

Ecosafe Plus: innovation and sustainability in hydraulic fluids

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Abstract: Foundry Alfe CHEM has developed and tested a new product which represents a breakthrough in the class of non-flammable hydraulic fluids. Ecosafe Plus is a biodegradable hydraulic fluid particularly suitable to be used in hydraulic circuits located near sources of heat, due to its complete non-flammability. Ecosafe Plus formulation is glycol-free and, compared to traditional water/glycol based hydraulic fluids, it allows for easy disposal of the exhausted fluid and environmental safety. For what concern the technological properties, Ecosafe Plus has a greater compatibility with most of the seals and the elastomers normally used in hydraulic plants. Ecosafe Plus has also been credited, according to OECD 310 F, as biodegradable. In addition, Ecosafe Plus has been tested by accredited laboratories with tribological trials (4 Ball wear test ASTM D 4172, Ball on disc test ASTM D 6425, Brugger test DIN 51347, Vickers test ASTM D 2882). In particular, the Vickers test has shown a value of wear of the vanes, of the stator and of the rotor equal to 25% than the one measured after the same period with the competing product; this means that Ecosafe Plus has anti-wear performances and active lubrication four times higher than the traditional products.

Keywords: “Hydraulic fluids”; “HFC”; “Biodegradability”; “Lubrication”

Introduction

Hydraulic fluids are the medium by which power is transferred in hydraulic machinery. The products based on oil and mineral oil form the most common class of hydraulic fluids. The main advantages of this class are the low cost and the wide variety of viscosity grades available. On the other hand, they may constitute a hazard because of their flammability and of their negative environmental impact; moreover, also their non completely defined chemical composition may represent a disadvantage. Their performance can be improved by the addition of additives to ensure lubrication, oxidation stability, corrosion protection and a long life time for both the fluid and the system components.

The synthetic hydraulic fluids are viable alternatives to mineral oil, especially for particular applications, such as those that require a higher operating temperature.

Synthetic fluids may be used in specific technical applications; in fact, they offer a greater range of operating temperature, as well as improved stability and environmental sustainability. Because of their more advanced technology, synthetic fluids present higher cost. They may also show incompatibility with the materials present in hydraulic systems (gaskets, o-rings ..).

Another particular class of hydraulic fluids is represented by non-flammable fluids. A danger exists whenever a hydraulic system is located near a heat source, such as hot surfaces, molten metal and open flames. Because of vibration, pressure, and temperature variations of the surrounding environment, a breakage may occur, resulting in contact of the hydraulic fluid with such sources of ignition. The non-flammable fluids are used in applications where exist the risks listed above. Their properties of non-flammability are given by the chemical nature of the base and by the water content. Maximum

protection is achieved thanks to the water-based products, adequately additivated to improve lubrication, anti-corrosion and anti-microbial properties. A wide selection of hydraulic fluids with varying degrees of resistance to fire and heat is available; the hydraulic fluids are classified according to ISO 6743 as: HFA, HFB, HFC and HFD. The HFC class fluids contain approximately 35-45% water, in which are dissolved: glycol as antifreeze, thickeners to provide viscosity, anti-wear and anti-corrosion additives packages. They show excellent fire resistance, minimum change in viscosity with temperature, high stability over the time, and outstanding performance even at low temperatures. The performance can be modulated with the choice of appropriated additives. It is very important to control the evaporation rate for temperatures above 60°C, in order to avoid an excessive loss of water and cavitation phenomena.

In this work, Foundry Alfe CHEM has developed and tested a new product which represents a breakthrough in the class of non-flammable hydraulic fluids, Ecosafe Plus. Ecosafe Plus is a fire-resistant biodegradable hydraulic fluid (Type HFC and Viscosity Class ISO 46).

Ecosafe Plus is particularly suitable to be used in hydraulic circuits located near sources of heat, due to its complete non-flammability and guarantee of safety in case of fire. Ecosafe Plus formulation is based on a mixture of polymers and biopolymers, and it is glycol-free (monoethylenic, diethylenic and others). Compared to traditional water/glycol based HFC hydraulic fluid, Ecosafe Plus allows for easy disposal of the exhausted fluid and environmental safety. In addition, Ecosafe Plus has a greater compatibility with most of the seals and the elastomers normally used in hydraulic plants compared to traditional water/glycol fluids thanks to its glycols-free formulation. It introduces a technological innovation due

to its excellent performances combined with high environmental sustainability: non flammability, excellent performances during laboratory tests and during operation, high lubrication and resistance, high biodegradability, raw materials from renewable sources, auto-sustainability. The product has been subjected to various tests, carried out by accredited laboratories, in order to evaluate and confirm the excellent properties, i.e.: non-flammability, biodegradability, environmentally sustainable disposal, compatibility with elastomers, lubrication.

Experimental Procedure

To test the non-flammability properties, Ecosafe Plus has been heated to over 100°C and atomized at a pressure of 70 kg/cm². It is then sprayed on the flame of an oxyacetylene torch or on a steel plate heated to 650°C, verifying the absence of flame.

Ecosafe Plus compatibility with elastomers commonly used in "O rings" has been tested following the standard ASTM D 471 (immersion in the fluid for 166 h at 80°C) [1]. The product then has undergone rigorous testing to assess its biodegradability, according to OECD 310 F (biodegradability > 60% after 28 days) [2]; the Chemical Oxygen Demand (COD) measurement completes the evaluation on environmental sustainability and on disposal. Tribological properties have been valued according the following ASTM and DIN tests: 4 Ball wear test (ASTM D 4172) [3], Ball on disc test (ASTM 6425) [4], Brugger test (DIN 51347) [5], Vickers test (derived from ASTM D 2882) [6].

Results and Discussions

The results of non-flammability shows that any contact of Ecosafe Plus with heat sources, due to accidental losses, does not cause risk situations because the product is not flammable. This is the confirmation that Ecosafe Plus can be used as HFC type safety fluid in critical conditions.

Ecosafe Plus has passed the rigorous tests and has been credited, according to OECD 310 F [2], as biodegradable (biodegradability > 60% after 28 days, Fig.1), in contrast to water/glycol based hydraulic fluids of normal use (biodegradability < 40% after 28 days). The biodegradability is an important advantage of this new glycol-free technology, as it combines high working and environmental safety to technological compatibility with fluids normally used in the industrial process. The biodegradability does not affect the technical properties of Ecosafe Plus, which remains stable during operation, with no modification of the chemical-physical characteristics and no alteration of biological nature. Besides, the disposal of exhausted product is facilitated; the disposal of the exhausted product at its end life will prove to be easier and cheaper than the traditional hydraulic fluids, being possible to lean to a plant for the biological treatment of waste water or similar disposal systems. Ecosafe Plus is not classified as dangerous and

eliminates the costs and the disposal procedures as special waste. Moreover, Ecosafe Plus has a value of COD (Chemical Oxygen Demand) lower compared to a water/glycol hydraulic fluid of reference; the product Ecosafe Plus thus results to be a more easily manageable as regards the disposal. The leakage or spillage of this product in environmentally sensitive areas implies a greater ease of clean-up and minor restoration costs.

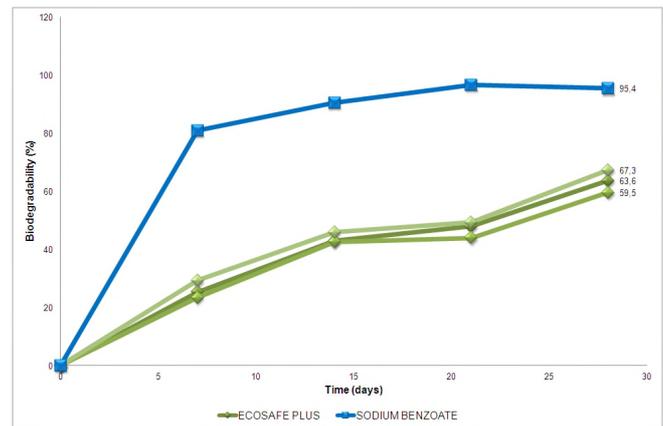


Figure 1

Fig. 1: The graph shows the results of the biodegradation test on Ecosafe plus compared to a reference substance (sodium benzoate) with high biodegradability.

Ecosafe Plus compatibility with elastomers commonly used in "O rings" has been tested following the standard ASTM D 471 [1] with positive results: in particular, it is compatible with Red and White Silicone, Viton, Teflon, EPDM, NBR and Polyurethane. These high performances are reachable thanks to the absence of glycols in the formulation.

Ecosafe Plus has also been tested by accredited laboratories with tribological trials, carried out by comparison with a market leader water/glycol based hydraulic fluid, in order to evaluate the lubricant characteristics. The results of the performed test are the following:

- 4 Ball wear test (ASTM D 4172) [3]: results comparable to the products in use.
- Ball on disc test (ASTM D 6425) [4]: results comparable to the products in use.
- Brugger test (DIN 51347) [5]: performance far superior to the traditional product (Fig. 2).

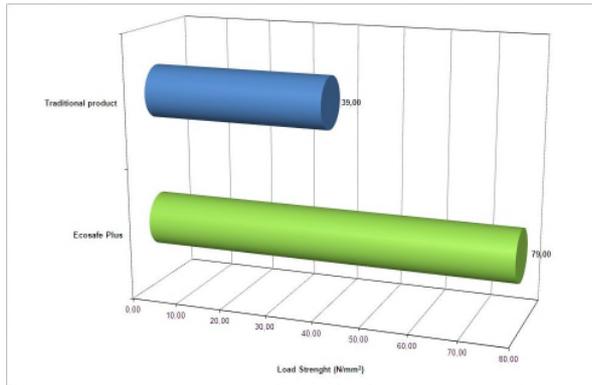


Figure 2

Fig. 2: In the picture are shown the results of Brugger test for the traditional water glycol fluid of reference (in blue) and for Ecosafe Plus (in green), which presents far superior anti-wear properties.

- Vickers test (test derived from ASTM D 2882) [6]: after 600 hours of operation, it has shown a value of wear of the vanes, of the stator and of the rotor equal to 25% than the one measured after the same period of operation with the competing product, so Ecosafe Plus has antiwear performances and active lubrication four times higher than the products in use.

Conclusion

The selected raw materials, the high biodegradability and the non-toxic nature of Ecosafe Plus make this product an excellent choice to combine the best technical performance with a sustainable vision for the environment. In particular, its excellent results in tribological tests and its compatibility with the most commonly used elastomers, combined with its biodegradability, make this product a true technological innovation in the field of hydraulic fluids.

References

- [1] ASTM Standard D471, 2012a, " Standard Test Method for Rubber Property—Effect of Liquids", ASTM International, West Conshohocken, PA, 2012, DOI: 10.1520/D0471-12A, www.astm.org.
- [2] OECD 301 F, 1992, "OECD Guidelines for the Testing of Chemicals, Section 3 Degradation and Accumulation", OECD, 1992, DOI: 10.1787/9789264070349-en, www.astm.org.
- [3] ASTM D4172, 1994(2010), "Standard Test Method for Wear Preventive Characteristics of Lubricating Fluid (Four-Ball Method)", ASTM International, West Conshohocken, PA, 2010, DOI: 10.1520/D4172-94R10, www.astm.org.
- [4] ASTM D6425, 2011, "Standard Test Method for Measuring Friction and Wear Properties of Extreme

Pressure (EP) Lubricating Oils Using SRV Test Machine", ASTM International, West Conshohocken, PA, 2011, DOI: 10.1520/D6425-11, www.astm.org.

[5] DIN 51347, 2000, "Testing of lubricants - Testing under boundary lubricating conditions with the Brugger lubricant tester", Deutsches Institut Fur Normung E.V. (German National Standard), 2000.

[6] ASTM D2882, 2000, "Standard Test Method for Indicating the Wear Characteristics of Petroleum and Non-Petroleum Hydraulic Fluids in Constant Volume Vane Pump (Withdrawn 2003)", ASTM International, West Conshohocken, PA, 2000, DOI: 10.1520/D2882-00, www.astm.org.

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