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BIO-HY-GARD II

The New Generation of an Environmentally-friendly Universal Tractor Transmission Oil with a Rapeseed Oil Base

In a research project supported by the German government, the second generation of an environmentally-friendly lubricant for vehicles, consisting of approx. 75 % native rapeseed oil, with a common oil reservoir for transmission and hydraulics was developed. The project's general framework and the objectives of this new development are presented, as well as the reasons leading to this unique lubricant concept. Based on experiments carried out, properties of this new fluid are described. Comparing BIO-HY-GARD with other reference fluids tested facilitates an evaluation of the performance of different lubricant technologies and the progress achieved with this new development.

In 1993 John Deere approved a rapeseed oil based UTTO (Universal tractor transmission oil). The joint development of an agricultural full liner together with a leading additive supplier was driven by the intention to provide an industrial product that helps to improve the market situation for the required raw products of agricultural customers. This strategy led directly to the conception of the fluid. The major part of this environmentally friendly oil must come from renewable sources to achieve a sales effect for non-food products of our customers. For the second generation of BIO-HY-GARD - whose development is this paper's topic - this strategy has to be carried over due to the unchanged situation of interests. Therefore the project was supported by the German Agricultural Ministry through its agency for renewable raw materials (Fachagentur für nachwachsende Rohstoffe (FNR)). The motivation for developing a new formulation can be derived from the original development goals (*Fig. 1*).

Based on the experience achieved with the current fluid, the improvements in additive technology since 1993, the requirements of new developed machinery and the necessity of a competitive price to mineral oil based alternatives; the conception of the new fluid was easy to define. Similar to the current formulation [2], BIO-HY-GARD II is a joint development of John Deere and the additive supplier. The new formulation consists of native rapeseed oil plus an appropriate additive package. Thus the required fluid properties, prescribed in the John Deere standard JDM J20C [1] could be achieved,

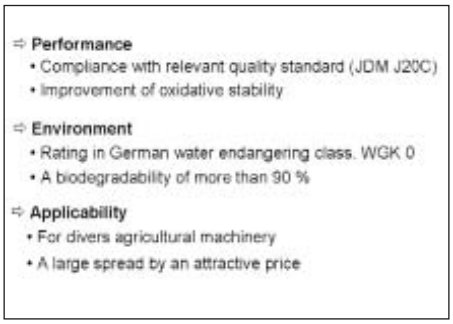

Fig. 1: Original development goals for BIO-HY-GARD II

which does not discriminate between different base oils.

Experimental Investigations

Figure 2 shows the major steps of the fluid development. Most steps are representing a large variety of single tests, which needed to be passed. The top of the pyramid represents the final approval tests.

The eco-toxic and biodegradability properties have been screened at some base formulations. The candidates with best potential for environmental friendliness have been chosen for further work. The focus of investigation was put on technological performance, which can be experienced every day by the customer. A high amount of these tests

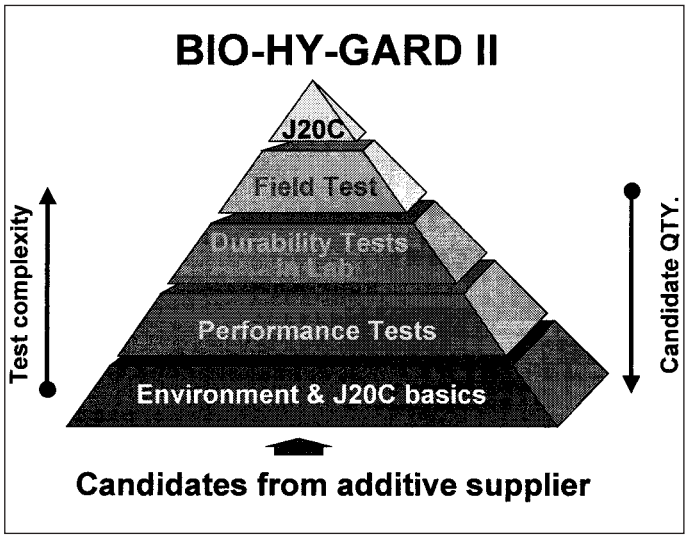

Fig. 2: Major steps of fluid development

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Keywords
Bio oil, additives, characteristics

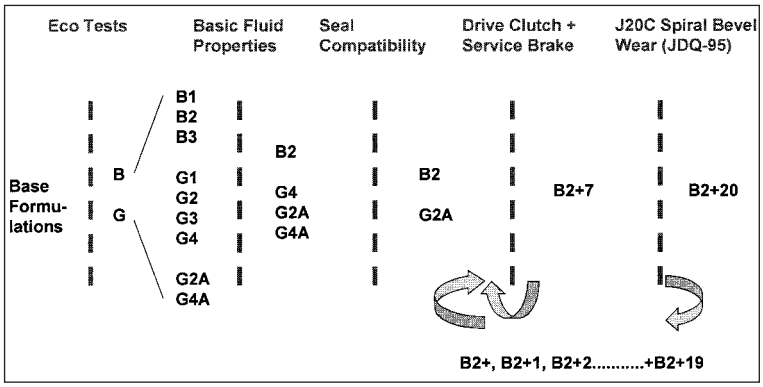

Fig. 3: Selection of candidates

have been performed with tractor components or complete machines.

Results

In practice the test sequence varied a little from the scheme given in *Figure 2* due to the necessity to repeat tests with further modified fluids [3]. It has been a real challenge to combine satisfying performance in wet brakes (noise), together with sufficient anti wear properties in EP contacts. Some loops with continuously improved candidates were necessary to get passes in both tests. For verification of new candidate's properties, a performance test to detect brake chatter and an approval test checking the EP performance have been chosen. *Figure 3* shows this connection together with earlier hurdles, which had to be passed as well.

After a candidate was found with sufficient anti chatter and anti wear properties, the remaining test program was passed with this candidate and two reference fluids. In general, this candidate showed equivalent or even superior performance in application tests as for instance with different clutches or synchronizers and even in the JDM J20C approval tests. Further important results are no complications in field tests, approximation to mineral based reference oil in DKA oxidation test and improved cold temperature performance in comparison to current BIO-HY-GARD and a pass for FZG load stage 10. The environmental friendliness has significantly improved to a biodegradability of 75 % according to OECD resp., of 92 % according to CEC. Due to a revision of German WGK regulations during the project a WGK 1 could be achieved.

Discussion

Based on the results achieved a validation of output can be tried by a comparison with the development goals (Fig. 1). With the new formulation, the technological requirements are accomplished. In *Figure 4* end of test viscosities (DKA oxidation test) of the reference fluids are correlated with the acceptable permanent sump temperature known by experience in our machinery. If these two points are worse case connected and the equivalent viscosity data of BIO-HY-GARD II is added on this line, the acceptable permanent sump temperature of the new formulation can be estimated. The oxidative stability has been improved significantly. With appropriate tests this estimation was confirmed.

With regard to the environment the goals have been achieved as well. Following the revision of German WGK regulation [4], fluids like BIO-HY-GARD II are considered as mixtures, which cannot get a better WGK rating as WGK 1 [5]. The biodegradability goal with a measured CEC value of 92 % has even been surpassed.

The applicability goals have also been achieved. The reason is the fluid conception with its abandonment of any synthetic ester. Therefore the compatibility to divers seal materials is given, which is the main assumption for an application in any machine. In addition, the native ester in comparison to all kinds of synthetic esters has the best price ratio to mineral base oil.

Conclusion

The development of an environmentally friendly fluid for transmissions and hydraulics based on native rapeseed oil plus an additive package tailored to the base oil circumstances has proven the high potential of this conception for a further step forward in technological and environmental related fluid properties. In comparison to the similarly designed predecessor fluid, significant improvements with regard to upper and lower operating temperature limits in combination with equal other application properties could be achieved. Simultaneously the fluid's environmental aspects - especially in terms of biodegradability - could be improved. Due to identical base oil with its predecessor fluid, this significantly extended environmental friendliness underlines the meaning of improvements made on the real technology carrier, the additive package. In addition to that, the fluid will find a broad application not only as consequence of its fulfilment of John Deere and other technical specifications. The fluid conception makes specific seal materials obsolete and saves costs due to the neglected usage of expensive base oils.

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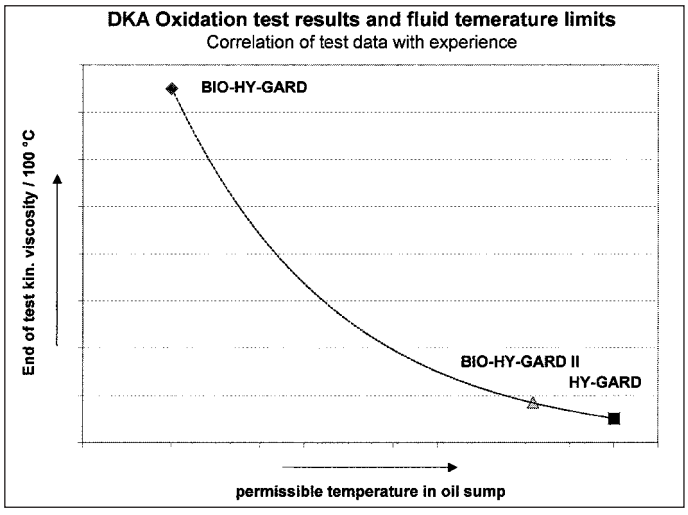

Fig. 4: Impact of improved oxidative stability on temperature limits