (68 °F)	1,05 - 1,08	DIN 51757
Kinematic viscosity at 20 °C at 40 °C at 60 °C	 77 mm²/s (cSt) 38 mm²/s (cSt) 21 mm²/s (cSt)	 DIN 51562 DIN 51562 DIN 51562
Kinematic viscosity at 70 °F at 100 °F at 150 °F	 343 SUS 194 SUS 91 SUS	
Viscosity Index	>> 150	
pH-value	9,2 - 9,4	
Pourpoint	- 50 °C (- 58 °F)	ISO 3016
Flashpoint	none	ISO 2592
Ash-content	0,05 %	DIN 51575
Coefficient of expansion $°C^{-1}$ (K^{-1}) $°F^{-1}$	 7.0×10^{-4} 3.9×10^{-4}	
Specific heat kJ/kg K	3,15	
Thermal conductivity W/m K	0,43	

PETROFER

HFDR hydraulic fluids

are water-free synthetic fluids based on phosphoric acid esters. Some are capable of being used at temperatures from over +100° C. HFDR fluids have limited hydrolytic stability, so they require careful monitoring and maintenance. Elastomers and coatings commonly used in mineral hydraulic systems are often incompatible with HFDR fluids, so before switching a system over to HFDR, it is important to check the materials used to verify that the fluid is suitable. With new plants and systems, suitable materials can be selected during the design and engineering phase. HFDR fluids are used primarily in fluid couplings and in steam and gas-turbine management and control systems.

HFDR hydraulic fluids offer:

- good fire-resistance
- high oxidation stability
- good air-release characteristics
- rapid foam dissipation
- good demulsification properties

table 2

	ULTRA-SAFE® 1120
Density at 20 °C (68 °F)	1,14 g/ml
Kinematic viscosity at 20 °C at 40 °C at 80 °C	mm ²/s 176 46 9
Neutralization number mg koH/g	< 0,2
Flashpoint	240 °C
Pourpoint	-20 °C
Evaporation loss % at 150 °C, 1h	< 0,1
Ash	< 0,3
Coefficient of expansion (K^{-1})	$7{,}0 \cdot 10^{-4}$

PETROFER

Fire-resistant hydraulic fluids

HFA
ULTRA-SAFE® 10 series

HFC
ULTRA-SAFE® 100 series

HFD
ENVOLUBRIC PE

HFDU
ENVOLUBRIC HE series

Fire-resistant hydraulic media

Hydraulic fluids are mainly formulated using combustible mineral oils. These have been an established and proven pressure-transmission medium in hydraulic systems for decades, primarily due to their lubrication and corrosion-inhibiting qualities. However, in certain areas of operation with an elevated risk of fire or explosion, mineral oils pose an unacceptable safety risk.

In a number of these areas, hydraulic systems can be replaced with electric drives. However, when there is a need for more power, or maximum possible performance, there is no practical alternative to hydraulics. This resulted in the development of the first fire-resistant pressure media over 50 years ago.

Typical areas of use for fire-resistant hydraulic fluids:

- Mining (underground coal mining)
- Aluminum, magnesium and zinc die-casting
- Tunnel construction
- Petrochemicals industry
- Iron and steel industry
- Power generation (turbine control gear, etc.)
- Stage and theatre hydraulics

Users today can choose from a range of hydraulic media, which fall into two main classes according to their composition: water-based and water-free hydraulic fluids.

HFDU hydraulic fluids

HFDU fluids are mostly manufactured from synthetic esters (polyol and carboxylic esters) or polyglycols. By and large, HFDUs based on esters tend to biodegrade very well but, in contrast to polyglycol-based HFDUs, they are more sensitive to hydrolysis.

HFDU fluids are water-free and share similar tribological properties with mineral oil-based pressure-transmission media (HM oils). This means that switching a system over from a mineral oil hydraulic fluid to an ester-based HFDU fluid can be carried out easily. HFDUs do generally differ, however, from mineral oils in terms of their material compatibility, and ester-based HFDUs differ from their polyglycol (PAG) counterparts. When switching to an HFDU fluid, it is therefore important to check which elastomers and coatings have been employed in the hydraulic system.

HFDU hydraulic fluids such as ENVOLUBRIC HE 46 and 68 offer:

- rapid biodegradability
- exceptional protection against wear
- very good ageing and oxidation stability
- outstanding viscosity/temperature performance
- good air-release characteristics
- low foaming tendency

table 3	ENVOLUBRIC HE 46	ENVOLUBRIC HE 68
Appearance	yellow-brownish	yellow-brownish
Density at at 20 °C at 40 °C at 80 °C	mm ²/s 117 49 33	mm ²/s 158 65 45
Viscosity index	185	185
Flashpoint	280 °C	290 °C
Firepoint	335 °C	375 °C
Auto-Ignition-Temperatur	430 °C	490 °C
Pourpoint	- 25 °C	- 32 °C

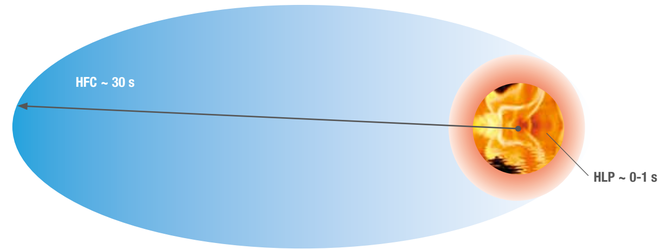
PETROFER

Can fire-resistant pressure media be used in any hydraulic system?

New systems designed from the outset for fire-resistant hydraulic fluids can operate problem-free using fire-resistant fluids that contain water. Barring a small number of exceptions, existing systems can also be switched over to water-based hydraulic fluids like HFCs. However, these fluids may impose certain constraints that need to be addressed, such as lower maximum operating pressures and temperatures. To use HFAs, systems need to be designed from the outset for this specific fluid type because of its high water content. HFA fluids cannot be generally used in existing systems, at least not without costly, large-scale modifications. Of the HFD fluids, HFDUs based on synthetic esters have proven to be relatively unproblematic. When using polyglycols, the seal materials and component coatings need to be checked for compatibility. For reasons of safety, and wherever technically and economically viable, we generally recommend HFA and HFC fluids rather than water-free HFDR and HFDU fluids. The following example helps to illustrate the advantage of water-based fire-resistant pressure media such as HFCs compared to mineral hydraulic fluids:

This show, in theory, how much time there is in the event of a fire to get people to safety, trigger a fire alarm and begin firefighting operations. The times indicated are based on studies into how hydraulic fluid behaves in fires when it comes into contact with molten aluminum.

TIME TO ESCAPE IN SECONDS (s):



If you are planning to convert a hydraulic system over to a fire-resistant fluid, please contact us. Our technical service team can offer more extensive guidance as well as recommendations on which materials to choose.

PETROFER