www.ELGI.org
Bezuidenhoutseweg 12, Den Haag
The Netherlands
+31 6 1736 1962
+31 70 318 00 37

European Lubricating Grease Institute Position Paper on MOSH and MOAH

About the European Lubricating Grease Institute (ELGI)

The main objective of the organisation is to promote the understanding of all matters concerning lubricating grease and its associated products, to disseminate information that can lead to the development of better products for the consumer, and also provide improved lubrication service to the industry. In addition the ELGI facilitates the exchange of information concerning design, manufacture, use, handling and sale of lubricating grease between all interested organisations and individuals.

The ELGI is a not-for-profit technical institute, funded by its members primarily composed of grease manufacturers and marketers, raw material and equipment suppliers, end users and other technical and trade-related bodies.

One way in which some of these objectives are met is through active working groups. The ELGI continuously strives to strengthen their association with the industry by rendering services to the end user as well as those on the manufacturing and supply side.

Food Grade Lubricants Working Group (FGLWG)

Food grade lubricants are among the most crucial products in the food chain, produced and used in small volumes but with a high impact. As food safety is increasingly in the spotlight, our industry must continue to respond and remain proactive. It is in the industries interest to cooperate with decision makers to define and meet global standards. The Food Grade Lubricants Work Group is the platform where future developments on standards and legislation are reviewed and has the following Vision, Mission and Goals;

Vision: To be recognized as the leading source of information and knowledge related to lubricants and lubricating greases used in the food industry. To promote the safe & appropriate use of lubricants in the food industry and related industries.

> **Mission:** The goal is to increase knowledge and awareness about the use of food-grade lubricants and their potential risks, in order to support legislators and other interested parties. This involves connecting with stakeholders within and related to the food production industry from an advisory and knowledge-sharing perspective, and communicating openly as an industry about actual and potential issues related to the use of lubricants and greases in the food sector.

Goals:

- Increase & share knowledge, and awareness.
- Unify and amplify the voice of the food-grade lubricants industry.
- Collaborate with other organisations and stakeholders.
- Proactive impact in the food production chain.
- Monitor and evaluate pending legislation and regulatory changes.

In this paper, the reference to the food industry include, food, beverage preparation and filling, animal feed and foods, personal care and the pharmaceutical industry. This can be extended to cover any production facility that wishes to operate in or supply to the food chain, for example a mineral preparation company supplying to the food supplement sector. For simplicity throughout, reference is made to the food industry.

The ELGI supports the concerns of the FGLWG members and underwrites the attached position paper on MOSH and MOAH clarification.

- Terry Dicken President ELGI
- Sofia Oberg Co- Author & Co Chairperson FGLWG
- Perry Peters Co-Author & Co Chairperson FGLWG
- Max Jopen Co- Author

All interested parties are encouraged to distribute this document as a whole to any interested or affected party.

Definitions:

MOH Mineral Oil Hydrocarbon. A very complex product that can be gas, fuel, lubricant base oil, wax, tar and so on. Mineral oil consists of a complex mixture of hydrocarbons. The main composition is aliphatic hydrocarbons (MOSH) and aromatic hydrocarbons (MOAH). In general about 80% is aliphatic and about 20% is aromatic. Mineral Oils are derived substances, produced by refining crude oils. It is the black stuff coming from natural source and as such is also present in nature in other compositions than “oil”. A definition of mineral oil is not possible as the product is too complex so it will require to specify which fraction is under consideration.

It all starts with crude oil refining which is carried out using two main distillation processes, first atmospheric and then vacuum distillation at temperatures between ~300^{0}C and ~700^{0}C. Vacuum distillation is necessary to prevent hydrocracking at temperatures around 300^{0}C at which the so called “long residue” from atmospheric distillation is processed.

The long residue entering the vacuum distillation unit is the starting material used for the manufacturing of “mineral oils”. Because the mineral oils’ feedstock contains unwanted carcinogenic compounds, these must be eliminated by further, specific refining processes.

MOSH Mineral Oil Saturate Hydrocarbon (in lubricants). The main component after the various refining stages. Present for 97% or more in the lubricant base oil and correlates with the viscosity of the product.

MOAH Mineral Oil Aromatic Hydrocarbon (in lubricants). A small remaining fraction in the base oil after the various refining stages. Present below 3% to nearly nil, however always a remaining fraction is present. All base oils are tested for the effectiveness of the refining process.

PAH Polycyclic Aromatic Hydrocarbons. These are present in 1 to 7 rings. An extensive database has been generated over the last 40 years with evidence of the health effects and possible cancer potential. Now the accepted status is that 3 to 7 ring PAH represent a health risk due to their carcinogenic potential. The 1 and 2 ring PAH are proven free of this potential. For that reason the refining process of lubricant base oils (also the basis for grease) will have the 3 and higher number of PAH rings removed.

MORE Highly refined mineral base oils. The base material that is used to produce food grade lubricating oils, food grade greases and pharmaceutical products. These base oils are virtually free of 3 to 7 ring PAH. The main part is MOSH and a very small part can be MOAH of the safe 1 and 2 ring PAH. All base oil leaving a refinery is, by law, tested for the effective refining stage where the 3 to 7 ring PAH are removed.

From a toxicological point of view, the MOSH and MOAH fractions do not correspond to petroleum derived mineral oils and waxes that are placed on the market. Furthermore, these MOSH and MOAH fractions are also found in products of other than of mineral oil origin, further adding to the difficulty of tracing their origin and the health risk they pose. As an example, n-alkanes have been attributed as MOSH, but are ubiquitously present in nature and are natural components of fruits and vegetables. There are also many other products that would lead to false positives in a “MOSH/MOAH” analysis. The most important ones and their false positive influence are presented in the following points.

POSH Polyolefin Oligomeric Saturated Hydrocarbons. Poly-alpha-Olefins (POSH) or better known as PAO in the lubricant industry are synthetic hydrocarbons produced through the polymerization of linear alpha-olefins. They belong to the group of synthetic manufactured hydrocarbons and are characterized by a defined chemical structure. POSH are highly stable and pure liquids that are free from aromatic compounds (MOAH) and saturated hydrocarbons (MOSH) as you find them in mineral oils. Due to their synthetic origin, they do not contain impurities such as polycyclic aromatic hydrocarbons (PAH). They exhibit excellent thermal and oxidative stability, making them often used as safe base oil for applications in the food and pharmaceutical industries.

Analytical Challenge: Difficult Differentiation Between MOSH and POSH

A key analytical challenge related to MOSH (Mineral Oil Saturated Hydrocarbons) and POSH (for example Poly-alpha-Olefins) is their structural similarity. Both groups consist of saturated hydrocarbons but with different connectivities, often exhibiting similar physicochemical properties like boiling points and molecular weights, making precise differentiation in analytical procedures difficult. Conventional analytical methods, such as

gas chromatography (GC), often show overlapping peaks, leading to misinterpretations and inaccurate quantifications/results. Advanced techniques, such as two-dimensional gas chromatography (GCxGC) and specialized software solutions, are required to overcome these challenges and ensure reliable differentiation. As a result, POSH is sometimes mistakenly assigned to the MOSH phase, or it is concluded that the phases are indistinguishable.

Some questions answered, FAQ:

Q1. ***If I do not use a mineral oil-based lubricant will my final food product be free of MOSH/MOAH?***

A1. No, there is no such guarantee. The crops could have been exposed to MOH by pollution, as part of the agricultural process, it could have been added to the food in the production process and in nature these components occur.

Q2. ***Are all MOAH bad?***

A2. No, there are good and bad MOAH. In crude oil all these are present. In lubricating oils and greases the “bad” MOAH has been removed. Crude oil contains both, but highly refined mineral base oils contain only the “good” MOAH. (See definitions)

Q3. ***Is there a MOAH free mineral oil?***

A3. No, there might always be a small remaining fraction of MOAH.

Q4. ***Are the testing methods of the final food able to tell me if my lubricant is in the foodstuff?***

A4. No, it is highly unlikely to be able to determine where a MOSH and MOAH fraction come from when found in the final foodstuff. What we do know is that the lubricant when unforeseen, entered the food, consists only of the safe fraction (1-2 ring PAH).

Q5. ***Are test methods and results comparable between laboratories?***

A5. Unfortunately not yet. The extraction from the final food is difficult and this results in inconsistent repeatability, reproducibility and comparability.

Q6. ***If I use PAO or other based lubricants will there be no MOSH and MOAH in these lubricants?***

A6. No, this cannot generally be stated as all individual components must be tested. Additives can be, as example, be dissolved in mineral oil.

Q7. ***MOSH is found in our (foodstuff) product. What could be the source?***

A7. During the food production some processes are a cause for MOH to intentionally entering the food stuff. Possible sources could be anti-dusting oils, glazing oils, cutting oils etc. Contamination could be another possible source.

Q8. ***Is MOSH a hazardous substance for human health?***

A8. There is no current evidence that there is serious negative effect on human health, but studies are ongoing. (in 2023 EFSA updated the risk assessment)

Q9. ***Do mineral oil based lubricants contain MOSH?***

A9. All mineral based lubricants contain MOSH to a certain extent

Q10. ***How can the lubricant industry ensure that mineral oils are safe to use in my production?***

A10. All mineral base oils are tested before leaving the refinery to meet the IP346 and must pass the requirements. That test guarantees the safety of the base oil.

Q11. ***I use H1 lubricants is it MOSH MOAH free?***

A11. H1 guarantees the formulation is according to the requirements based on the USA FDA 21 CFR and ISO 21469 have requirements linked to the production. All mineral oil-based lubricants can still contain traces of MOSH and MOAH.

Q12. ***What are the legal requirements of the limits MOSH and MOAH for lubricants within the EU?***

A12. Contrary to the USA, there is no general legislation for lubricants in the EU. EFSA has in their scientific opinion defined limits for daily human consumption of MOSH. For the food stuff there are set limits for different purposes and markets. For MOAH, however, there are suggested guideline values for products between 0.5 and 2 ppm, depending on the fat content, which should not be exceeded in the food product.

Lubricants and their contact with food

When considering MOSH and MOAH contamination in food contact materials in relation to lubricants, one crucial factor is often overlooked: Measuring MOSH and MOAH levels in food provides a direct and realistic assessment of contamination, regardless of its source. However, when analysing a lubricant, the detected MOSH/MOAH content does not directly translate to the real amount that could transfer to food during the production process.

Lubricants are classified as incidental food contact substances, meaning their presence in food is unintended but cannot be entirely avoided in industrial processing. This often leads to misconceptions regarding concentration levels and potential contamination risks.

To improve understanding and ensure traceability, a worst-case scenario calculation for lubricant contamination in food contact situations is provided using the example of a homogenizer equipped with a Foodgrade Gear oil (150 Cst) based on realistic leakage figures.

Homogenizers in the food industry are used to break down and evenly distribute particles in liquid products, enhancing texture, stability, and shelf life. They are widely utilised in dairy, beverage, and sauce production to prevent separation and ensure a smooth, uniform consistency. In food processing, homogenizers can have a throughput rate of up to 25,000 liters per hour, with the machine's oil filling varying significantly depending on its size. In a worst-case scenario, an undetected leakage could result in up to 250 mL of oil per day, which equates to approximately 10 mL per hour.

Given the high throughput, each new liter of processed food would contain 0.00004% lubricating oil, corresponding to 4 ppm of lubricant per liter in the worst-case scenario. If a MOSH/MOAH analysis is conducted on the lubricant and it would contain 10 ppm of MOSH or MOAH contamination, this means that 10 ppm of the lubricant is present within the 4 ppm of oil in the food product. Consequently, the MOSH/MOAH contamination level in the final product would be 0.4 ppm or 400 ppb.

Comparable calculations can be made for other appliances used in the food industry. The results obtained remain comparable.

Conclusion:

Mineral based lubricants and greases are safe products developed to support the mechanised food production, animal feed production and pharmaceutical production. Highly refined mineral base oils and POSH are used as approved component of medicinal and pharmaceutical products. Importance remains the avoidance of lubricants accidentally entering the foodstuff. It is important to use products that have a H1 registration (NSF or 2Probity) and are produced under ISO21469 certification, so in case of an incident the risks for the consumers are minimised.

Mineral oil-based food grade lubricants meet many technical requirements for economic food production and are safe to use.

PAO, PAG and Ester based lubricants and Greases might be MOSH & MOAH free. All components in the formulation however need to be evaluated.

Testing of MOSH, MOAH and POSH remains complicated. Single GC analyses gives in many cases false readings while GCxGC being the better and more reliable method is not readily available. Unfortunately often Food and Beverage producers are used to the GC method and can base their conclusions on false analytical results.

IMPORTANT NOTE

This paper is based on scientific studies and publications. The content of this paper is an extraction of those studies and as a result it aims to represent the spirit of the facts of those studies. The scientific explanation of this complex problem, as discussed in the position paper, would require several hundred pages. For that reason, an extremely condensed but accurate explanation is presented here, based on those scientific studies. For more detailed information on MOSH and MOAH contact CONCAWE or the Food Grade Lubricants Working Group via the ELGI office.

ELGI
Terry Dicken
Chairman