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ECOSAFE PLUS: the first glycol-free environmental friendly HFC hydraulic fluid

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Project objective

To develop a glycol-free fire-resistant HFC hydraulic fluid with equivalent or superior functional performance compared to traditional water-glycol based formulations, and improving disposal of the exhausted fluid and environmental safety.

Background

The use non flammable hydraulic fluids avoids the potential risk to fire hazard and explosions in areas where fire sources are present. Aluminium manufacturing is very sensitive to this issue because of the flammability nature of molten Aluminum.

Among the different types of hydraulic fire-resistant fluids, HFCs are the most widely used because of their price-quality balance and their combination of fire resistant properties with reasonable lubrication performance. They are normally formulated with a mixture of water and glycol.

However, in eventual HFC fluid escapes in a plant, the lubricant is conducted to the sewage treatment area, and glycol contamination oblige to perform both physico-chemical and biological depuration because of the high levels of COD (Chemical Oxygen Demand). Using a glycol-free biodegradable HFC fluid becomes a key strategy to minimize environment impact and operate under proper conditions.

Prototype formulations

Five different prototypes of HFC formulations (Sample 1 to 5) were developed, all of them glycol-free. Formulation were based on a mixture of polymers, biopolymers and water (35% approx.). Different additives packages (wear and corrosion protection) and stabilizators were used in each sample. As external reference sample a commercial water-glycol HFC fluid from a direct Industrial Competitor was also tested.

Experimental verification

PHYSICO-CHEMICAL PROPERTIES

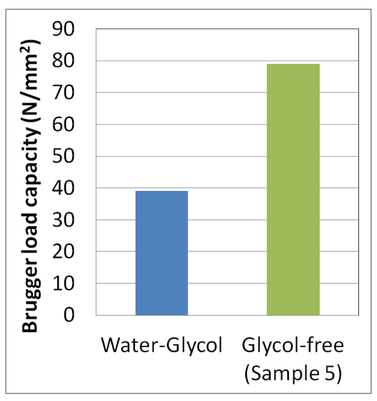
Some basic properties were studied in the five prototype samples. All the glycol-free samples accomplished the following results:

- Fire-Resistance (Test of spray ignition–Luxemburg 6th Report): samples heated to >100 C and atomized at a pressure of 70kg/cm^2. Then sprayed on a flame of an oxyacetylene torch or on a steel plate heated to 650 C, verifying the absence of flame.
- Anticorrosion properties: Samples passed IP 135 corrosion test.
- Antifoam properties (ASTM D 892-13): samples passed 1st step of test run at 24 C; results 100/0 ml.
- Viscosity (ASTM D 445 -65): 41,0-50,6 cSt at 40 C (ISO 46).
- pH: 8,5-9.
- Stability (internal method, summer and winter simulation): Samples were stored immerging a test tube in a bath at 40 C and also at 0 C for 24 h, respectivelly. Samples were stable in both situations.

LUBRICITY AND ANTI-WEAR PROPERTIES

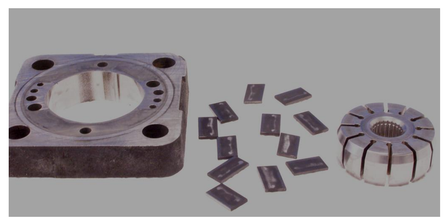
Once ensured some basic physico-chemical properties, a detailed study was focused on the lubricity and wear behavior of the six HFC fluids to identify the one offering the best performance.

A first selection was carried out based on ASTM D 4172 (anti-wear four ball test) where the diameter of the ball wear scar is reported. Results determined that Sample 5 offered the best wear protection (ball scar 868 μm).



Sample 5 was then analyzed more in detail in comparison the water-glycol fluid. Complementary test to analyze anti-wear properties was also performed (Brugger-type test) based on DIN 51347 where the load carrying capacity of the oil according to Brugger is calculated. Results showed an excellent load carrying capacity, doubling load capacity of traditional water-glycol product.

SRV test (ASTM 6425) was used to quantify friction generation with the fluids. With both fluids friction was very stable and constant during all the test. Mean coefficient of friction of water-glycol sample and Sample 5 was 0.14 and 0.11, respectivelly, showing a very similar lubricity performance.



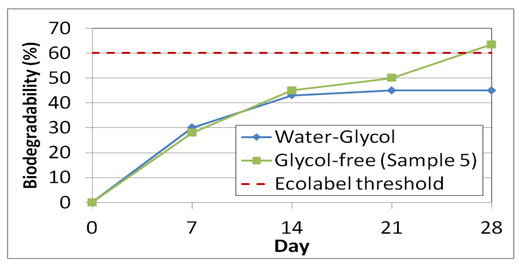
A final validation of wear protection of Sample 5 was performed by a vane pump test (V10/01D1A02 equiv. Vickers V10/1P1P; 138 bar; 3 l/min, 38-42 ºC; 600 h). Vane, rotor and stator weigth loss was measured. Very good results were obtained since total mass loss with water-glycol fluid was almost twice total mass loss with developed glycol-free fluid (7.15 g vs 3.81 g).

ELASTOMERS COMPATIBILITY

Elastomer compatibility was tested following ASTM D-471 (immersion in the fluid for 166 h at 80 C). Materials tested were Red and White Silicone, Viton, Teflon, EPDM, NBR and Polyurethane. Variations of mass, volume and hardness were in all the cases <5%, so very good compatibility of the glycol-free (Sample 5) with those elastomers is expected.

BIODEGRADABILITY

Results (OECD 301F) showed a biodegradability of 63% in the glycol-free sample while water-glycol product had a biodebradability of 45 %, below the Ecolabel threshold (60%).



ENVIRONMENTAL SUSTAINABLE DISPOSAL AND COD

Glycol-free sample showed 18% less COD compared to the water-glycol fluid of reference (1055750 mgO_2/l vs 1291250 mgO_2/l) thus the glycol-free sample results to be a more easily manageable and economic as regards the disposal in case of spillage.

Final Result: ECOSAFE PLUS

A new **glycol-free fire-resistant biodegradable hydraulic fluid** (ISO 46) has been developed. It offers a functional performance comparable or better than traditional water-glycol HFC hydraulic fluids and allows for **easy disposal** and **environmental safety.**