The challenge of MOSH & MOAH in Food Industries

Introduction

Increasing focus on food safety has driven manufacturers to review every aspect of their food production process including risk assessments on the manufacturing itself and also on external contamination along the supply chain. One of the sources of contamination in food is its packaging.

Due to their ability to migrate from packaging into food, hydrocarbons such as Mineral Oil Saturated Hydrocarbon (MOSH) and Mineral Oil Aromatic Hydrocarbon (MOAH) are in sharp focus to food professionals. To measure the content of MOSH and MOAH in various materials, the BfR test (Federal Institute for Risk Assessment in Germany) can be used. On detection, these molecules can then be traced back to the original source by examining each stage of the supply chain.

There are a multitude of potential sources of MOSH and MOAH including harvesting, processing, the environment, contamination of feeds, etc., as well as the subject of this Mobil Tech Topic, lubricants, which are used to lubricate equipment during food and packaging production. As discussed in the Mobil Tech Topic 'The challenge of MOSH & MOAH in Food Industries', there is a common assumption made that all MOSH and MOAH compounds are toxic. Concawe however has stated clearly that the profile of lubricants does not indicate the presence of harmful or carcinogenic compounds and are not relevant to safety.

This Mobil Tech Topic focuses on the origins of MOSH and MOAH contamination arising from lubrication to support the understanding of what the BfR test detects in lubricants and its implications.

Composition of Lubricants Used in Food Machinery

Industrial lubricants normally consist of 90%-99% baseoil which can be derived from either mineral or synthetic sources with the remainder of the finished product being performance additives. As outlined in the Concawe document "Mineral oils are safe for human health?", there are very well established controls in place to ensure baseoils are safe for handling and use (1).

Baseoils are generally classified into groups based on their processing and final properties.

Group I are traditional paraffinic mineral oil baseoils refined through distillation/solvent extraction and may be treated with hydrogen to further purify and remove undesirable molecules.

Group II are base oils derived from different chemical processes, in particular hydrocracking, which removes, or converts more undesirable molecules, like unsaturated hydrocarbons, or those containing elements such as Sulphur, to enhance performance properties.

Group III are base oils derived from very severe and/or selective refining processes to produce high performance, stable molecules. Normally the process involves severe hydrocracking (breaking and converting the molecules) to the desired structure.

Group IV, which are polyalphaolefins, source highly specific olefin molecules from the chemical refining process and polymerise or oligomerise them to build a range of very discrete synthesized paraffinic molecules.

Group V are classified as all other base oils including more exotic molecules with very specific chemistries which may be used for their specific properties not found in or limited with Groups I-IV.

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For the food industry, where there is a risk of lubricant leakage from machinery onto the food, components and finished lubricants are rigorously controlled to meet standards from such regulatory bodies as the FDA or NSF to ensure they are safe for incidental food contact. Such lubricants are identified as safe when compliant with FDA 21 CFR 178.3570 for use in "lubricant for incidental food contact" and are registered as either components (NSF HX-1) or the fully formulated lubricant (NSF H1). HX-1 baseoils can be made from any of the generic Groups I to V, but must be selected depending on their individual properties. Performance additives also are selected . It is important to note that H1 lubricants are for "incidental food contact" only. All leakages need to be avoided to ensure they do not exceed the 10 ppm contamination threshold.

The Federal Institute for Risk Assessment, Germany (BfR) Test

Based on a GC - FID technique, the BfR have developed an analytical method to determine MOSH and MOAH content in parts per million (ppm) in food or food contact (ie packaging) materials. The uncertainty in testing is given with ±25%. There is currently no test specifically for lubricants to determine MOSH and MOAH content. The lubrication industry uses the BfR test to generate data to respond to end customer questions or to develop marketing claims.

Link to test: BfR test method

BfR Testing to Determine MOSH and MOAH Content

A range of baseoils and commercially available finished lubricants, including some that are "safe for incidental food contact" (HX-1 and H1) were tested to determine MOSH and MOAH content. The results are presented in the table below.

Baseoil/Product	HX-1 or H1?	Baseoil type Group	MOAH detected?	MOSH detected?
Light Mineral Baseoil	No	I	Yes	Yes
Medium Mineral Baseoil	No	I	Yes	Yes
Heavy Mineral Baseoil	No	I	Yes	Yes
Hydrocracked Baseoil	No	II	Not detected	Yes
Severely Hydrocracked Baseoil	No	III	Not detected	Yes
White Oil	HX-1	II	Not detected	Yes
Light PolyAlphaOlefin (PAO)	HX-1	IV	Not detected	Yes
Synthetic Alkylated Naphthalene	HX-1	V	Yes	Yes
Synthetic Alkylated Benzene	No	V	Yes	Yes
Commercially Available Oil Based Lubricants				
High Performance Hydraulic oil ISO VG 46	No	II	Not detected	Yes
High Performance Multi-grade Hydraulic Oil ISO VG 32	No	III & I blend	Not detected	Yes
High Performance Multi-grade Hydraulic Oil ISO VG 68	No	III & I blend	Not detected	Yes
High Performance Gear Oil ISO VG 320	H1	IV & II blend	Not detected	Yes
Synthetic Gear Oil ISO VG 220	No	IV & V blend	Not detected	Yes
Synthetic Gear Oil (Poly-Alkylene-Glycol)	H1	V	Not detected	Not detected
Commercially Available Oil Based Greases				
Lithum Complex Grease	No	Grp I	Yes	Yes
Aluminum Complex Grease	H1	Grp II	Not detected	Yes

: NSF H1 - product safe for incidental food contact - even if MOSH/MOAH is detected

: MOAH content is below the detection limit which "will not contribute to MOAH content in food"

: MOSH and/or MOAH detected

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Observations

1. All mineral (Groups I-III) and synthetic (Groups IV and V) baseoils are detected as containing MOSH with the exception of the synthetic gear oil which is based on polyalkylene glycol (Group V). The BfR test does not distinguish between mineral and synthetic baseoils.
2. The BfR test identifies MOSH and/or MOAH, irrespective of whether the lubricant is safe for incidental food contact (NSF H1 or HX-1 registered).
3. MOAH was not detected in Group II, III and IV baseoils.
4. MOAH content is detected in some synthetic Group V oils, such as alkylated naphthenes and benzenes, which do contain cyclic ring structures. The test does not discriminate between MOAH components that are HX-1 or non HX-1 registered.

Conclusions

The BfR test is designed to support the food industry to identify contamination of MOSH and MOAH in food. There are many potential sources of these molecules throughout the production and supply chain and lubricants are only one of them. In this study of work, it is noted that :

1. MOSH and MOAH are considered as "mineral" in their description, however the BfR test cannot discriminate between mineral oil and synthetic origin. So purely using synthetic lubricants does not mean it will not be detected if contamination in food should occur. The use of synthetic material in lubricants does not exempt the need to correctly manage the risk of contamination in food.
2. To help guard against MOAH contamination in food, it is recommended that food manufacturers make use of high performance NSF H1 registered lubricants in their operations.
3. Formulating lubricants that are not detected as MOSH in the BfR test is not possible unless using uniquely specific Group V technology, which presents further challenges in performance and cost. MOSH cannot be avoided easily in lubricants.
4. NSF H1 registered lubricants are available that can claim to be "not formulated to contain MOAH and will not contribute to MOAH content in food".

Since MOSH and MOAH are detected in the BfR test, irrespective if the lubricant is safe for incidental food contact or not, then the only sure way of ensuring risk mitigation is the safe use of NSF H1 lubricants. MOSH can be detected in almost all lubricants and some may contain MOAH. However, since detection of contamination in the food industry is focused more on MOAH than MOSH, then high performance NSF H1 registered lubricants can be formulated not to contain MOAH and which will not contribute to MOAH content in food to help reduce time consuming MOAH investigations.

References:

(1) "Mineral oils are safe for human health?" Prepared by the Concawe Mineral Hydrocarbons Task Force Special MOCRINIS (STF-33)