MOSH and MOAH – White Paper

Fact sheet MOSH & MOAH for NSF-H1 food grade lubricants (21.CFR178.3570 compliant)

December 2024

1. Introduction

For food processing companies reducing the risk of contamination is important. Mineral oil compounds (MOSH and MOAH) are known contaminants. This white paper summarizes facts about MOSH and MOAH in relation to NSF-H1 lubricants.

Competing products are analyzed during our research. They have been used for benchmarking and validation only and are not linked to quality or performance indicators of any kind.

To avoid misunderstanding: Interflon is not disputing nor denying that unwanted and unhealthy contamination was found in food during third party research (which is referred to in this document). The sole purpose of this white paper is to inform our valued customers.

2. Definitions and terms

21CFR.178.3570	21st Title of the **C**ode of **F**ederal **R**egulations Section 178.3570 from the F.D.A.
Alkane	Saturated hydrocarbon with carbon and hydrogen atoms.
C.L.P.	EU Regulation for **C**lassification, **L**abelling and **P**ackaging.
Chromatography	Technique to separate a mixture into individual components.
E.F.S.A.	The **E**uropean **F**ood **S**afety **A**uthority.
F.D.A.	The **F**ood and **D**rug **A**dministration is a U.S. government body and responsible for protecting U.S. public health by assuring safety, efficacy, and security of human & veterinary drugs, biological products, medical devices, food supply, cosmetics, and products that emit radiation.
Mineral oil	Hydrocarbons originating from earth.
MOH	**M**ineral **O**il **H**ydrocarbons; Mineral oils .
MOSH	**M**ineral **O**il **S**aturated **H**ydrocarbon.
MOAH	**M**ineral **O**il **A**romatic **H**ydrocarbon.
PAC	**P**olycyclic **A**romatic **C**ompounds.
PPM	**P**arts **P**er **M**illion.
REACH	EU legislation for **R**egistration, **E**valuation, **A**uthorization and restriction of **CH**emicals.

3. Background and context

In 2013 a German consumer organization (Warentest, 2012) published a report that mineral oil was found in chocolate. Based on analysis packaging material was pointed out as primary source for contamination. The report was taking over by different news channels and was spread out over Europe. Based on this information gradually supply chain partners for the food industry were asked to deliver products free of mineral oil.

4. Mineral oils

Mineral oils are very versatile and are used in a wide range of products. In i.e. rubbers, processing aids, coating, lubricants, cosmetics and cleaners mineral oil is used (Boogaard, et, al, 2018).

5. What are MOSH and MOAH?

MOSH and MOAH derive from mineral oil. Both are distinguished by measuring certain content with chromatography. MOSH is the alkane content in oil, MOAH is the aromatic content in oil. MOAH can be classified based on the number of membered rings.

6. Food Grade Lubricants

Currently MOSH and MOAH are surrounded by confusion, especially about the presence of MOAH and MOAH in NSF-H1 registered food grade lubricants.

NSF-H1 lubricants are intended for incidental food contact (GovInfo, z.d.) under US Law (FDA Code of Federal Regulations Title 21, section 178.3570). NSF-H1 lubricants are registered based on formulation. NSF, (formerly) INS and 2Probity are registering the products.

Although the system is US based it is globally recognized and adapted. For decades it has been the standard for food grade lubricants in food processing companies and HACCP environments.

NSF-H1 lubricants are designed for incidental food contact. They should never be considered as edible ingredients. As such they should not come in contact with food. The FDA has set a limit of ten parts per million in case of contamination (CFR - Code of Federal Regulations Title 21, z.d.). Ingredients in NSF-H1 lubricants are not per se dangerous, but they do not meet the technical specifications to be used for direct food contact.

7. Classification of MOSH and MOAH

Where there is MOAH you most likely will find MOSH as well. Despite this connection tracing the origin of MOSH and MOAH can be challenging; if not impossible (Boogaard, et, al, 2018). MOSH and MOAH showing up in analyses in food is not uncommon. i.e. In some fruits and edible oils natural MOSH is present. It’s origin cannot be distinguished.

Multiple sources (RIVM, 2019; Foodwatch, z.d.; Boogaard, et, al, 2018), show research about the presence of MOSH and MOAH in the supply chain for the food processing industry. Most recent data points out again packaging as a primary source for contamination followed by contamination during harvesting.

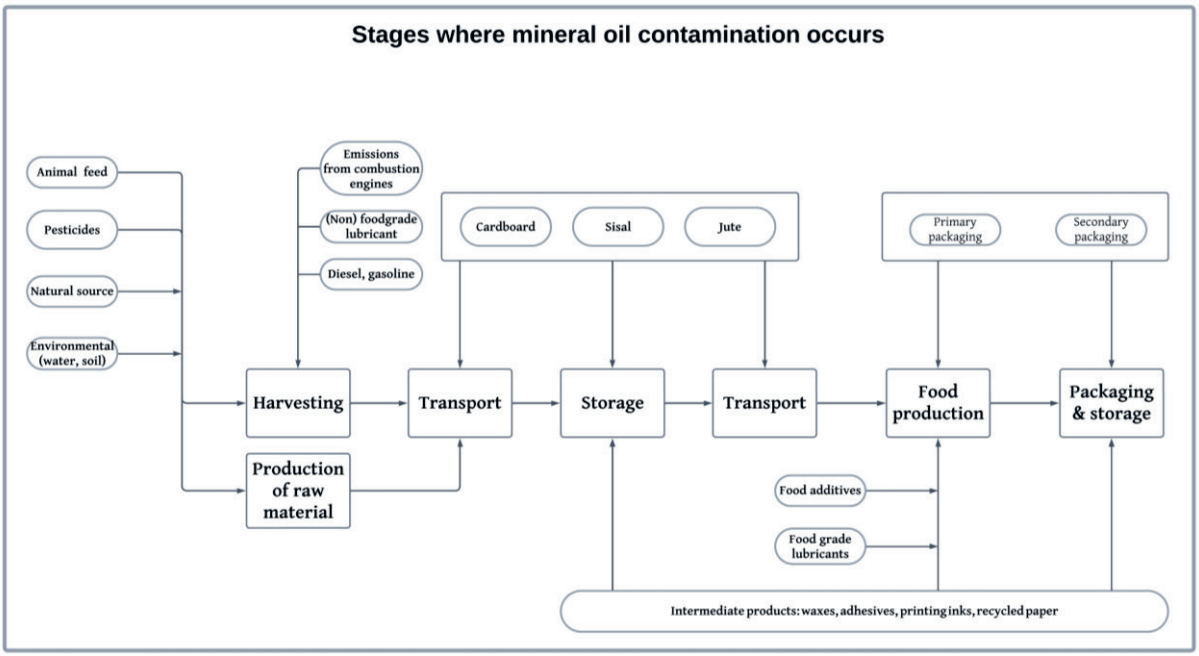

Figure 1 – Possibilities of contamination in the supply chain

MOSH

In the past there was an indication that MOSH could have an adverse effect on human health. The result from this individual "Fischer 344 rat" test was extrapolated to humans. More scientists shared the opinion that it was a false positive test (EFSA, 2023). This type of rat cannot be extrapolated to humans and number of studies show no health issues. With the current evidence and after decades of safe use the EU authorities (EFSA, 2023) concluded with a certainty of 66-95% that dietary exposure to MOSH does not present a public health risk.

MOAH

MOAH is used in lubricant for decades. One of the properties of MOAH in lubricants is to improve solvability. MOAH can be exemplified and simplified: There are two types of MOAH in the context of food grade lubricants.

MOAH contains Polycyclic Aromatic Compounds (PAC). PAC containing 3-7 rings raise a concern; they are potentially carcinogenic (EFSA, 2023). PAC containing 1-2 rings are safe (EFSA, 2023) but need further research to gather reliable oral toxicity data.

IP346 is a method that can determine presence of 3-7 rings PAC and if refinement has been performed properly. This is part of the EU REACH and CLP legislation (Boogaard, et, al, 2018). If mineral oil is used by Interflon for NSF-H1 lubricants they are 1-2 rings PAC containing oils and safe for their intended use (NSF-H1 lubricants).

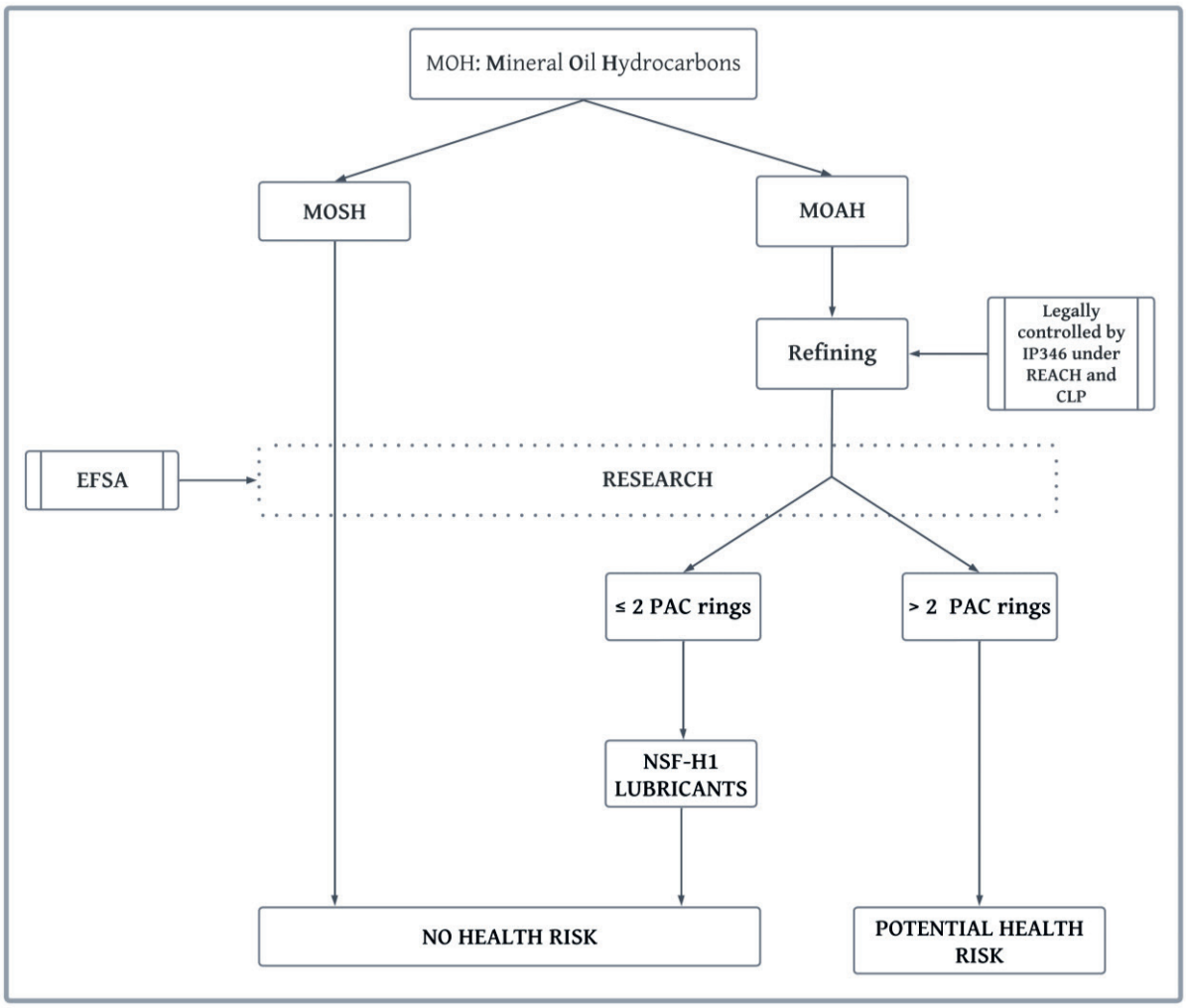

Figure 2 - MOSH MOAH outline

8. Analysis

Current analyzing techniques cannot distinguish with 100% certainty PAC 3-7 and PAC 1-2 MOAH (German Federation of Food Law and Food Science, 2019). Without context it is impossible to have a reliable risk assessment. Another issue is the detection limit of current equipment. Most innovative research centers have equipment with a detection limit higher (Frauenhofer, 2023) than the upcoming legislation (which can be as low as 0,5 ppm in dry food).

9. Numbers will tell the tale

Interflon cooperated with Fraunhofer-Institut IVV Germany for chemical analyses. Frauenhofer analyzed a total of five samples. Two products from Interflon; Interflon Food Lube HT and Interflon Food Grease S1/2 and three products from another lubricant manufacturer. The manufacturer from the competing products claims to have MOSH and MOAH free products according their product data sheets and website. Interflon considers these products to be a good benchmark in terms of lubrication quality.

Tabelle 1: Gehalt an Kohlenwasserstoffverbindungen in der MOSH-Fraktion in den Schmiermitteln gemäß LC-GC-Analysen

	Kohlenwasserstoffe in MOSH-Fraktion [%]						
Sample	C_{10} - C_{16}	C_{16} - C_{20}	C_{20} - C_{25}	C_{25} - C_{35}	C_{35} - C_{40}	C_{40} - C_{50}	Total
RM Food Grease S1/2 (#25277)	< 0,01	< 0,01	< 0,01	< 0,01	< 0,01	< 0,01	< 0,03
[redacted] *(indirect)* (#25278)	< 0,01	< 0,01	< 0,01	7,7 ± 0,5 (0,01)	1,6 ± 0,1 (0,01)	25,8 ± 0,5 (0,01)	35,1 ± 0,7 (0,03)
Food Lube HT (#25279)	0,1 ± 0,01* (0,01)	0,2 ± 0,01* (0,01)	0,003 ± 0,001* (0,01)	< 0,01	< 0,01	< 0,01	0,4 ± 0,01* (0,02)
[redacted] *(direct)* (#25280)	< 0,01	< 0,01	< 0,01	6,7 ± 0,02 (0,01)	1,4 ± 0,04 (0,01)	23,3 ± 0,2 (0,01)	31,4 ± 0,2 (0,03)
[redacted] *(canister)* (#25281)	< 0,01	< 0,01	0,04 ± 0,01 (0,01)	48,3 ± 5,3 (0,01)	6,8 ± 0,7 (0,01)	12,4 ± 1,8 (0,01)	67,6 ± 5,6 (0,03)

* MOSH
Werte in Klammern: Nachweisgrenze
< Werte: unter der Nachweisgrenze

Figure 3 - MOSH content

Tabelle 2: Gehalt an Kohlenwasserstoffverbindungen in der MOAH-Fraktion in den Schmiermitteln gemäß LC-GC-Analysen

	Kohlenwasserstoffe in MOAH-Fraktion [%]				
	C_{10} - C_{16}	C_{16} - C_{25}	C_{25} - C_{35}	C_{35} - C_{50}	Total
RM Food Grease S1/2 (#25277)	< 0,01	< 0,01	< 0,01	< 0,01	< 0,01
[redacted] *(indirect)* (#25278)	< 0,01	< 0,01	3,3 ± 0,1 (0,01)	4,7 ± 0,1 (0,01)	8,0 ± 0,2 (0,01)
Food Lube HT (#25279)	< 0,01	< 0,01	< 0,01	< 0,01	< 0,01
[redacted] *(direct)* (#25280)	< 0,01	< 0,01	2,9 ± 0,2 (0,01)	4,1 ± 0,3 (0,01)	6,9 ± 0,4 (0,01)
[redacted] *(canister)* (#25281)	< 0,01	< 0,01	< 0,01	< 0,01	< 0,01

Werte in Klammern: Nachweisgrenze
< Werte: unter der Nachweisgrenze

Figure 4 - MOAH content

Citation from the report (Frauenhofer, 2023):

All lubricants are high-purity samples. A total MOSH value of 0.4 % was determined for Food Lube HT (#25279). The other three samples contained non-MOSH hydrocarbons in quantities of 31 and 68 %.

In the MOAH fraction, hydrocarbons that are not classified as MOAH were detected with total concentrations of 7 and 8 %. The standard deviation is in the range between 0.01 and 0.03 %.

Only one sample (Food Lube HT; #25279) was found to contain MOSH in the low percentage range.

None of the samples contained MOAH. However, many samples contained MOSH and MOAH-like compounds in the higher percentage range from a molecule size of C24. These can be "incorrectly" evaluated as MOSH or MOAH if the sources and samples are not taken into account in a control measurement. The detection limit is between 0.01 and 0.03 % for MOSH and 0.01 % for MOAH.

10. What is the factual problem?

Looking at the data (fig. 3 and 4) MOSH and or MOAH is found in several samples. At a glance it seems to contradict with the conclusion "*None of the samples contained MOAH"* (Frauenhofer 2023). More in depth reading provides the conclusion that the samples contained "*MOSH and MOAH-like compounds"* which can be wrongly assessed and that samples containing MOSH and/or MOAH are of the "unharmful" types. Even in 100% synthetic base oils suitable for NSF-H1 formulated products MOSH and MOAH can be false positive detected (Mobil, 2022).

EU 2017/84 legislation "*monitoring of mineral oil hydrocarbons in food and in materials and articles intended to come into contact with food"* clearly states "to come into contact with food". NSF-H1 lubricants are not intended for contact with food but minimize the risk. This could pose the first potential challenge: NSF-H1 lubricants should not be in contact of food.

Secondly; current legislation is clear about food. Enforcement will presumably (most likely customers as well) approach food grade lubricants to comply with legislation EU 2017/84.

Furthermore the maximum level of contamination is 0,5 ppm (dry food) and the most advanced equipment has a detection limit of ≥ 5 ppm (EFSA, 2023).

11. Interflon's point of view

Interflon will always promote safe and hygienic best practices. Nevertheless we share the opinion of other suppliers in the marketplace that within the current public discussion some factual information is overseen or ignored.

Although minimizing the risk with NSF-H1 products; they have never been and are not intended for food contact. Under normal conditions processed food will not contain MOSH and MOAH originating from NSF-H1 lubricants. Only in highly unlikely events (incidents and accidents) very small amounts of "**unharmful"** MOSH and "**unharmful"** MOAH coming from H1-lubricants could end up in the final food product.

Interflon product development program has always been on reducing friction, but furthermore reducing frequency of lubrication and reducing quantity of lubricant as well.

We emphasize that with the right products, lubrication procedures and HACCP measures the risk of contamination from NSF-H1 lubricants can be minimized to a minimum.

On request the full Frauenhofer report can be obtained.

12. Sources and references

Boogaard, et, al (2018). *Mineral oils are safe for human health?* Concawe, Brussels.

EUR-LEX - 32017H0084 - EN - EUR-LEX. (z.d.). https://eur-lex.europa.eu/legal-content/NL/TXT/?uri=CELEX%3A32017H0084

CFR - Code of Federal Regulations Title 21. (z.d.). *https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm?fr=178.3570*

European Food Safety Authority. (2023, 13 September). *Update of the Risk Assessment of Mineral Oil Hydrocarbons (MOH) in food.* https://www.efsa.europa.eu/en/plain-language-summary/update-risk-assessment-mineral-oil-hydrocarbons-moh-food

ELGI, (2022). *European Lubricating Grease Institute Position Paper on MOSH and MOAH*. www.elgi.org.

German Federation of Food Law and Food Science (BLL e. V.). (2019). *Guideline for the assessment of MOSH/MOAH migration from packaging into food with the aim of minimization.* www.researchgate.net. German Federation for Food Law and Food Science (BLL).

GovInfo. (z.d.). https://www.govinfo.gov/app/details/CFR-2022-title21-vol3/CFR-2022-title21-vol3-sec178-3570

Kung, M. H. (2016, March). *Critical review of the relationship between IP346 and dermal carcinogenic activity*. www.concawe.eu.

Unit, S. A. (2022, 3 April). *Recent challenges faced by food and drink businesses and their impact on prices - Office for National Statistics*. https://www.ons.gov.uk

The challenge of MOSH & MOAH in Food Industries. (2022, 13 oktober). https://www.mobil.eu/en gb/lubricant-expertise/resources/mosh-moah-challenge-in-food-industries.

Warentest, S. (2012, 26 november). *Adventskalender mit Schokoladenfüllung: Mineralöl in der Schokolade.* https://www.test.de/Adventskalender-mit-Schokoladenfuellung-Mineraloel-in-der-Schokolade-4471436-0/

Wat je moet weten over minerale olie in voedsel. (z.d.). Foodwatch. https://www.foodwatch.org/nl/minerale-olie-in-voedsel-qa