Product stewardship summary: Phenates

Introduction

At Chevron Oronite, we foster a culture grounded in operational excellence and are committed to protecting people and the environment. This Product Stewardship Summary is an example of that commitment.

The metallic salts of alkyl phenol sulfides, commonly referred to as "phenates," belong to the class of lubricating oil additives known as detergents. Unlike household detergents, these detergents are specifically designed to be soluble in oil, and insoluble in water.

Detergents are critical components of an engine's lubricating oil, providing protection to machines such as lawn mowers, automobiles, or massive two-story marine diesel engines. These machines must be powered and protected by fuels and lubricants enhanced with the most technologically advanced additives to perform their everyday functions as expected.

Detergents provide a means for dissolving otherwise insoluble metallic salts, like calcium or magnesium carbonate, into lubricating oil. These salts have a key function to neutralize corrosive combustion acids that would otherwise corrode key metal parts of the engine.

Detergents also prevent the buildup of harmful deposits on the rings and in the grooves of the engine pistons. These deposits can cause the rings of the piston to stick, causing potentially catastrophic wear to liners, which leads to loss of engine compression (power), poor emissions quality and fuel economy, and eventually engine failure.

Description and Properties

Phenates are a specific class of detergents that, in addition to fulfilling the general purpose of the detergent, also contain sulfur. Sulfur provides oxidation protection to the oil, preventing oil viscosity increase which can impede the oil's ability to lubricate. The chemical structure of a phenate contains four critical moieties: a hydrocarbon tail, a linking group, metallic carbonate, and a sulfur bridge.

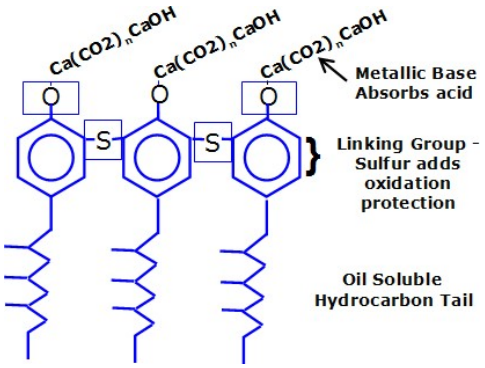

Figure 1. The chemical structure of a phenate

This summary is based on information as of June 2020

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The hydrocarbon tail, a low molecular weight polymer derived from ethylene or propylene, allows the phenate to dissolve in lubricating oil. The linking group connects the hydrocarbon tail to the metallic salt. For phenates, the linking group is phenol from which the generic name phenate is derived. In a first step, the olefin is reacted with the phenol. The alkylphenol containing four repeating propylene units is known as tetrapropenyl phenol (TPP). Due to the human health and ecological hazards of this chemical, TPP-free phenates are being developed.

The product, an alkyl phenol, is further converted into phenate in a reaction with sulfur, a metal oxide or hydroxide, and carbon dioxide in the presence of a glycol catalyst. The metallic carbonate performs the function for which the detergent was designed, and sulfur links the phenates together into a larger polymeric molecule to aid oil solubility, but also to impart other beneficial properties to the detergent molecule.

At ambient temperature, phenates appear as a highly viscous, water insoluble, almost black liquid with no appreciable odor. When phenates are heated, they may give off the faint odor reminiscent of burning tires, but this is generally not detected in the applications for which they are intended.

Health Information

Studies of phenates by the dermal, oral and inhalation routes of exposure indicate that these substances are relatively low in acute toxicity by all three routes of exposure. Exposure via inhalation to the highest vapor concentration attainable did not cause any deaths or signs of systemic toxicity.

Studies indicate that these substances are not irritating to the skin or to the eyes. Studies have not shown any evidence of skin sensitization.

Repeated-dose toxicity studies with phenates demonstrated that none of the tested substances caused systemic toxicity. Toxicity studies conducted by oral exposure demonstrate that phenates do not cause developmental malformations. Signs of systemic toxicity occur only at very high dose levels that are much greater than typical human exposure.

In studies, TPP and its calcium salt caused a reduction in fertility, a reduction in number of offspring and a reduction in the size of reproductive organs. An experimental campaign aimed at measuring inhalation and dermal exposure to TPP was conducted by TPP-based phenates manufacturers in 2016. The empirical data was collected at one manufacturing plant, two plants that formulate phenates into additive packages, and at a professional garage, and show that the risk is adequately managed.

The phenate molecule is not a reproductive hazard based on test data, but depending on the phenate, the residual alkylphenol may cause reproductive toxicity, specifically those made from TPP.

Toxicity studies conducted on TPP and its calcium salt found a reduction in fertility, a reduction in the number of offspring, and a reduction in the size of reproductive organs. Observations of these effects were dependent upon the concentration of residual TPP.

Environmental Information

Phenates are not expected to be degraded by hydrolysis, photolysis, or oxidation, based on their chemistry, computational modeling and test data. They are expected to have limited biodegradation. Additional modeling predicts that these chemicals are likely to partition into soil and sediment. Based on both modeling and actual testing, phenates are unlikely to bioaccumulate in the environment. Phenates are not toxic to aquatic organisms. These substances are not expected to inhibit wastewater treatment plant microorganisms at typical discharge rates.

In the event of a spill of a product containing phenate, stop the source of the release if it can be done safely. Refer to Safety Data Sheet for spill response and clean-up procedures. Report spills to local authorities. For USA, call National Response Center at 1-800-424-8802.

Regulatory Information

Requirements may exist that govern the manufacture, importation, sale, transportation, use and/or disposal of phenate or products containing them. These requirements may vary by jurisdiction. For more information, consult Safety Data Sheet.

Exposure Potential

The low volatility and low water solubility of phenates limit the potential for exposure, and therefore the risk, to people in the workplace and consumers. Indirect exposure to these chemicals via the environment is likely to be negligible.

Manufacturing of phenate generally occurs in dedicated closed systems with proper engineering controls, thereby minimizing exposure. Solid waste is either incinerated or recycled. Therefore, there is no significant release to the environment. Wastewater is treated before it is released. Workers in manufacturing plants, including those completing sample analysis, blending, maintenance and cleaning are well trained in their operations and wear appropriate personal protection equipment. Professional mechanics, service station attendants, and other skilled workers wear personal protective equipment and use hygiene practices that reduce exposure to the oil. Consumer exposure may occur while working around engines, but this is likely to be infrequent. In summary, there is minimal potential for exposure to phenate to the consumer.

Responsible Care Contact Information
Chevron Oronite Company LLC
6001 Bollinger Canyon Road
San Ramon, CA 94583