# The Basics of Food-Grade Lubricants

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# The Basics of Food-Grade Lubricants

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The food processing industry presents unique challenges to lubricant formulation engineers, lubricant marketers, plant lubrication engineers and equipment designers. While it is never desirable for lubricants to be allowed to contaminate raw materials, work-in-progress or finished product, the consequences of a lubricant-contaminated product are rarely more acute than in the food processing industry. As such, lubricants used in this industry have requirements, protocols and performance expectations that go well beyond typical industrial lubricants. This article will identify the basic differences between H1, H2 and H3 lubricants, their requirements and formulations, as well as proper lubricant selection, which is critical to food safety and machine reliability.

**Costly Consequences**

While it is never desirable for lubricants to be allowed to contaminate produced goods, the consequences of lubricant contamination are rarely more acute than in the food industry.

While few recalls occur due to lubricants, they can be costly when they do occur. Some case histories have been documented.

1. In 1996, a total of 4,740 pounds of turkey sausage was recalled by Jennie-O Foods because the product had been contaminated with grease. One year later, only 31 pounds were recalled.[1]

2. In 1998, more than 490,000 pounds of smoked boneless hams were recalled by Smithfield Foods because they were contaminated by a gear lubricant after several customers reported a "bad taste" and "burning in the throat for up to three hours" from eating the ham.[2]

3. In 2000, 86,000 pounds of sliced and packaged turkey products (mostly deli meats) were voluntarily recalled from exposure to a non-food-grade lubricant. Consumers reported off-odor and off-flavor product. A few experienced "temporary intestinal discomfort."[2]

4. On September 1, 2000, the Stoke-on-Trent City Council in the United Kingdom confirmed that tests on a can of baby food revealed a toxic substance. The investigations indicated that a can of Heinz Cheesy Parsnip and Potato Bake was contaminated with mineral oil lubricant, possibly from a machine in the manufacturing process or from the can manufacturing process. A mother complained that the food smelled of tar and alerted the environmental health officials.[2]

5. In November 2002, a shipment of soft drinks was recalled because of lubricant contamination. The product was "Big Thirst", five flavors in 1.25-liter bottles, distributed through NQR Grocery Clearance Stores in Victoria, Australia. Food Standards Australia indicated that the lubricant may cause irritation if consumed.[2]

6. In 2002, Arinco, a manufacturer of milk powder at Vidabaek, Denmark, found contamination in its product. A total of 1,100 tons of milk powder manufactured between January 3 and June 28, 2002, were contaminated by one-half to three-quarters of a liter of lubricating oil containing very fine iron particles. This was discovered when a customer in Thailand complained that the milk powder had a pale gray tint. This was traced back to a packaging plant, to a worn axle in a gearbox. This allowed oil to seep out through a ball joint and into the powdered milk.[2]

**Brief History**
In the United States, the two government agencies primarily involved in food processing historically were the U.S. Department of Agriculture (USDA) and the U.S. Food and Drug Administration (FDA). Prior to 1998, approval and compliance of food-grade lubricants was the responsibility of the USDA. The USDA reviewed the formulations of maintenance and operating chemicals.

To gain USDA approval, lubricant manufacturers had to prove that all of the ingredients in the formulation were allowable substances in accordance with the Guidelines of Security Code of Federal Regulations (CFR) Title 21, §178.3570. This did not include lubricant testing; rather, the approval was based primarily on a review of the formulation ingredients of the lubricant.3

Starting February 1998, the USDA significantly altered its program requiring the manufacturer to assess risk at each point in the operation where contamination might occur.
In essence, the manufacturer became responsible for reviewing and approving the chemical compositions of lubricants to decide whether they were safe as food-grade lubricants.5

In response to industry need, third-party groups emerged to manage the lubricant certification needs. Currently, in the United States as well as in other countries, the National Sanitation Foundation (NSF) manages a lubricant evaluation program that essentially mirrors the USDA plan. Each component in the formulation is submitted to NSF by the lubricant manufacturer along with other supporting documentation. This is then reviewed to verify it is within the FDA list of permitted substances.4 NSF's Web site (www.nsf.org) provides food processing manufacturers with a continually updated list of approved lubricants at www.nsfwhitebook.org.

NSF is not the only organization working this area. A joint effort by three recognized industry professional associations – the National Lubricating Grease Institute (NLGI), the European Lubricating Grease Institute (ELGI) and the European Hygienic Equipment Design Group (EHEDG) – developed a Joint Food-Grade Lubricants Working Group. This group has been active in drafting an authorization program for food-grade lubricants and developed DIN V 0010517, 2000-08 (Food-Grade Lubricants – Definitions and Requirements). There have been plans to use the DIN standard to develop an ISO (International Standards Organization) standard.

**Challenges Facing Food-Grade Lubricants**
The food processing industry poses unique lubrication challenges. Large-scale food processing requires machinery such as pumps, mixers, tanks, hoses and pipes, chain drives, and conveyor belts. Machinery used in food processing facilities face many of the same tribological and lubrication challenges found in other non-food processing plants. Lubricants must offer similar protection of internal surfaces to control friction, wear, corrosion, heat and deposits. They must also offer good pumpability, oxidation stability, hydrolytic stability and thermal stability where the application requires. In addition, certain applications within the food and drug manufacturing facilities demand that lubricants resist degradation and impaired performance when in contact with food products, certain process chemicals, water (including steam) and bacteria.

Unfortunately, many of the raw materials used to formulate lubricants that effectively address these challenges in conventional industrial applications are not permissible in food applications for safety reasons.

**Food-Grade Categoriesand Definitions**
Food-grade lubricants are lubricants acceptable for use in meat, poultry and other food processing equipment, applications and plants. The lubricant types in food-grade applications are broken into categories based on the likelihood they will contact food. The USDA created the original food-grade designations H1, H2 and H3, which is the current terminology used. The approval and registration of a new lubricant into one of these categories depends on the ingredients used in the formulation. The three designations are described as follows:[3]

**H1 lubricants** are food-grade lubricants used in food processing environments where there is some possibility of incidental food contact. Lubricant formulations may only be composed of one or more approved basestocks, additives and thickeners (if grease) listed in 21 CFR 178.3750.

**H2 lubricants** are lubricants used on equipment and machine parts in locations where there is no possibility that the lubricant or lubricated surface contacts food. Because there is not the risk of contacting food, H2 lubricants do not have a defined list of acceptable ingredients. They cannot, however, contain intentionally heavy metals such as antimony, arsenic, cadmium, lead, mercury or selenium. Also, the ingredients must not include substances that are carcinogens, mutagens, teratogens or mineral acids.[4]

**H3 lubricants**, also known as soluble or edible oil, are used to clean and prevent rust on hooks, trolleys and similar equipment.

### Approved Lubricants

As previously mentioned, the USDA approvals are based on the various FDA Codes in Title 21 that dictate approval for ingredients used
in lubricants that may have incidental contact with food. These are mentioned in the following sections.

- 21.CFR 178.3570 – Allowed ingredients for the manufacture of H1 lubricants
- 21.CFR 178.3620 – White mineral oil as a component of non-food articles intended for use in contact with food
- 21.CFR 172.878 – USP mineral oil for direct contact with food
- 21 CFR 172.882 – Synthetic isoparaffinic hydrocarbons
- 21.CFR 182 – Substances generally recognized as safe

Some information from these standards is highlighted below.

### Acceptable Food-Grade Basestocks

Depending on whether a food-grade lubricant is H1 or H2, the list of approved basestocks will vary. H2 lubricant basestock guidelines are less restrictive and, consequently, allow a broader variety of basestocks. Many products used in industrial (non-food) plants are also used in food plants for H2 applications. H1 lubricants are much more limited since they are designed to allow for accidental exposure with the processed foods. H1-approved lubricant basestocks can be either mineral or synthetic:

**Petroleum-based lubricants –** Mineral oils used in H1 food-grade lubricants are either technical white mineral or USP-type white mineral oils. They are highly refined and are colorless, tasteless, odorless and non-staining. Technical white oils meet the regulations specified in 21 CFR 178.3620. USP mineral oils are the most highly refined of all white mineral oils.6

**Synthetic lubricants –** Synthetic H1 lubricant basestocks are often polyalphaolefins (PAO). Compared to white mineral oils, they have significantly greater oxidation stability and greater range of operating temperatures. Another approved H1 synthetic basestock is polyalkylene glycols (PAG). These lubricants are more increasingly used in high-temperature applications.

Dimethylpolysiloxane (silicones) with a viscosity greater than 300 centistokes (cSt)7 is also permitted for H1 lubricants. Silicones have even higher thermal and oxidation stability than PAO and PAG base oils.

### Acceptable Food-Grade Additives and Thickeners

Often, basestocks are not able to meet the severe demands required in food processing work environments. To improve the performance characteristics of base oils, additives are blended into the formulation. The types of antioxidants, corrosion inhibitors, anti-wear, extreme pressure additives and concentration are limited by 21 CFR 178.3570.

Greases are lubricating oils that have a thickening agent added to the formulation. Among approved grease thickeners are aluminum stearate, aluminum complex, organo clay and polyurea. Aluminum complex is the most common H1 grease thickener. They can withstand high temperatures and are water resistant, which are important properties for food processing applications. Greases with calcium sulfonate thickeners have not been explored for approval by the USDA or FDA, but have been approved in Canada for incidental contact.[8]

### Selecting Which Machines Require Food-Grade Lubricants

Selecting whether to use an H1 or H2 lubricant can be challenging. A lubricant used on a conveyor system running over a food line must be an H1 category oil; however, a conveyor system running underneath a food line may not necessarily be safe to use an H2 oil.

According to the Hazard Analysis and Critical Control Point (HACCP) program implemented by the USDA, each lubrication point has to be evaluated for where contamination might occur. Most major food-producing companies have begun using the HACCP system, but their plans don't always recognize the importance of a lubrication survey. A number of lubricant suppliers offer to assist with the lubrication survey portion.

Because H1 lubricants are limited by types of additives and in the past only used mineral oil basestocks, H1 lubricants in certain instances provided less protection and shorter lubricant life. Now that synthetics are used, some H1 lubricant performance can exceed non-food-grade lubricants. This is significant in allowing consolidation and avoiding accidental cross-contamination of H1 and H2 oils and contamination of H2 oils with food.

### Other Issues Surrounding Food-Grade Lubricants

Using H1 food-grade lubricants is no replacement to sound design and maintenance. H1 lubricants are still only approved for minimal, incidental contact. If a plant uses food-grade lubricants, the FDA limits lubrication contamination to 10 parts per million – that's 0.001 percent.
Also, the lubricant certification process does not include lubricant plant audits and sample testing to ensure formulation; it is strictly comparing the formulation to the approved list. Richard Pinchin, formerly with Shell International and a supporter of a more rigorous certification process, indicated at an NLGI meeting: "I know of five instances in the last three years where food-grade claims are not justified."[1]

### Conclusion

Understanding the differences between H1, H2 and H3 lubricants and making the proper lubricant selection is critical to food safety and machine reliability. As an additional source, NSF's Web site provides lubricant requirements for food-grade products and gives a free access listing of certified food-grade lubricants at www.nsf.org/usda/psnclistings.asp.

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## About JAX

JAX has been at the forefront of food and beverage plant lubrication since the inception of true USDA food-grade lubricants nearly 50 years ago. JAX was first with a registered food-grade grease at the birth of commercial food-grade lubricants, and we continue to be a driving, innovative force in lubrication for food processors today.

Since that time JAX has developed nearly 200 NSF-registered products for use as lubricants in food-processing environments. We continue to develop high-performance products to help you get the most from your machinery.

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