Sustainable, Safe, Efficient and Modern Food Grade Lubricants (NSF-H1 Lubricants) Minimise Risk of Food Contamination

Joanne Soh* and Chan Loong Chow*
*Klüber Lubrication (Malaysia) Sdn. Bhd.,
Unit 3-5, Level 3, Tower 9, UOA Business Park, No.1, Jalan Pengaturcara U1/51A,
40150 Shah Alam, Selangor, Malaysia.
E-mail: joanne.soh@my.klueber.com

INTRODUCTION

Palm oil is a vegetable oil with the highest production rate in the world. It is omnipresent in our everyday lives, from bread spreads in the morning to baby food or face cream in the evening. One aspect, which is increasingly gaining the attention of operators and end users is the potential contamination of palm oil during its extraction and manufacture.

One of the many potential source of contaminations is the lubricants used in lubricating machines during extraction and processing of palm oil. This is particularly problematic in applications where contact with the product cannot be ruled out. Even small traces of mineral oil hydrocarbons (MOH) in food, so-called Mineral Oil Saturated Hydrocarbons (MOSH)/ Mineral Oil Aromatic Hydrocarbons (MOAH) contamination, can potentially cause an adverse effect on human health. MOSH and MOAH not only accumulate in human tissues, they may also cause adverse effect in the liver. Moreover, their carcinogenic effect cannot be ruled out. The European Union (EU) therefore called for stronger control on the monitoring of mineral oil hydrocarbons in food, and in materials or articles intended to come into contact with food.

Such demand caused a considerable amount of uncertainty among food manufacturers, as reports about MOSH/ MOAH findings can have negative effect, such as expensive call-backs, as well as damage to the company's reputation. Leading food manufacturers are thus increasingly pushing for the replacement of mineral oil-based products with synthetic H1 lubricants in the machines and plants in all production steps involved in palm oil processing.

HIGH-PERFORMANCE LUBRICANTS FOR HIGHEST HYGIENIC REQUIREMENTS

One way in which traces of mineral oils such as the chemical compounds MOSH and MOAH can enter the food chain is the production process and the process aids used, including lubricants selected for the production of food and food packaging*.

Lubricants for incidental food contact can be based on non-alkane oils, such as silicone oil or perfluoropolyether (PFPE), or synthetic or non-synthetic hydrocarbons. Non-synthetic white oils used for NSF-H1 products should be highly purified and thus, virtually free of aromatic compounds.

*Note: For an overview, please see: 'Scientific opinion on mineral oil hydrocarbons in food EFSA panel on Contaminants in the Food Chain (CONTAM)'. Retrieved from: https://efsa.onlinelibrary.wiley.com/doi/epdf/10.2903/j.efsa.2012.2704.

REGULATIONS AND LIMIT VALUES

Complied with 21 CFR 178.3570 issued by the United States Food and Drug Administration (FDA), H1 lubricants are designed for incidental, unintentional food contact. The amount used must be the minimum required to accomplish the desired technical effect and no non-H1 product should be used in and around the food-processing area. Correct use of H1 lubricants normally means that there is no contact with food at all. In case of unavoidable food contact, the amount of lubricant in food must not exceed 1 ppm for silicone oils and 10 ppm for all other base oils. Due to the complexity of MOH determination in food, there is currently no standardised analytics and no legal limits for MOH in food in Europe. The German Bundesministerium für Ern

ührung und Landwirtschaft (BMEL) has been working on statutory limits for migration through packaging in which maximum 2 mg MOSH kg^{-1} food and 0.5 mg MOAH kg^{-1} food are being discussed.

Very small quantities of modern, innovative high-performance lubricants are sufficient to achieve the desired lubricating effect thus reduces the risk of contamination. Even with the highest hygienic standards, a contamination or cross-contamination with these substances during production, transport and stock, due to leakages, vapours, evaporation loss or ventilation, cannot be ruled out.

USING SYNTHETIC BASED FOOD GRADE H1 LUBRICANTS PAYS OFF

There is a persistent prejudice that food grade lubricants are expensive and lagged behind mineral oil-based products in terms of performance. However, using them could pay off in many ways: Today's modern specialty lubricants are developed for specific applications and are therefore characterised by their enormous efficiency. With these specialty products, energy efficiency can be significantly increased, while maintenance and relubrication frequency, as well as downtimes of the machines are reduced.

ACHIEVING HIGHEST PERFORMANCE WITH SYNTHETIC GEAR OILS

In addition to wide service temperature range, synthetic gear oils offer many advantages. Among the most important benefits are their oil change intervals, which are three to five times longer compared to mineral oils. *Figure 1* shows the service life of gear oils with different types of base oils according to the oil sump temperature. Synthetic gear oils also offer higher wear protection and better cold start with the same nominal viscosity (ISO VG).

In addition, they may not require oil coolers due to reduced temperatures. The prolonged service life of synthetic lubricants and the consequent longer oil change intervals can reduce equipment downtime and save resources.

SUPERIOR TEMPERATURE PERFORMANCE, IMPROVED EFFICIENCY IN GEARBOXES

In the worm gear test rig, different base oils were tested at 350 min^{-1} input speed and 300 Nm output torque for 300 hr. The results confirmed a significant improvement in efficiency and reduction of wear when food grade synthetic oils of high quality were used (*Figure 2*).

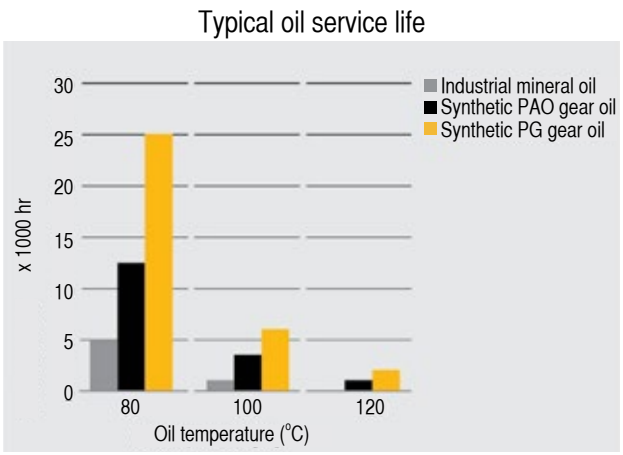


Figure 1. Typical oil service life.

Changing over from mineral to synthetic based gear oils in worm gears also offered very good potential for temperature reduction in the gearboxes. The same is true for spur gears, the most-used type of gearbox in the food industry. Thermal pictures showed considerable lower oil temperatures in this kind of gearbox when specialty synthetic gear oils were used indicated a significantly higher efficiency than standard gear oil.

Synthetic polyalphaolefin, ester or polyglycol based gear oils showed considerably lower gear friction coefficient than mineral oils due to their particular molecular structures. The frictions generated in gears with synthetic oils can be 30% lower or more, than with industrial EP mineral gear

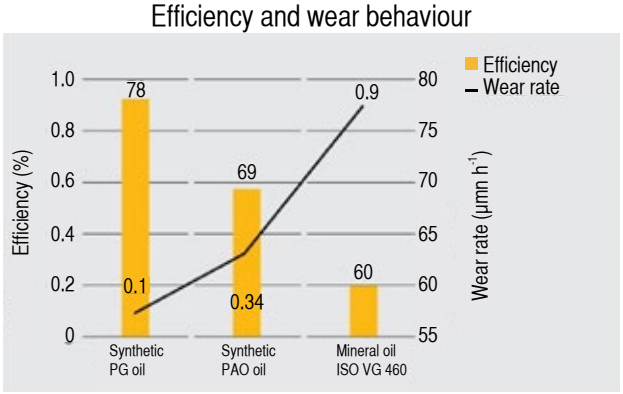
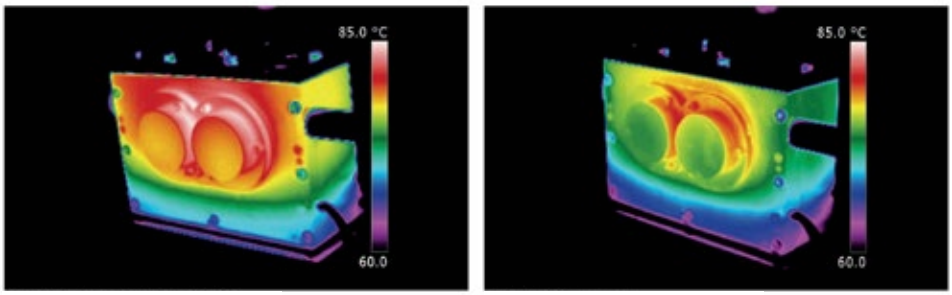


Figure 2. Efficiency and wear behaviour.

oil. Even in spur gears, an oil temperature reduction from 85°C (with mineral oil) to 80°C (with high quality synthetic gear oils based on PAO) can be achieved. This resulted in reduction of energy consumption, longer lifetime of the gearbox and less maintenance (*Figure 3*).

The synthetic gear oils offer significantly higher efficiency than a standard gear oil based on mineral oil, resulting in a lower oil temperature even in spur gears, as shown in the thermal pictures.



Standard gear oil: mineral oil, ISO VG 220 | Synthetic PAO H1 gear oil

Figure 3. Synthetic gear oils offers higher efficiency than a standard gear oil.

Due to the lower friction coefficients of synthetic gear oils, gearing losses were considerably reduced, hence gear efficiency is increased. Particularly in gearboxes with high proportion of sliding friction, *e.g.* worm or hypoid gears, a changeover from mineral to synthetic gear oils can lead to more than 20% increases in efficiency. Reduced friction, of course, also led to lower energy cost.

REDUCTION IN OIL CONSUMPTION DUE TO LOW OIL CONTENT IN COMPRESSED AIR

Figure 4 shows the oil content (measured in mg m^{-3}) in the compressed air when different types of oils were used in a system operated at 100°C. In general, compressor oils with higher base oil viscosity will offer better stability against evaporation. Food grade synthetic compressor oils led to lower oil vapour content in the compressed air when compared to mineral based products. This positive impact contributed to less oil consumption, better efficiency and longer lifetime. As a result, compressors operating with synthetic oil required less maintenance due to reduced residual oil content in the compressed air, thus increases filter lifetime. This enabled savings in terms of maintenance costs.

A RELIABLE, COMPETENT PARTNER IS KEY

Today, there are quite a number of lubricant manufacturers who have high-quality food grade lubricants in their portfolios. However, it is not enough to simply select a suitable lubricant from a brochure for these complex applications. Only with competent advice a lubricant concept that takes all the food safety and hygiene aspects into account and helps companies achieve their sustainability goals can be developed.

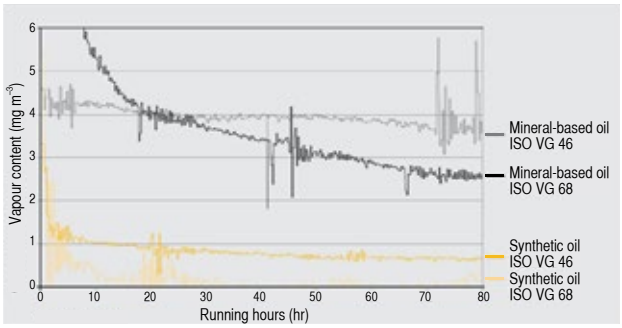


Figure 4. Oil content in the compressed air at 100°C.

Last but not least, on top of reducing the risk of mineral oil contamination at production area, a tribology expert can also help identify points in production with is potential for energy efficiency increases and improving production efficiency as value added services.

With this in mind, Klüber Lubrication has developed a comprehensive range of services (*Figure 5*) that enabled existing optimisation potentials to be identified and systematically implemented. In close cooperation with the operator, tribology experts at Klüber Lubrication work on systematic optimisation of lubrication processes of machinery and equipment. All services and expert consultations are precisely tailored to the requirements and tasks of the respective customer and go well beyond the selection of lubricants. The aim of all measures is optimised use of the machinery. Special energy saving programs helped to systematically identify existing

potential in increasing company's energy efficiency and to implement all modifications necessary to reach this goal. This way, we can save energy cost, with relatively little effort when the right type of lubricant is used.

Klüber Lubrication's services help to optimise maintenance in a plant and ensure that the machines run efficiently and reliably, for a long time. This includes complete preparation of a professional operational lubrication plan for all lubrication points in the plant with the aim of optimising the lubrication processes and reducing the risk of contamination.

This also includes the prevention of over- or under-lubrication through correctly dosed lubricant, determining precise re-lubrication interval and quantity needed, as well as lubricant and component analysis services. The consultation is preceded by a comprehensive examination of all relevant factors, and there is a clear report at the end that gives precise overview of the relevant parameters such as cost savings, CO_2 balance and energy consumption.

Figure 5. Klüber Lubrication's services.

INDUSTRY 4.0 - THE *EFFICIENCYMANAGER*

To control all these activities effectively, a systematic and reliable program to manage all these tasks is required. For example, Klüber Lubrication has developed the *EfficiencyManager*, a mobile software solution that enabled operators to map the entire infrastructure, including all maintenance elements to be coordinated, with just one tool (*Figure 6*). This includes, in particular, information on the required relubrication and maintenance intervals. With this software, which is also available as an app, it's maintenance and repair work on site can be carried out and documented. This gives operators an overview of the status of all maintenance tasks and a transparent overview of all relevant components and equipment, as well as existing optimisation potential.

CONCLUSION

While having major impact on total cost of ownership, the cost for necessary lubricants is only about one percent of the operating budget. The savings are reflected in the three largest items of operating costs: maintenance and repair, components (spare parts stocks), and energy consumption. With a precisely tailored specialty

Figure 6. The EfficiencyManager App allows you to access your data anywhere, anytime, including unplanned occurrences on site.

lubricant, maintenance intervals is extended as the machines no longer have to be relubricated as often. We save spare parts costs as the individual components last longer. Last but not least, the use of high-quality synthetic food grade lubricants increased the efficiency of the systems and thus reduced overall energy consumption and enabled full compliance to maximise food safety against contamination from MOSH and MOAH.

REFERENCES

Klüber Lubrication (2015). Gear up with success. Useful information on oil lubrication of gears (B023001002/ Edition 11.15).

Ulrich Mann (2006). Economical gear lubrication with synthetic oils. Klüber Lubrication Tribojournal, Edition 1/2006. P. 4-7.