Whitepaper

# Facing the hygienic lubrication challenge: food safety is people safety

## Understanding and minimising the risk of MOSH/MOAH contamination from lubricants

KLÜBER LUBRICATION

your global specialist


## Brief summary

The food industry is large, global, and diverse – yet its production equipment shares common requirements for hygienic lubricants whenever contact with the product is technically unavoidable. While H1 types offer safe solutions, they must keep contaminants like mineral oil hydrocarbons (MOH) – either mineral oil saturated hydrocarbons (MOSH) or mineral oil aromatic hydrocarbons (MOAH) – low.

Problems can arise because synthetic hydrocarbons contained in H1 lubricants exhibit analysis patterns similar to MOSH and MOAH, possibly yielding false positive test results. The challenge is exacerbated when H1 lubricants contain additives with MOSH/MOAH for essential reasons like corrosion prevention or anti-foaming.

Klüber Lubrication uses its global yet locally-available expertise and resources to help customers solve these issues and realise the full benefits of high-performance H1 lubricants. With a project management approach, the company investigates each customer's production situation, provides real insights into analysis results, and implements appropriate solutions, from the pilot stage to full-scale production.

Overall, the paper highlights the benefits of a lubrication partner offering innovation, expertise and support over an off-the-shelf stockist.



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## Uncertainties in legislation and analysis

Food industry machinery lubricants must present a minimal or zero risk of food contamination, as contamination presents a serious risk to human health, with consequential losses and damage to brand reputation. However, no single or simply defined solution is available, or even possible, for several reasons.

**Firstly**, the food industry has so many dimensions of diversity. The entire food chain, 'from farm to fork', involves many aspects, such as packaging materials, raw materials, and ingredients, as well as the final food production. And food types are so diverse, from animal feed to beverages, bakery, confectionary, meat, and many others – all produced by organisations of all sizes around the world.

**Secondly**, although experts recommend H1 lubricants as the safest solution when contact with food is unavoidable, a correct use of H1 lubricants normally means that no contact with food occurs at all. However, there is no general law stating that H1 lubricants must be used. Each country across Klüber Lubrication's international operation has its own food laws, or sometimes no laws at all. Although recommendations and standards exist, it is ultimately each food manufacturer's responsibility to find the market's best available solutions and maintain the safest possible manufacturing processes.

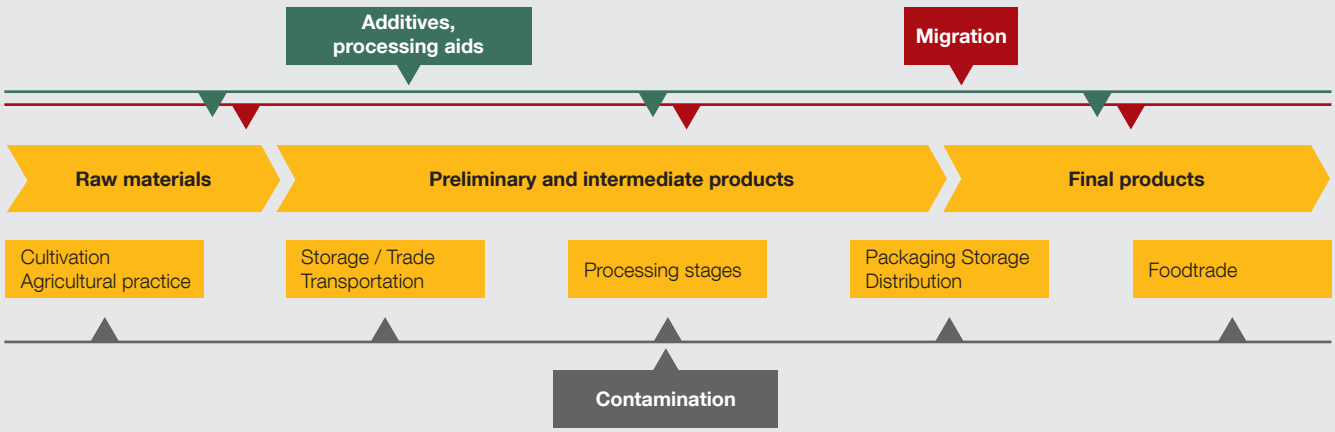
**The third** area of uncertainty has to do with chemical analytics. Analytics are essential for measuring contamination levels in lubricants, but analytical approaches are driven by state-of-the-art practices rather than by any law. Then, irrespective of the standard chosen, interpreting the results of an analysis can be difficult, as we shall see.

Organisations that work with the H1 and related standards include the US-based National Sanitation Foundation (NSF), which collaborates closely with the US Food and Drug Administration (FDA), United States Department of Agriculture (USDA), World Health Organization (WHO) and the European Food Safety Authority (EFSA). Klüber Lubrication follows EFSA recommendations as given by the Panel on Contaminants in the Food Chain (CONTAM) – including those related to mineral oil hydrocarbons (MOH).

## What are MOSH and MOAH?

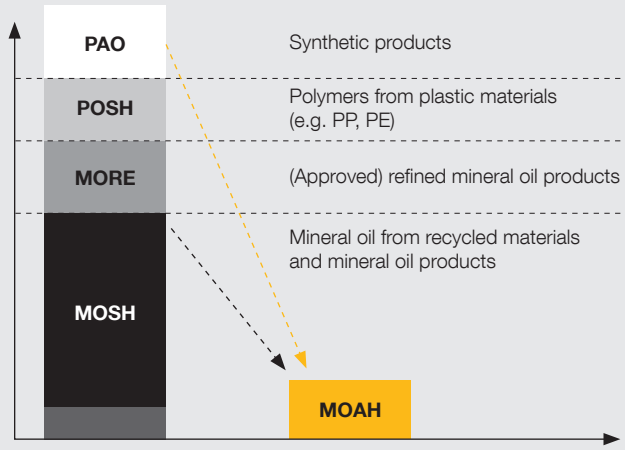
MOH can be divided into mineral oil saturated hydrocarbons (MOSH), which comprise linear and branched alkanes, cycloalkenes, and mineral oil aromatic hydrocarbons (MOAH), including mainly alkyl-substituted polyaromatic hydrocarbons. The term mineral oil usually refers to MOH of technical grade. These are alkane-based but typically contain approximately 25 % MOAH. If food contact is technically unavoidable, the amount of lubricant remaining in the food should not exceed 1 ppm for silicone oils, and 10 ppm for all other base oils. If these limits are exceeded, the food product should be considered unsafe.

**Where does MOSH/MOAH come from?**




Systematic illustration of the routes of entry of MOSH/MOSH analogues and MOAH into food

**Analyses of MOSH/MOAH are challenging**




MOH in food are present as a complex mixture that needs to be quantified as a sum of all components. Shifting of the MOSH/MOAH ratio commonly found in mineral oil by MORE, POSH and PAO as MOSH analogues

PE: Polyethylene; PP: Polypropylene

The analytical methods for MOH determination are continuously being improved. For the quantitative determination of MOSH and MOAH, online-coupled liquid/gas chromatography with flame ionisation detector (LC–GC/FID) is commonly applied. This analytical method separates the MOSH/MOSH analogue fraction from the MOAH fraction. It also uses a state-of-the-art limit of quantification (LOQ) in lubricants (as of 2021) corresponding to 1000 mg/kg for the MOSH content and 10 mg/kg for the MOAH content.

## Synthetic hydrocarbons and analysis results

Lubricants for incidental food contact can be based on non-alkane oils, such as (1) silicone oil or PFPE, (2) non-synthetic or (3) synthetic hydrocarbons. The first do not play a significant role for mineral oil contamination in food. Fully synthetic hydrocarbons (SHCs) like polyalphaolefins, however, exhibit analysis patterns similar to MOSH and might yield positive test results with the above-mentioned analysis method, even if no MOSH is contained in the sample. Such results would lead to users rejecting lubricants that are actually fit for purpose.

SHCs also affect the quantification of MOAH in food-grade lubricants, as they are frequently used as base oils. If the SHC content is high, its unsaturated portion may lead to misinterpretation of analysis results. In the MOAH fraction, the signal pattern of unsaturated SHC oligomers interferes with the MOAH ‘hump’, so the LOQ for MOAH needs to be increased. However, we advise that a higher LOQ does not directly indicate a greater level of MOAH in the lubricant.

Further insight into the MOAH signal components can sometimes be gained through coupling two-dimensional gas chromatography with a mass spectrometer. In some cases, this allows differentiation of MOAH and false positive quantities, possibly resulting in a retrospective LOQ decrease.

However, mineral oil-related substances cannot be totally excluded, not just due to undetectable cross-contamination during multilayered production and transport processing stages but also because of the LOQ of the current MOH analysis techniques available. The presence of a multitude of hydrocarbons, from fossil and synthetic origin and of constituents exhibiting alkyl or aromatic groups, considerably impedes the quantification of MOH level in lubricants.

## The impact of application-specific additives

Another important consideration is that specialist lubricants may have application-specific additives that exhibit MOSH/MOAH values above LOQ – yet removing these ingredients may reduce food safety levels. For example, machines like injection moulders, presses and homogenisers need oils with defoaming additives. Otherwise, excessive foaming and oil aeration may lead to inadequate lubrication for the application. Additionally, carbon deposits could be formed, potentially creating varnish. Thermal conductivity could also be reduced, with possibly serious consequences where, for instance, gears are running at elevated temperatures.

Furthermore, oils with poor antifoaming additives may cause loss of system pressure, valve damage, piston blockage, or leakage of oil/foam from the tank, creating significant risk of massive contamination, machine downtime, significant damage and risk to operator health.

Similarly, high-performance bearing greases need corrosion inhibitors, which can give a high false positive result in MOAH analysis, leading a user to reject a versatile and high-performance H1 bearing grease. Yet the inhibitors are essential in preventing premature rolling surface degradation, vibration, elevated temperatures, damage to rolling elements, cages and seals, and premature component failure – with a high risk of grease and wear particles leaking into the food processing areas. Often, even state-of-the art lab analysis cannot give all the elements that can be selected, because fully synthetic oil-based MOSH analogues can be interpreted as MOSH.

## Optimising solutions: a project-driven approach

The above-mentioned considerations mean that simply buying lubricants from a stockist would almost certainly fail to secure the benefits of food safety and plant reliability that would be available from a specialist with lubrication application expertise and corresponding resources; one that could optimally address the diverse requirements of all the lubrication points across a production line or plant with appropriate high-performance lubricants.

To begin with, a lubricant specialist can offer valuable insights and comments on analysis results that a third-party laboratory never could, because they understand the formulation and constituents of the lubricant under analysis. This allows them to supply an accurate and detailed interpretation of the analysis results.
But this is just one aspect – albeit an important one – of Klüber Lubrication's wider, holistic, and project-driven approach. The company has developed a **unique five-step programme**, which starts with a high-level discussion of what the customer wants to achieve – for example, a 50 % reduction of quantity of lubricants yearly used per ton of food or a 20 % reduction in water consumption over the next year.

In any case, the first detailed step is to **clarify objectives**: understand the customer's needs, and identify their business issues and objectives. The scope of the evaluation is then defined.

The second step is to **evaluate and find possibilities**: We check the production processes and equipment as defined within the scope, and document the possibilities for improvement that they identify.

**Five-step programme**


They then involve the customer in a **joint analysis**. Issues like application criticality and availability of a solution are factored into a cost/benefit analysis. After a presentation of their evaluation, they seek agreement on KPIs, timescales and actions, and ask for an order or commitment. Next come **implementation and the associated actions**. These usually start in a pilot area, allowing early results to be compared with the KPIs. If these are favourable, the solution can be expanded or multiplied across the line or entire plant, with progress being tracked by project meetings with stakeholders.

## Opportunities for further improvement

Klüber Lubrication can continue in partnership with the customer long after the original project is completed, helping them identify and act on opportunities for ongoing improvement. If access to a plant is restricted for COVID or other reasons, Klüber Lubrication can still collect data remotely, use augmented reality, perform audits, and provide support without need for physical site access.
In planning projects like this, we offer some unique advantages. For example: We have a headquarters team – rather than just a single person – plus a globally distributed team of experts in chemistry, analysis and other disciplines dedicated specifically to the food industry; a resource that customers can turn to wherever they are in the world.

This is backed by six state-of-the-art ISO21469-certified production facilities around the world which are compliant to produce food-grade lubricants, as recognised by NSF. This represents a considerable advantage, as the largest alternative supplier has four, while other suppliers each have just one. Working with us not only improves local availability but also reduces supply chain risk.

Another unique Klüber Lubrication benefit derives from our depth of technical knowledge and many decades' experience of working with machine and component OEMs. Accordingly, if a food manufacturer encounters a problem on a machine, yet is reluctant to attempt a fix because it is core to their production, we can work with the machine OEM to approve a new solution, allowing it to be applied without harm or risk to food production continuity.

Additionally, if a suitable product does not already exist, Klüber Lubrication is unique in possessing R&D capacity to develop a solution together with the customer; one that completely meets their requirements.

Food manufacturers, like any other business, are under increasing pressure from their shareholders, customers and staff to demonstrate sustainable practices. Our products contribute to increased sustainability through facilitating lower lubricant consumption and

waste generation. KlüberEnergy services also help reduce energy consumption and greenhouse gas emissions. Additionally, new lubricant technologies allow a reduction in water consumption. Overall, Klüber Lubrication's specialists always seek to reduce the amount of lubricant needed in their customers' food processes through optimising their performance and application. This reduction is achievable only through innovative high-performance lubricants, formulated by combining our tribological know-how with the mechanical and design expertise of our customers and partners such as OEMs and lubrication system manufacturers.

## Summary

Food manufacturers of all types and sizes worldwide need to lubricate their production equipment hygienically and effectively to avoid risk of food contamination from lubricants or wear particles causing safety issues and brand reputation damage.

Yet finding the right lubricants is challenging, because additives essential to protecting machine performance and reliability in different applications can contain polluting MOH hydrocarbons, or synthetic analogues which are indistinguishable from them through analysis. Simply buying lubricants from a stockist is not a solution that will reliably protect the food manufacturer and their machinery, products, staff, and consumers.

Conversely, our consultative, cooperative, project-driven approach delivers the desired solutions. Our unique step-by-step process and insightful analyses help customers identify root causes and implement optimal solutions providing the high-performance protection they need.

Klüber Lubrication's problem-solving project capability is facilitated by our global expert presence, in-depth technical knowledge, long-standing relationships with food machinery OEMs, and R&D resources. Above all, though, the company is motivated to help its customers find sustainable solutions, rather than simply sell products.

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