

FOOD GRADE LUBRICANT COMPOSITIONS

TECHNICAL FIELD

[001] The embodiments described herein relate to food grade lubricant compositions and in particular to lubricant compositions that exhibit improved sludge control properties compared to conventional food grade lubricants.

BACKGROUND

[002] The equipment used in the food processing industry varies by segment with the three leading segments comprising meat and poultry, beverages, and dairy. While the equipment varies from segment to segment, the moving parts such as bearings, gears, and slide mechanisms are similar and often require lubrication. The lubricants most often used include hydraulic, refrigeration, and gear oils as well as all-purpose greases. However, food industry oils must meet more stringent standards than other industry lubricants.

[003] Lubricant contamination has been a problem in the food and beverage processing industry, where a major accident could require a company to make a massive product recall, which could be devastating to its reputation.

[004] Minor lubricant leaks in machinery are common, sometimes unavoidable, and not always obvious. Just the normal wear and tear on seals can cause a gearbox or hydraulic system to leak, releasing minute levels of oil that can come into contact with food. Contamination can also come from drips from chains or a release of compressed air that contains an oily mist.

[005] If a plant uses a nonfood-grade lubricant, the U.S. Food and Drug Administration (FDA) allows zero amounts of lubricant to come into contact with the food. If the lubricant accidentally comes into contact with food, the batch must be discarded. If the plant uses food-grade lubricants, which are nontoxic, odorless, colorless and tasteless, the FDA limits lubrication contamination to 10 parts per million.

[006] The Food Safety and Inspection Service (FSIS) is custodian of the official list of authorized compounds for use in federally inspected plants. The official list states that lubricants and other substances which are susceptible to incidental food contact are considered indirect food additives under USDA regulations. Therefore, these lubricants, classified as either H-1 or H-2, are required to be approved by the USDA before being used in food processing plants. The most stringent classification, H-1, is

for lubricants approved for incidental food contact. Lubricants meeting the H-1 classification are used where food may potentially be exposed to the lubricated part of the machine. The H-2 classification is for uses where there is no possibility of food contact and assures that no known poisons or carcinogens are used in the lubricant. For the purpose of this disclosure, the terms "food grade" and "lubricant" will be used interchangeably herein.

[007] In addition to meeting the requirements for safety set by federal regulatory agencies, the lubricant must be effective for the particular application and may also be required to meet Kosher and Halal requirements. Lubricating oils for food processing plants should lubricate machine parts, resist viscosity change, resist oxidation, protect against rusting and corrosion, provide wear protection, prevent foaming, and resist the formation of sludge in service. The product should also perform effectively at various lubrication regimes ranging from hydrodynamic thick film regimes to boundary thin film regimes. Lubricants which can meet or exceed DIN 51524 part II specification may meet the foregoing performance criteria. Conventional food grade lubricants contain antiwear agents. Of the antiwear agents used in food grade applications, certain amine salts of acid phosphates may result in increased sludge/varnish formation. It is, therefore, desirable to provide an improved food grade lubricating oil which overcomes the sludge and varnish tendencies of conventional food grade lubricants.

SUMMARY OF THE EMBODIMENTS

[008] In one embodiment herein is presented a food grade lubricant composition including a major amount of food grade base oil and a minor amount of at least one additive composition. The additive composition includes one or more non-sludge promoting wear reducing agents. An advantage of the lubricant composition is that it may exhibit lower sludge formation tendencies than a lubricant composition containing a conventional wear reducing agent.

[009] In another embodiment, there is provided a method of operating machinery for food processing. The method includes providing the machinery with a food grade lubricant containing a major amount of food grade base oil and a minor amount of an additive composition and operating the machinery. The additive composition includes one or more non-sludge promoting wear reducing agents. During operating of the machinery on the lubricant, the lubricant composition may exhibit lower sludge

formation tendencies than a lubricant composition containing a conventional wear reducing agent.

[0010] As set forth briefly above, embodiments of the disclosure may provide an improved food grade lubricant composition that exhibits reduced sludge and/or varnish formation, and meets the wear criteria for food grade lubricants. Other features and advantages of the compositions and methods described herein may be evident by reference to the following detailed description which is intended to exemplify aspects of the embodiments without intending to limit the embodiments described herein.

[0011] It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and are intended to provide further explanation of the embodiments disclosed and claimed.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0012] According to exemplary embodiments described herein, there is provided an improved food grade lubricant composition that may be particularly effective for reducing sludge and varnish formation, and may meet the H-1 and/or H-2 requirements for use in food processing industries. The exemplary food grade lubricants are also suitable for providing good wear protection, suitable protection against rust and corrosion, and good foam and air release properties. As set forth above, the lubricant composition includes a food grade base oil.

[0013] The base oil for use in the food grade lubricating oils described herein may be selected from food grade hydrocarbon oils such as food grade mineral oil, food grade polybutene, food grade hydrogenated polybutene, food grade polyolesters, food grade diesters, food grade hydrogenated poly(alpha olefin) with an alpha olefin monomer of not less than 6 carbon atoms, and a wide variety of vegetable oils. The base oil should be substantially odorless, colorless, and tasteless and comply with the USDA H-1 and/or H-2 specifications and requirements for use in food processing plants and other applications.

[0014] In one exemplary embodiment, the base oil may be a mineral oil such as a technical grade white oil made from select lubricant base stocks. The food grade mineral oil may also be a white mineral oil which meets the more stringent requirements of the United States Pharmacopeia (USP) or a light mineral oil which meets the more stringent requirements of the National Formulary (NF). These food

grade mineral oils are often directly derived from crude oil through the processing steps of distillation, extraction, dewaxing, and severe hydrotreating. Suitable base oils, derived from other means are food grade polybutene, food grade hydrotreated polybutene, food grade polyolesters, food grade diesters, and food grade hydrogenated poly(alpha olefin) with an alpha olefin monomer of not less than 6 carbon atoms.

[0015] Vegetable oils may also be used as the base oil component, either alone or in combination with the foregoing oils. Suitable vegetable oils may include, but are not limited to, rapeseed oil, jojoba oil, tung oil, castor oil, tall oil, linseed oil, olive oil, peanut oil, rope oil, coconut oil, soybean oil and mixtures thereof. Oils derived from meat products, such as lard oil, tallow oil, mink oil, and the like are avoided for lubricant applications meeting Kosher and/or Halal requirements.

[0016] The base oil comprises from about 85.0% to 99.9% by weight of the lubricant composition containing additives to provide a product having a viscosity ranging from 10 cSt at 40° C. to 1000 cSt at 40° C. The additives used may suitably meet the HX-1 criteria for providing H-1 food grade lubricant compositions and may meet the HX-2 criteria for providing H-2 food grade lubricant compositions.

ANTI-WEAR ADDITIVES

[0017] Anti-wear additives which may be used in the compositions described herein include food grade oil-soluble sulfur and/or phosphorus containing compounds and neutralized alkyl phosphate esters, and mixtures of the foregoing.

[0018] One sulfur and/or phosphorus compound that may be used is triphenyl phosphorothioate. Other sulfur and/or phosphorus containing materials which are not currently approved for food grade use include: zinc dialkyl dithiophosphate, zinc dithiocarbamate, amine dithiocarbamate, and methylene bis dithiocarbamate. Any of the above compounds, with HX-1 approval, would be a suitable anti-wear additive.

[0019] A suitable neutralized alkyl phosphate ester component may include a component containing a mixture of mono- and di-C₄-C₈-alkyl phosphate esters and/or polyphosphate esters that have been neutralized with a non-branched chain amine. The non-branched chain amines may be selected from tetramethylnonylamines, C₁₁-C₁₄ alkylamines, and the like.

[0020] The food grade lubricant may contain from about 0.1 to about 0.5 of the anti-wear additive based on a total weight of the lubricant composition. For a food grade lubricant containing the triphenyl phosphorothioate component and the neutralized

alkyl phosphate ester wear reducing agents, the anti-wear additive component of the composition may include from about 0 wt. % to about 50 wt.% of the triphenyl phosphorothioate component and from about 35 wt.% to about 100 wt.% of the neutralized alkyl phosphate ester component.

[0021] A criteria for the anti-wear additive is that the additive be a non-sludge promoting antiwear additive. Conventional antiwear additives typically include a neutralized dialkyl phosphate that have been neutralized with a C₁₂-C₁₄ t-alkyl primary amine. Surprisingly, food grade lubricants containing antiwear additives that have not be neutralized with a branched alkyl amine exhibit reduced sludge/varnish formation tendencies compared to the same lubricants containing an anti-wear additive that is neutralized with a C₁₂-C₁₄ t-alkyl primary amine.

ANTI-OXIDANT ADDITIVES

[0022] Antioxidation additives that may be used as a component of the food grade lubricant composition include phenolic and amine antioxidants and mixtures thereof.

[0023] The phenolic antioxidants which may be include, but are not limited to, food grade, oil-soluble, sterically hindered phenols and thiophenols. Included within the definition of phenolic and thiophenolic antioxidants are sterically hindered phenolics such as hindered phenols and bis-phenols, hindered 4,4'-thiobisphenols, hindered 4-hydroxy-and 4-thiolbenzoic acid esters and dithio esters, and hindered bis(4-hydroxy-and 4-thiolbenzoic acid and dithio acid) alkylene esters. The phenolic moiety may be substituted in both positions ortho to the hydroxy or thiol groups with alkyl groups which sterically hinder these groups. Such alkyl substituents usually have 3 to 10 carbons, suitably 4 to 8 carbons, with one alkyl group generally being branched rather than straight-chain (e.g., t-butyl, t-amyl, etc.).

[0024] The first group of hindered phenolic antioxidants is the single hindered phenols. Examples of such compounds include 2,6-bi-tert-butylphenol, 2,6-di-tert-butyl-p-cresol, 2,6-di-tert-amyl-p-cresol, and 2-tert-butyl-6-tert-amyl-p-cresol.

[0025] A second group of hindered phenolic antioxidants is the hindered bisphenols. Examples of these compounds include 4,4'-methylene bis(2,6-bi-tert-butylphenol), 4,4'-dimethylene bis(2,6-di-tert-butyl phenol), 4,4'-trimethylene bis(2,2-di-tert-amyl phenol), and 4,4'-trimethylene bis(2,6-di-tert-butyl phenol).

[0026] Another group of hindered phenolic antioxidants is the hindered 4,4'-thio bis-phenols. Examples of these compounds include 4,4'-thio bis(2,6-di-sec-butyl phenol),

4,4'-thio bis(2-tert-butyl-6-isopropyl phenol), and 4,4'-thio bis(2-methyl-6-t-butyl phenol).

[0027] A fourth group of hindered phenolic antioxidants is 4 alkoxy phenols. Examples of these compounds include butylated hydroxy anisole, butylated hydroxy phenetole, and butylated hydroquinone. Any of the above compounds, with HX-1 approval, would be a suitable phenolic antioxidant.

[0028] Butylated hydroxy toluene (BHT) is cost effective, commercially available, and is HX-1 approved. Butylated hydroxy toluene may be present in the food grade lubricating oil in an amount less than about 1% by weight and most typically is present in an amount ranging from about 0.1 to about 0.6% by weight of the food grade lubricating oil composition. Likewise, the food grade lubricant composition may contain less than 1% by weight of the phenolic antioxidant.

[0029] Suitable food grade, oil-soluble aromatic amine antioxidants are naphthyl phenyl amines, alkylated phenyl naphthyl amines, and alkylated diphenyl amines. Examples of aromatic amine antioxidants include, but are not limited to, the naphthylamines such as N-phenyl-alpha-naphthylamine, N-p-methyl-phenyl-alpha-naphthylamine, and the diphenylamines such as di-sec-butyl diphenylamine, di-isobornyl-di-phenylamine, and dioctyl diphenylamine. Any of the above compounds, with HX-1 approval, may be a suitable aromatic amine antioxidant.

[0030] Particularly suitable aromatic amine antioxidants are the alkylated and dialkylated diphenyl amines, for example, the reaction products of the alkylation of n-phenylbenzenamine and 2,4,4 trimethyl pentene. The resultant product of may be a mixture of ortho, meta, and para bis(octyl phenyl)amine. Bis(octyl phenyl)amine may also be referred to as dioctyl diphenyl amine and is a food grade amine. Another suitable food grade diphenyl amine is an octylated, butylated diphenyl amine. The aromatic amine may be present in the lubricant composition in an amount of than about 1% by weight of the lubricating oil composition. A suitable amount of alkylated diphenyl amine may range from about 0.05 to about 0.5 wt.% of the total weight of the lubricant composition.

[0031] The lubricant composition may typically contain only one antioxidant additive. However, combinations of the foregoing antioxidant additives may also be used. When a combination of antioxidant additives is used, the phenolic and aromatic amine antioxidant components may range in ratio by weight from 20:1 to 1:20 although a suitable ratio ranges from 4:1 to 1:1.

ANTI-RUST ADDITIVES

[0032] The anti-rust additive component may include a combination of food grade ionic and non-ionic surface active anti-rust ingredients. The total amount by weight of ionic and non-ionic surface active anti-rust additive necessary to impart the desired degree of rust resistance may be significantly less than either anti-rust additive independently.

[0033] Ionic anti-rust lubricating additives which may be used in the compositions described herein may include food grade phosphoric acid, mono and dihexyl ester compounds with tetramethyl nonyl amines, and C₁₀ to C₁₈ alkyl amines. Any rust inhibitor compound with HX-1 approval would be a suitable anti-rust additive. Likewise, the amine salt of the acid phosphate used as an antiwear additive may also be used for its rust inhibiting properties as a anti-rust additive.

[0034] Non-ionic anti-rust lubricating additives which may be used in the compositions described herein may include food grade fatty acids and their esters formed from the addition of sorbitan, glycerol, or other polyhydric alcohols, or polyalkylene glycols. Other non-ionic anti-rust lubricating additives may include food grade ethers from fatty alcohols alkoxyated with alkylene oxides, or sorbitan alkoxyated with alkylene oxides, or sorbitan esters alkoxyated with alkylene oxides.

[0035] Examples of suitable food grade non-ionic anti-rust lubricating additives include: sorbitan mono-oleate, ethoxylated vegetable oil, isopropyl oleate, ethoxylated fatty acids, ethoxylated fatty alcohols, fatty glyceride esters, polyoxyethylene sorbitan mono-oleate, polyoxyethylene sorbitan, glycerol mono-oleate, glycerol di-oleate, glycerol mono-stearate, and glycerol di-stearate. Any of the above compounds, with HX-1 approval, would be a suitable anti-rust additive.

[0036] The food grade anti-rust additive may comprise less than about 1% by weight of the food grade lubricating oil and may comprise from about 0.01 to about 0.3% by weight of the food grade lubricating oil.

CORROSION INHIBITOR ADDITIVE

[0037] In some embodiments, corrosion inhibitors may constitute another class of additives suitable for inclusion in the compositions described herein. Such compounds include food grade thiazoles, triazoles and thiadiazoles. Examples of such compounds include benzotriazole, tolyltriazole, octyltriazole, decyltriazole, dodecyltriazole, 2-mercapto benzothiazole, 2,5-dimercapto-1,3,4-thiadiazole, 2-mercapto-5-hydrocarbylthio-1,3,4-thiadiazoles, 2-mercapto-5- hydrocarbyldithio-

1,3,4-thiadiazoles, 2,5-bis(hydrocarbylthio)-1,3,4-thiadiazoles, and 2,5-bis(hydrocarbyldithio)-1,3,4-thiadiazoles. Suitable compounds include the 1,3,4-thiadiazoles, a number of which are available as articles of commerce, combinations of triazoles such as tolyltriazole with a 1,3,5-thiadiazole such as a 2,5-bis(alkyldithio)-1,3,4-thiadiazole, and bis-alkyl-arylalkyl benzotriazole alkylamines such as N,N-bis(2-ethyl)ar-methyl-1H-benzotriazole-1-methanamine. The amount of corrosion inhibitor in the food grade formulations described herein may range from about 0.01 to about 0.5 wt% based on the total weight of the lubricant composition.

ANTIFOAM ADDITIVE

[0038] In some embodiments, a foam inhibitor may form another component suitable for use in the food grade compositions. Foam inhibitors may be selected from silicones, polyacrylates, methacrylates, surfactants, and the like meeting the HX-1 approval criteria. The amount of antifoam agent in the food grade formulations described herein may range from about 0.0025 wt% to about 0.01 wt% based on the total weight of the food grade lubricant composition.

PRESERVATIVE ADDITIVES

[0039] Suitable food grade preservatives include, but are not limited to vitamin E (α -tocopherol) and/or C₂-C₆ alkyl hydroxyl benzoates such propyl p-hydroxyl benzoate. The amount of preservative in the lubricant composition may range from about 0.001 to about 0.1 percent by weight of the total weight of the food grade lubricant composition.

[0040] Additives used in formulating the compositions described herein may be blended into the base oil individually or in various sub-combinations. However, it is suitable to blend all of the components concurrently using an additive concentrate (i.e., additives plus a diluent, such as the base oil). The use of an additive concentrate takes advantage of the mutual compatibility afforded by the combination of ingredients when in the form of an additive concentrate. Also, the use of a concentrate reduces blending time and lessens the possibility of blending errors.

[0041] In the following Table 1, the formulations for conventional food grade lubricant compositions (Samples 1-4) and for food grade lubricant compositions according to exemplary embodiments described herein (Samples 5-8) are given. Table 2 compares the results of testing the fluid compositions.

Table 1

Component	Sample 1	Sample 2	Sample 3	Sample 4
Base Oil	90	90	90	90
Antifoam agent	0.0	0.0	0.02	0.02
Conventional Antiwear Agent	0.20	0.15	0.0	0.0
Non-sludge forming Antiwear Agent	0.0	0.0	0.15	0.15
triphenyl phosphorothioate	0.20	0.20	0.20	0.20
vitamin-E	0.01	0.01	0.01	0.01
preservative	0.01	0.01	0.01	0.01
Antioxidant 1		0.20		0.20
Antioxidant 2	0.50		0.50	
Corrosion Inhibitor	0.10	0.10	0.10	0.10
Rust Inhibitor	0.05	0.05	0.05	0.05

Table 2

Test Results	Sample 1	Sample 2	Sample 3	Sample 4
CCMA Test				
sludge wt. (mg/100 ml)	39.11	39.72	9.4	11.68
FZG Scuffing Test	---	---	11 pass	12 pass
4 Ball wear 20 kg/1475 rpm/1hr/ambient	---	---	0.28	0.27
4 Ball wear 20 kg/1475 rpm/1hr/ambient	---	---	0.47	0.46

[0042] As shown in table 2, the fluid compositions according to the disclosure (Samples 3-4) provided relatively low sludge results of less than 15 mg/100 mls in the CCMA test versus a limit of 25 mg/100 mls.

[0043] By comparison, the use of a conventional antiwear agent (Samples 1-2) exhibited sludge results that were much higher than Samples 3-4 and were over 25 mg/100 mls. Beakers containing Samples 1-2 had much more varnish on them than the beakers of Samples 3-4. FZG scuffing and wear data for Samples 3-4 indicated that, even with low sludge, suitable wear protection may be obtained by the formulations of Samples 3-4 containing the non-sludge forming antiwear agent.

[0044] The foregoing embodiments are susceptible to considerable variation in its practice. Accordingly, the embodiments are not intended to be limited to the specific exemplifications set forth hereinabove. Rather, the foregoing embodiments are within the spirit and scope of the appended claims, including the equivalents thereof available as a matter of law.

[0045] The patentees do not intend to dedicate any disclosed embodiments to the public, and to the extent any disclosed modifications or alterations may not literally fall within the scope of the claims, they are considered to be part hereof under the doctrine of equivalents.

What is claimed is:

1. A food grade lubricant composition comprising:
a major amount of food grade base oil and a minor amount of at least one additive composition comprising one or more non-sludge promoting wear reducing agents, wherein the lubricant composition exhibits lower sludge formation tendencies than a lubricant composition containing a conventional wear reducing agent.
2. The food grade lubricant composition of claim 1, wherein the one or more non-sludge promoting wear reducing agents are selected from the group consisting of triphenyl phosphorothionates, amine neutralized phosphoric acid esters, and mixtures thereof, wherein the amine is a non-branched chain amine.
3. The food grade lubricant composition of claim 1, wherein the food grade base oil comprises an oil selected from the group consisting of white oil, vegetable oils, and mixtures thereof.
4. The food grade lubricant composition of claim 1, wherein the additive further comprises at least one antioxidant selected from the group consisting of amine antioxidants, phenolic antioxidants, and mixtures thereof.
5. The food grade lubricant composition of claim 1, wherein the wear reducing agent comprises a mixture of triphenyl phosphorothionate and an amine neutralized phosphoric acid esters, wherein the amine is a non-branched chain amine.
6. The food grade lubricant composition of claim 1, wherein the additive composition further comprises a methacrylate antifoam agent.
7. The food grade lubricant composition of claim 1, further comprising a component selected from the group consisting of a preservative, a corrosion inhibitor, and a rust inhibitor.
8. The food grade lubricant composition of claim 1, wherein the major amount of food grade base oil comprises from about 85 to about 99.9 weight percent based on a total weight of base oil and additive composition.

9. The food grade lubricant composition of claim 1, wherein the additive composition meets HX-1 approval criteria.
10. The food grade lubricant composition of claim 1, wherein the lubricant composition is devoid of base oils and additives derived from animals.
11. A method of operating machinery for food processing comprising:
providing the machinery with a food grade lubricant comprising a major amount of food grade base oil and a minor amount of at least one additive composition comprising one or more non-sludge promoting wear reducing agents, wherein the lubricant composition exhibits lower sludge formation tendencies than a lubricant composition containing a conventional wear reducing agent; and
operating the machinery.
12. The method of claim 11, wherein the one or more non-sludge promoting wear reducing agents are selected from the group consisting of triphenyl phosphorothionates, amine neutralized phosphoric acid esters, and mixtures thereof, wherein the amine is a non-branched chain amine.
13. The method of claim 11, wherein the food grade base oil comprises an oil selected from the group consisting of white oil, vegetable oils, and mixtures thereof.
14. The method of claim 11, wherein the additive further comprises at least one antioxidant selected from the group consisting of amine antioxidants, phenolic antioxidants, and mixtures thereof.
15. The method of claim 11, wherein the wear reducing agent comprises a mixture of triphenyl phosphorothionate and an amine neutralized phosphoric acid esters, wherein the amine is a non-branched chain amine.
16. The method of claim 11, wherein the additive composition further comprises a methacrylate antifoam agent.

17. The method of claim 11, wherein the additive composition further comprises a component selected from the group consisting of a preservative, a corrosion inhibitor, and a rust inhibitor.

18. The method of claim 11, wherein the major amount of food grade base oil comprises from about 85 to about 99.9 weight percent based on a total weight of base oil and additive composition.