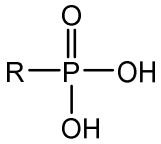
CLAIMS

1. A lubricating oil composition comprising:

a major amount of an oil of lubricating viscosity having a kinematic viscosity at 100°C in a range of 1.5 to 35 mm^2/s; and

an anti-wear mixture comprising: 0.001 to 20 wt. % of one or more ashless succinimide dispersants, based on the total weight of the lubricating oil composition, and 0.001 to 20 wt.% of an alkyl phosphonic acid having a structure given by



wherein R is a C_3-C_{20} hydrocarbyl group, based on the total weight of the lubricating oil composition; initial pH of the anti-wear mixture is between 5.0 – 9.5 as measured by ASTM D664; and wherein the lubricating oil composition is free of zinc.

2. The lubricating oil composition of claim 1, wherein the one or more ashless dispersants include a hydrocarbyl succinimide.

3. The lubricating oil composition of claim 1, wherein the one or more ashless dispersant include a borated hydrocarbyl succinimide.

4. The lubricating oil composition of claim 1, wherein the anti-wear mixture comprises one or more polyisobutenyl succinimide dispersants.

5. The lubricating oil composition of claim 1, wherein the one or more polyisobutenyl succinimide is borated.

6. The lubricating oil composition of claim 1, wherein at least one of the one or more polyisobutenyl succinimide has a polyisobutylene group with a number average molecular weight of 850 or greater.

7. The lubricating oil composition of claim 1 or claim 4, wherein the volume resistivity is greater than 1 x 10^8 Ω·cm at 80°C.

8. The lubricating oil composition of claim 1 or claim 4, wherein the lubricating oil composition is a hydraulic fluid, a slide way lubricant, automatic transmission fluid, continuously variable transmission fluid, battery electric vehicle, hybrid electric vehicle transmission fluid, or gear oil.

9. The lubricating oil composition of claim 1 or claim 4, further comprising:

a friction modifier, ashless anti-wear additive, antioxidant, metal deactivator, seal swell additive, foam inhibitor, or viscosity modifier.

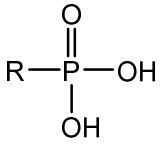
10. The lubricating oil composition of claim 1 or claim 4, wherein R is a linear alkyl group optionally containing an ether or thioether moiety.

11. A method of reducing wear of a transmission or gear comprising:

lubricating the transmission or gear with a lubricating oil composition comprising:

a major amount of an oil of lubricating viscosity having a kinematic viscosity at 100°C in a range of 1.5 to 35 mm^2/s; and

an anti-wear mixture comprising: 0.001 to 20 wt.% of one or more ashless succinimide dispersants, based on the total weight of the lubricating oil composition and 0.001 to 20 wt.% of an alkyl phosphonic acid of the following formula:



wherein R is a C_3-C_{20} hydrocarbyl group, based on the total weight of the lubricating oil composition;

wherein the initial pH of the anti-wear mixture is between 5.0 – 9.5 when measured by the ASTM D664 method; and

wherein the lubricating oil composition is free of zinc.

12. The method of claim 11, wherein the one or more ashless dispersants include a hydrocarbyl succinimide, for example, a borated hydrocarbyl succinimide.

13. The method of claim 11, wherein the volume resistivity is greater than 1 x 10^8 Ω·cm at 80°C.

14. The method of claim 11, wherein the lubricating oil composition further comprises:

a friction modifier, ashless anti-wear additive, antioxidant, metal deactivator, seal swell additive, foam inhibitor, or viscosity modifier.

15. The method of claim 11, wherein R is a linear alkyl group.