

LUBES'N'GREASES

HELPING YOU NAVIGATE THE LUBRICANTS INDUSTRY

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REGULATIONS

**PERFORMANCE
DEMANDS**

By Trevor Gauntlett

SURVIVING THE VISE OF CHEMICAL REGULATIONS

Are we close to the long-anticipated point where chemical safety laws and market expectations become incompatible at an accessible cost? Lubricant formulators discuss how they cope with the squeeze.

Chemical regulation has been a significant driver for change in lubricant formulations for most of this century. The list of chemistries that are no longer the “go-to” solutions they were in the late 20th century includes:

- Nonylphenols or their derivatives that were used to stabilize detergent micelles or as emulsifiers in soluble metalworking lubricants;
 - Certain isomers of tricresyl phosphate used as extreme pressure additives;
 - Short-chain chlorinated paraffins, then their medium-chain analogues, which have been shown to be carcinogenic, used in cutting oils.
 - Phthalate esters used in compressor lubricants, now classified as reproductive toxins.
- Sometimes hazard classifications can lead to a ban on the substances themselves. In other

instances the hazard labels for finished formulations based on these components are deemed unacceptable for the markets into which these formulations are supplied. Consumers in many markets don’t expect a hazard classification on a lubricant bottle, so it becomes a differentiator in a purchasing decision. Business customers may not want to receive classified products to protect the health of employees.

Regulations Squeeze

The United Nation’s Globally Harmonised System of Classification and Labeling of Chemicals has removed in the past decade some of the anomalies that existed between national regulatory systems, so the same formulation receives broadly the same classification in most countries in the world.

However, there are limitations. Fewer than 100

countries have implemented GHS, and its “toolbox” or “building block” approach can lead to different requirements for hazard communication for the same product. For example, while safety data sheets in the European Union must address “other hazards” including environmental and endocrine disrupting properties, the United States Occupational Safety and Health Administration’s Hazard Communication Standard focuses on workplace safety and excludes environmental considerations.

The European Union’s landmark REACH regulation, Registration, Evaluation and Authorization of Chemicals, was finalized in 2018 when every chemical manufactured in or imported into the bloc at greater than one ton per annum had to at least be registered. Analysis of the dossier of health and environmental information led to a classification, which since 2015 has used the GHS. Since then, new data, new understanding of cooperative effects of some chemical types and changes to tolerances have led to formulated products receiving ever more restrictive classifications.

REACH was intended to use market forces to encourage innovation. The logic was that downstream users would want lower hazard labels on the products they were using, so upstream formulators and/or manufacturers would seek alternative, lower hazard classification options.

But the cost of registering is substantial and increases further if data are required for authorization. This leads many to ask whether the regulation is stifling new product introduction. Indeed, a straw poll of industry

professionals approached for this article could think of no examples of new molecules targeted at the lubricants market being registered between June 1, 2018 — the final REACH deadline for registration of “phase-in” substances manufactured or imported in quantities of at least 1 metric ton per year — and mid-2025.

But formulating options are being removed. And one of the most serious situations for those supplying into or formulating in the lubricants market is when a widely used chemical or group of chemicals becomes classified as a substance of very high concern.

“The European Chemicals Agency defines SVHCs [substances of very high concern] as substances that can have very serious and often irreversible effects on human health and the environment,” said Sarah Huettner, product manager and category manager for products for food manufacturing at Setral Chemie, based in Romanswiller, France. “An inclusion on the candidate list means that suppliers face a complex and costly set of communication and other requirements if the concentration of the SVHC is 0.1% by weight or higher.”

Among the costs incurred by marketers of formulations that include substances of very high concern above threshold concentration are:

- re-writing material safety data sheets;
- higher transport costs due to special packaging and transport of dangerous goods;
- notifying ECHA of affected products;
- notifying downstream users and

consumers that the formulation contains a substance of very high concern;

- supplying safe use instructions for all downstream users.

Tightening Vice

The misalignment of rules on labeling for human health, the environment and worker safety with requirements for transport are not the only examples of conflicting regulation. Huettner and Kuhlmann presented at a session titled “Finding Replacement Chemistries” at the Lubricant Expo in Dusseldorf in September from the perspective of, respectively a formulator with and supplier of O,O,O-triphenyl phosphorothionate (TPPT).

Kuhlmann described how in the 1960s TPPT became one of the most preferred molecules to replace tricresyl phosphate as an extreme pressure and anti-wear additive after TCP was linked to neurotoxicological side effects. These were later shown to be associated with a single isomer, which could be removed. Hence, TCP is still used in some aviation turbine oils with effectively 0% of the toxic isomer. By that time, though, most players had moved to similar molecules with a lower known health impact.

The writing was on the wall for TPPT in the mid-2010s when the chemically similar molecule triisopropylphenyl phosphate (TiPP) was flagged as a potential carcinogen, mutagen or reprotoxin. TPPT was selected for re-assessment in 2024, due to concerns that it may be persistent, bioaccumulative and toxic, and it received a substance of very high concern classification with the REACH update of January 2025.

Huettner highlighted another significant non-alignment, noting that TPPT has been designated safe for use in lubricants that may have incidental contact with foods and beverages — a standard originally developed by the U.S. Department of Agriculture and now administered by private companies such as U.S.-based NSF, which names the category HX-1. “Since

“We are constantly monitoring ongoing regulatory landscape to be fast and agile in handling the next regulatory updates to come.”

— Sarah Huettner, Setral Chemie

there is no direct connection of HX-1 status and the concerns about human health and environment under the different chemical regulations worldwide, the future HX-1 status of TPPT remains uncertain," she said.

With a combination of certainty on formulations for mainstream lubricant applications and uncertainty around incidental food contact lubricants, both companies moved to develop alternatives.

Substitution

Costs of research and development followed by REACH registration of new chemistry is often considered to be too high to justify by projected sales, so many formulators instead seek to re-purpose existing chemistry, which removes the registration cost. (See "Innovation is More than New Molecules," *Lubes'n'Greases*, October 2024.)

However, the R&D costs of incorporating new, lower-hazard chemistry into lubricant formulations can still be significant. A robust screening program is required to ensure only the most suitable candidates are tested, as downstream users could require bench, rig or engine tests to ensure that original equipment manufacturer approvals and customer specifications are satisfied.

Metall-Chemie's first approach to the issues around TPPT followed the evolutionary logic that has driven this type of substitution in the past: modify the molecule so that it has a less severe hazard assessment. They found a candidate that met those criteria that was also ashless, liquid at room temperature (TPPT is a solid), thermally stable to higher temperatures than TPPT and low in both sulfur and phosphorus.

When screening using a Seta-Shell 4-ball rig (as used in ASTM D2783 for lubricants), the candidate gave comparable or better extreme pressure performance than TPPT and other phosphorus or sulfur-phosphorus alternatives when weld load was considered. However, when it came to

anti-wear performance, measuring the wear scar in a four ball test (modified ASTM D4172), the new candidate was not a good performer.

Synergies

This prompted a new approach from the Metall-Chemie team. "We first reviewed the PBT [environmental persistence, bioaccumulativity and toxicity] profiles of different classes of sulfur/phosphorus- or phosphorus-based species," said Kuhlmann. Then they created a series of mixtures of sulfur and phosphorus compounds with a low health, safety and environmental profile and screened for both extreme pressure and anti-wear performance using Design of Experiments protocols to minimize the number of experiments across chemical species and concentrations.

After screening for both extreme pressure and anti-wear performance, a blend of components was identified that showed improved performance and has a comparable or better HSE profile than many of the original substitutes for TPPT. That blend is now available in Metall-Chemie's portfolio. "The learning for us was that regulatory drivers can act as catalysts for innovation," said Kuhlmann. "By carrying out systematic reviews of REACH registration data by molecular class we gained insights into structure-property correlations. Coupling those insights with Design of Experiments enables discovery of sustainable chemical solutions."

Meanwhile Setral's formulators began investigating adapted formulation options to replace TPPT in a wide portfolio of specialty products. "Our products range from gearbox oils to chain oils, greases and pastes for diverse industries," explained Huettner. They are based on a wide range of base fluids, including PAGs, PAOs, mineral oils, perfluoropolyethers and silicones, which interact slightly differently with the performance additives in the blend.

"It is essential to carefully evaluate the performance requirements," she

added. "For example, products intended for use in the food industry must be modified in such a way that their H1 suitability is not affected. Even though TPPT is only one additive for enhancing EP/AW performance, the entire system needs to be evaluated."

In a classic example of less being more, Setral's formulators "were able to improve the EP/AW performance of the specialty lubricants after removing TPPT and create a series of modified formulations for hydraulic oil, gearbox oil, chain oil and grease," Huettner said. She reported some of the successes at the Lubricant Expo. "We successfully adapted multiple formulations already available on the market."

With the new formulations in place, she concluded, "We are constantly monitoring ongoing regulatory landscape to be fast and agile in handling the next regulatory updates to come. We take this regulatory turbulent environment as an occasion to drive technical progress of our products and create future-proof products."

Cliffhanger

So, at least in the short term, the vice of regulations has not yet closed on lubricant formulations. A scenario reminiscent of the cliffhanger endings to the 1960s American TV version of Batman has been averted by the ingenuity of formulators. But how long can it continue? The catchphrase of the TV series was "tune in tomorrow, same time, same channel." That may sound too immediate, for the challenge that chemical regulations pose to the lubes industry, but this certainly seems a subject to which we shall inevitably return. ♦



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