[0020] In a further embodiment, the sulfurized olefin in the additive package can deliver to the industrial gear oil lubricant from about 0.50 to about 20 wt% of at least one biodegradable sulfurized olefin.

[0021] In a still further embodiment, the additive package can deliver to the industrial gear oil lubricant, in addition to the biodegradable sulfurized olefin, from about 0.01 to about 1 wt% of at least one non-biodegradable sulfurized olefin.

[0022] There is also provided a method of operating an industrial gear comprising applying to the industrial gear an industrial gear oil as described above, and operating the industrial gear.

[0022a] In a still further embodiment, there is provided an additive package for industrial gear lubricants, comprising at least one sulfurized olefin, that delivers greater than about 0.80 wt% active sulfur to the industrial gear lubricant, as measured at 150℃ in ASTM D1662, wherein the at least one sulfurized olefin comprises from about 0.5 to about 20 wt%, based on the total weight of the industrial gear oil lubricant, of at least one biodegradable sulfurized, and from about 0.01 to about 1 wt%, based on the total weight of the industrial gear oil lubricant, of a non-biodegradable sulfurized olefin comprising at least one non-biodegradable sulfurized olefin derived from at least one of di-isobutylene, butylene isobutylene, or mixtures thereof, wherein the non-biodegradable sulfurized olefin comprises less than 0.10 wt% based on the total weight of the industrial gear oil lubricant, of a highly active non-biodegradable sulfurized olefin derived from di-isobutylene and less than 0.25 wt%, based on the total weight of the industrial gear oil lubricant, of a nominally active non-biodegradable sulfurized olefin derived from isobutylene.

[0022b] In a still further embodiment, there is provided an industrial gear oil lubricant comprising the additive package of the invention and a major amount of an oil of lubricating viscosity.

[0022c] In a still further embodiment, there is provided an additive package for industrial gear lubricants, comprising at least one sulfurized olefin, that delivers greater than 0.80 wt% active sulfur to the industrial gear lubricant, as measured at 150℃ in ASTM D1662, wherein the at least one sulfurized olefin comprises from 0.5 to 20 wt%, based on the total weight of the industrial gear oil lubricant, of at least one biodegradable sulfurized olefin, and from 0.01 to 1 wt%, based on the total weight of the industrial gear oil lubricant, of a non-biodegradable sulfurized olefin comprising at least one non-biodegradable

sulfurized olefin derived from at least one of di-isobutylene, butylene, isobutylene, or mixtures thereof, wherein the non-biodegradable sulfurized olefin comprises less than 0.10 wt% based on the total weight of the industrial gear oil lubricant, of a highly active non-biodegradable sulfurized olefin derived from di-isobutylene and less than 0.25 wt%, based on the total weight of the industrial gear oil lubricant, of a nominally active non-biodegradable sulfurized olefin derived from isobutylene wherein the highly active sulfurized olefin is a sulfurized olefin having 66 wt% or more of the sulfurs contained therein as active sulfurs, and wherein the nominally active sulfurized olefin is a sulfurized olefin having from 33 wt% to 66 wt% of the sulfurs contained therein as active sulfurs.

DETAILED DESCRIPTION OF THE INVENTION

[0023] Various preferred features and embodiments will be described below by way of non-limiting illustration.

[0024] The present technology relates in part to an additive package for industrial gear lubricants containing at least one biodegradable sulfurized olefin. The technology can further include an additive package for industrial gear lubricants comprising, consisting essentially of, or consisting of (a) at least one biodegradable sulfurized olefin, and (b) at least one non-biodegradable sulfurized olefin.

[0025] Sulfurized olefins are well known commercial materials prepared by reacting a single reactant or a mixture of appropriate reactants with a source of sulfur. The sulfurization reaction generally is effected at an elevated temperature, e.g., 50-350°C or 100-200°C, with efficient agitation and often in an inert atmosphere such as nitrogen, optionally in the presence of an inert solvent. The sulfurizing agents can include elemental sulfur, which is preferred, hydrogen sulfide, sulfur halide, sodium sulfide and a mixture of hydrogen sulfide and sulfur or sulfur dioxide. Usually, the amount of sulfur or sulfurizing agent employed is calculated based on the total olefinic unsaturation of the mixture. Typically 0.5 to 3 moles of sulfur are employed per mole of olefinic bonds. One type of sulfurized olefin can be prepared in accordance with the detailed teachings of U.S. Pat. No. 4,957,651.

[0026] In the case of sulfurized olefins, the reactant can be an olefinic compound. Olefinic compounds which may be sulfurized are diverse in nature, and broadly speaking are those that contain at least one olefinic double bond, which is defined as a non-aromatic double bond; that is, a double bond connecting two aliphatic carbon

The Claims defining the invention are as follows:

1. An additive package for industrial gear lubricants, comprising at least one sulfurized olefin, that delivers greater than 0.80 wt% active sulfur to the industrial gear lubricant, as measured at 150℃ in ASTM D1662, wherein the at least one sulfurized olefin comprises from 0.5 to 20 wt%, based on the total weight of the industrial gear oil lubricant, of at least one biodegradable sulfurized olefin, and from 0.01 to 1 wt%, based on the total weight of the industrial gear oil lubricant, of a non-biodegradable sulfurized olefin comprising at least one non-biodegradable sulfurized olefin derived from at least one of di-isobutylene, butylene, isobutylene, or mixtures thereof, wherein the non-biodegradable sulfurized olefin comprises less than 0.10 wt% based on the total weight of the industrial gear oil lubricant, of a highly active non-biodegradable sulfurized olefin derived from di-isobutylene and less than 0.25 wt%, based on the total weight of the industrial gear oil lubricant, of a nominally active non-biodegradable sulfurized olefin derived from isobutylene wherein the highly active sulfurized olefin is a sulfurized olefin having 66 wt% or more of the sulfurs contained therein as active sulfurs, and wherein the nominally active sulfurized olefin is a sulfurized olefin having from 33 wt% to 66 wt% of the sulfurs contained therein as active sulfurs.

2. The additive package of claim 1, wherein the at least one biodegradable sulfurized olefin comprises at least one of a minimally active biodegradable sulfurized olefin as measured under ASTM D1662 at 150°C, a nominally active biodegradable sulfurized olefin as measured under ASTM D1662 at 150°C, or mixtures thereof, wherein the minimally active sulfurized olefin is a sulfurized olefin having 0.1 to 33 wt% of the sulfurs contained therein as active sulfurs, and wherein the nominally active sulfurized olefin is a sulfurized olefin having from 33 wt% to 66 wt% of the sulfurs contained therein as active sulfurs.

3. The additive package of any one of the previous claims, wherein the at least one biodegradable sulfurized olefin comprises at least one biodegradable sulfurized olefin derived from a natural source.

4. The additive package of any one of the previous claims, where the at least one biodegradable sulfurized olefin derived from a natural source comprises at least one biodegradable sulfurized olefin derived from rapeseed oil.

5. The additive package of any one of the previous claims, comprising further additive components.

6. An industrial gear oil lubricant comprising the additive package of any one of the previous claims and a major amount of an oil of lubricating viscosity.

7. The industrial gear oil lubricant of claim 6, wherein the oil of lubricating viscosity comprises at least one of synthetic oils, vegetable oils, mineral oils, or mixtures thereof.

8. The industrial gear oil lubricant of claim 7, wherein the major amount of an oil of lubricating viscosity is biodegradable saturated synthetic oil.

9. A method of operating an industrial gear comprising applying to the gear an industrial gear oil as claimed in claim 6, and operating the gear.