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71 Applicant: **NIPPON STEEL CHEMICAL CO. LTD.**
13-16 Ginza 5-chome Chuo-ku
Tokyo 104(JP)

72 Inventor: **Uchiyama, Hiromitsu**
9-6, Onda-cho 4-chome
Higashimurayama-shi Tokyo(JP)
Inventor: **Komoto, Tadashi**
13-3, Nakai 2-chome Kokurakita-ku
Kitakyushu-shi Fukuoka-ken(JP)
Inventor: **Urata, Yuichi**
14-7, Hiyoshidai 3-chome Yahatanishi-ku
Kitakyushu-shi Fukuoka-ken(JP)
Inventor: **Tezuka, Takeshi**
4-27, Ohyachi
Sendai-shi Miyagi-ken(JP)

74 Representative: **Rees, David Christopher et al**
Kilburn & Strode 30 John Street
London WC1N 2DD(GB)

54 Composition suitable for traction drives and process for operating the same.

57 The present invention discloses a composition suitable for use in traction drives, which comprises a small amount of an antioxidant in combination with a naphthenic oil having as a main component thereof a condensed polycyclic alicyclic hydrocarbon resulting from the hydrogenation of a hydrocarbon oil obtained by decomposing a coat type raw material oil. The sum of the carbon atoms of the condensed polycyclic alicyclic hydrocarbon and the carbon atoms directly bonded to the polycyclic moiety accounts for not less than 80% of the total number of carbon atoms of the naphthenic oil and the hydrogen/carbon atomic ratio (H/C) of the naphthenic oil is in the range of 1.68 to 1.80.

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COMPOSITION SUITABLE FOR TRACTION DRIVES AND PROCESS FOR OPERATING THE SAME

The present invention relates to a composition suitable for use in traction drives and to a process for operating the same.

Heretofore, gears and hydraulic devices have been used for power transmission or speed control. A system of drives, called traction drives (rolling friction drive devices), which resort to point contact or line contact between rolling solid bodies has found recognition. These traction drives are particularly useful in industrial machines because they provide high power transmission efficiency without the vibration characteristic of devices using gears and similar positive forms of engagement.

The fluid to be interposed between contact parts of such traction drives must be a selected lubricant which proves most suitable from the functional point of view. Specifically, the fluid intervening between contact parts is required to possess an ability to undergo reversible glass transition, viscosity increase and should enhance the efficiency of power transmission between rolling contact surfaces under high pressure. On departure from the contact surfaces, it should immediately return to its original fluid state. It must also be capable of precluding direct contact between metal bodies, preventing metal bodies from seizure, wear and fatigue damage and, as with lubricants of all kinds, must fulfil the important functions of preventing the occurrence of rust and the elevation of temperature.

Friction or traction drive devices for the transmission of mechanical power have been disclosed in a number of reports in prior technical literature. They are dealt with in full detail in US Patents 3,394,603 and 3,411,369; the Journal of Chemical and Engineering Data, Vol. 5, No. 4, p.p.499-507 (1960), and Hewko et al., in Proceedings of the Symposium on Rolling Contact Phenomena, p.p.157-185 (1962), Elsevier, Amsterdam, Netherlands, for example.

As compositions for use in traction drives, a host of substances have been advanced, including mineral oils (Japanese Patent Publication 24,635/1964), mixtures of dialkyl aromatic hydrocarbons with diarylalkanes (Japanese Patent Publication 40,525/1972), polymethylmethacrylate (Japanese Patent Publication 31,828/1973), adamantanes (Japanese Patent Publication 42,067/1973 and 42,068/1973), polyolefins (Japanese Patents KOKAI 4,766/1971 and 2,229/1972) and alkylnaphthalenes (US Patent 2,549,377), for example. Japanese Patent KOKAI 40,726/1980 has proposed fluids which are obtained by hydrogenating bis-(α -methylbenzyltoluene) and/or bis-(α -methylbenzyl)-xylene.

Besides, proposals abound which concern naphthenic oils having naphthenic rings. These naphthenic oils include dicyclohexylethane (US Patent 3,577,361), dicyclohexylpropane (Japanese Patent Publication 36,105/1978), hydrogenated condensation ring compounds (US Patent 3,411,369), hydrogenated benzyl biphenyls (US Patent 4,371,726), naphthenes containing at least one saturated carbon-containing cyclic ring (US Patent 3,440,894), naphthenes containing at least two saturated carbon-containing cyclic rings (US Patent 3,925,217), and mixtures of naphthenes and paraffins (US Patents 3,595,796 and 3,595,797).

The oils for use in traction drives, however, have a disadvantage that they are very expensive because they are invariably produced through a complicated procedure.

An object of this invention, therefore, is to provide a novel and inexpensive composition for use in traction drives and a process for the operation of the traction drives.

Another object of this invention is to provide a naphthenic composition which excels in such basic physical properties as traction coefficient and in its suitability for use in traction drives, the composition being easily produced while having an improved oil film-forming capacity.

The objects described above are accomplished by a composition which comprises a small amount of an antioxidant in combination with a naphthenic oil having as a main component, a condensed polycyclic alicyclic hydrocarbon resulting from the hydrogenation of a hydrocarbon oil obtained by decomposing a coal type raw material oil, in which the sum of carbon atoms of the condensed polycyclic alicyclic hydrocarbon and the carbon atoms directly bonded to the polycyclic moiety accounts for not less than 80% of the total of carbon atoms of the naphthenic oil and the hydrogen:carbon atomic ratio (H/C) of the naphthenic oil is in the range of 1.68 to 1.80.

The invention also extends to a process for operating traction drives which have an area of point or line contact between rolling solid bodies in which the area of contact is oiled with the above composition.

The naphthenic oil to be used in this invention can be produced by the method disclosed, for example, in Japanese Patent Application KOKAI 120,896/1986. The hydrocarbon oil as the raw material therefor is obtained by decomposing a coal type or coal-based raw material oil such as, for example, coal tar, coal-tar pitch, coal tar oil, liquefied coal oil, or liquefied coal pitch by hydrogenolysis, pyrolysis, or the combination of hydrogenolysis and pyrolysis and is desired to contain a condensed polycyclic component of 2 to 10

rings in a concentration of not less than 50% by weight, preferably not less than 60% by weight, and possess a boiling point in the range of 200° to 600° C or over. As examples of the hydrocarbon oil of the foregoing description, the hydrocarbon oil which is formed when coal-tar pitch is subjected to hydrogenolysis and the thermally decomposed oil which is formed when coal-tar pitch is converted into coke may be mentioned.

Since this hydrocarbon oil originates in coal, it generally contains sulphur compounds in an amount in the range of 0.02 to 2% by weight as elementary sulphur and nitrogen compounds in an amount in the range of 0.1 to 3% by weight as elementary nitrogen. In the present invention, if the hydrocarbon oil happens to have a large sulphur content and nitrogen content, it is desirably refined by hydrogenation so as to lower the sulphur content and the nitrogen content each to below 1,000 ppm, preferably the sulphur content below 100ppm and the nitrogen content below 100ppm.

The refinement by hydrogenation performed for this purpose can be carried out batchwise or continuously, preferably continuously, in the presence of a catalyst having deposited on a carrier such as of alumina or silica at least one member selected from the group consisting of such metals as molybdenum, tungsten, nickel, and cobalt which belong to Group VIa and group VIII in the Periodic Table of Elements. The reaction proceeds advantageously when the reaction temperature is in the range of 250° to 500° C, preferably 350° to 430° C, the reaction pressure in the range of 20 to 300 kg/cm².G, preferably 50 to 200kg/cm².G, the spatial liquid velocity (LHSV) in the range of 0.01 to 10hr⁻¹ preferably 0.1 to 5hr⁻¹, and the liquid-gas ratio (G/L) in the range of 100 to 5,000 H₂ oil.

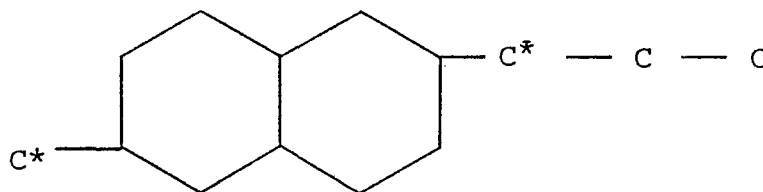
When the hydrocarbon oil has both its sulphur content and nitrogen content lowered to below 1,000 ppm, when necessary, through a desulphurisation and denitrification treatment, it may then be subjected to nuclear hydrogenation. This nuclear hydrogenation is preferably carried out until naphthenic carbons account for 70 to 90%, aromatic carbons 1 to 20%, and paraffinic carbons the balance of all the carbons in the nuclearly hydrogenated hydrocarbon oil produced, and preferably until the aromatic hydrocarbons in the hydrocarbon oil are converted as thoroughly as possible into naphthenic hydrocarbons.

The nuclear hydrogenation of the hydrocarbon oil can be carried out batchwise or continuously, preferably batchwise, in the presence of a large excess of hydrogen gas by use of a catalyst having deposited on a carrier such as of diatomaceous earth, alumina magnesia, boria, or silica a metal selected from the metals of Group VIII in the Periodic Table of Elements such as, for example, nickel, platinum, and palladium. The reaction in this case proceeds advantageously when the reaction temperature is in the range of 50° to 300° C and the reaction pressure in the range of 10 to 200 kg/cm².G. As regards the reaction time, the reaction is desired to be continued until the absorption of hydrogen is completed.

In this invention, for the purpose of removing residual impurities from the hydrocarbon oil, the oil is preferably washed with sulphuric acid and/or subjected to purification with a solid absorbent either before or after the nuclear hydrogenation.

Desirably, the aforementioned washing with sulphuric acid is carried out by admixing 80 to 98% sulphuric acid with oil at a sulphuric acid/oil volumetric ratio in the range of 0.01 to 10, preferably 0.1 to 1.0, and stirring the resultant mixture at a temperature in the range of 25° to 80° C for a period in the range of 15 to 150 minutes. The purification with the solid absorbent is desirably carried out by passing the oil through a bed of solid absorbent such as activated clay, activated alumina, or silica alumina at a temperature in the range of 0° to 150° C at a spatial liquid velocity (LHSV) in the range of 1 to 50hr⁻¹, preferably, 0.5 to 10hr⁻¹.

From the naphthenic oil obtained by nuclear hydrogenation, traction oil fractions possessing varying degrees of viscosity can be obtained by separating the naphthenic oil through distillation, preferably through vacuum distillation, into several fractions in a suitable boiling point range such as, for example, 300° to 400° C and optionally blending these fractions in varying proportions. The particular fraction to be used for the oil for traction gears is a naphthenic oil formed mainly of condensed polycyclic alicyclic hydrocarbon so that the sum of the carbon atoms constituting the polycyclic moiety of the condensed polycyclic alicyclic hydrocarbon and the carbon atoms directly bonded to the polycyclic moiety is not less than 80% of the total of carbon atoms of the naphthenic oil, preferably falling in the range of 85 to 95%, and the hydrogen/carbon atomic ratio (H/C) is in the range of 1.68 to 1.80, preferably 1.70 to 1.78. The carbon atoms directly bonded to the polycyclic moiety are the carbons designated C* in a compound such as



and the carbon vicinally positioned to the polycyclic moiety (C at alpha-position). The naphthenic oil can be adjusted to fulfil its requirements by suitably selecting the coal type raw material oil or its fractions, by selecting the conditions for the nuclear hydrogenation, or by selecting the fractions to be combined. If the sum of the carbon atoms constituting the polycyclic moiety of the condensed polycyclic alicyclic hydrocarbon and the carbon atoms directly bonded to the polycyclic moiety is less than 80% of the total of carbon atoms of the naphthenic oil and the H/C ratio deviates from the range of 1.68 to 1.80, the naphthenic oil tends to be deficient in oxidation stability and oil film-forming capacity.

The composition suitable for use in traction gears is obtained by incorporating an antioxidant in the naphthenic oil obtained by the nuclear hydrogenation. The amount of the antioxidant to be incorporated may be in the range of 0.1 to 5% by weight, preferably 0.3 to 3% by weight, more preferably 0.5 to 2% by weight, based on the amount of the composition. As examples of the antioxidant, alkyl phenols such as 2,6-ditertiary butyl paracresol, 4,4'-methylene bis(2,6-di-t-butyl phenol), 4,4'-thio bis(2,6-dialkyl phenol), amines such as p-octyl diphenylamine, p,p'-dioctyl diphenylamine, 2,2'-diethyl-4-octyl diphenylamine, and sulphur-phosphorus compounds such as zinc dialkyldithiophosphates, zinc diaryldithiophosphates, dialkyl sulphide, dialkyl disulphide, N,N'-disalicylidene-1,2-diaminopropane and alizarine may be cited. Optionally, the composition may be used mixed with other traction oils such as, for example, a mineral oil. The composition may incorporate an amine, an ester, or a metal salt as a rustproofing agent, a polymethacrylate as a viscosity index improver, and a silicone type polymer as a defoaming agent.

The present invention will now be described more specifically with reference to the following non-limiting examples.

The traction coefficient of a given oil is generally measured by use of a traction drive device described in US Patent 4,371,726.

A 370°-470° fraction (H/C = 0.70, N = 1,000ppm, and S = 5,500ppm) of the hydrocarbon oil obtained by subjecting coal-tar pitch to hydrogenolysis was hydrogenated in the presence of a Ni-Mo/Al₂O₃ catalyst under the conditions of 350° to 400°C, 180 kg/cm².G, LHSV = 0.2 hr⁻¹ and G/L = 1,000. Consequently, a refined hydrocarbon oil of H/C = 1.50, N = 2,000 ppm, and S = 1 ppm was obtained. This hydrocarbon oil was treated with clay to lower the N content below 10 ppm. It was then subjected to through nuclear hydrogenation in the presence of stabilised Ni catalyst under the conditions of 200°C, 180 kg/cm².G, LHSV = 0.3hr⁻¹, and G:L = 1,000, to produce a naphthenic oil of the present invention. The naphthenic oil had an H/C ratio of 1.72, less than 0.1% of aromatic hydrogen, less than 5% of hydrogen bonded to the carbon directly bonded to the polycyclic moiety, and less than 10% of hydrogen bonded to the alkyl group, a nitrogen content of less than 10ppm, a sulphur content of less than 1ppm, and an average molecular weight of 270.

This naphthenic oil was fractionally distilled into a 300°-320° C fraction (41.4% in yield) (the sum of the carbon atoms constituting the condensed polycyclic alicyclic hydrocarbon and the carbon atoms directly bonded to the polycyclic moiety, 87% of the total of carbon atoms of the naphthenic oil), a 320°-345° C fraction (31.0% in yield) (the sum, 88%), a 345°-365° C fraction (12.4% in yield) (the sum 88%), and a 365°-390° C fraction (15.2% in yield) (the sum, 89%). These fractions were used as oils for traction gears. The physical properties of the base oils of these traction oils were as shown in Table 2. These base oils of the traction oils were tested for traction coefficient and oil film thickness with a twin-tube tester under conditions of 0.45m.s of sliding speed and 300 kg of load. The test pieces has a surface roughness of 0.06 μm. The results are shown in Table 3.

Table 2

Main fraction (°C)	300-320	320-345	345-365
H/C	1.70	1.72	1.75
Specific gravity (15/4 °C)	0.9573	0.9666	0.9821
Viscosity (40 °C, cSt)	10.52	21.46	67.11
Flash point (°C)	152	160	180
Pour point (°C)	-50	-30	-15
Aniline point (°C)	56.9	62.2	66.1
Viscosity-pressure coefficient (GP ⁻¹)	30	40	60

Table 3

	Main fraction (°C)	Viscosity (40 °C)(cSt)	Traction coefficient	Oil film thickness during measurement (μm)
Example 1	300-320	10.52	0.075	2.1
Example 2	320-345	21.46	0.078	3.2
Example 3	345-365	67.11	0.081	5.1
Control 1	Paraffinic mineral oil	15.01	0.045	0.2
Control 2	Naphthenic mineral oil	12.45	0.056	0.6
Control 3	Hydrogenated naphthalene	3.450	0.060	0.1
Control 4	Hydrogenated acenaphthene	3.890	0.069	0.1
Control 5	Polybutene	27.10	0.070	1.0

Examples 4 to 6 and Controls 6 to 10

From the base obtained in Examples 1 to 3 and Controls 1 to 5, oils for traction gears were obtained by adding to the base oils 2,6-ditertiarybutyl paracresol and a zinc dialkyldithiophosphate as antioxidant each in a proportion of 0.5% by weight. This oil was tested for traction coefficient under the aforementioned conditions and then subjected to an oxidation test by the procedure described in Paragraph 3.2 (Testing Method for Oxidation Stability of Internal Combustion Engine Oil of Japanese Industrial Standard (JIS) K-2514-1980 (Testing Method for Oxidation Stability of Lubricating Oils).

The oxidation test was carried out under the following conditions.

Amount of test specimen 300 ml
 Temperature 165.5 °C
 Time 72 hours
 Oxidation catalyst Copper and iron

The results are shown in Table 4.

Table 4

	Base oil Specific gravity (15.4 °C)	Test		
		Viscosity ratio	Increase in total acid number (mg KOH/g)	Heptane insolubles after oxidation test (% by weight)
Example 4	Example 1	1.1	1.18	0.8
Example 5	Example 2	1.1	1.18	0.8
Example 6	Example 3	1.2	1.20	0.9
Control 6	Control 1	1.5	1.32	1.1
Control 7	Control 2	1.8	1.81	1.7
Control 8	Control 3	1.9	1.85	1.8
Control 9	Control 4	2.0	1.90	2.0
Control 10	Control 5	1.4	1.29	1.1

The composition of the present invention for use in traction gears can be produced from an inexpensive raw material. It excels in physical properties such as traction coefficient, oil film thickness, and oxidation stability which are essential for the oil to be used in traction gears. Thus, it can be used efficiently for a long time.

Claims

1. A composition for use in traction drives, which comprises an antioxidant in combination with a naphthenic oil, characterised in that a main component of the naphthenic oil is a condensed polycyclic alicyclic hydrocarbon resulting from the hydrogenation of a hydrocarbon oil obtained by decomposing a coal type raw material oil, in which the sum of the carbon atoms of the condensed polycyclic alicyclic hydrocarbon and the carbon atoms directly bonded to the polycyclic moiety accounts for not less than 80% of the total number of carbon atoms of the naphthenic oil and the hydrogen:carbon atomic ratio (H/C) of the naphthenic oil is in the range of 1.68 to 1.80.
2. A composition as claimed in Claim 1 characterised in that the sum of the carbon atoms of the condensed polycyclic alicyclic hydrocarbon and the carbon atoms directly bonded to the polycyclic moiety account for a proportion in the range of 85 to 95% of the total number of carbon atoms of the naphthenic oil and the hydrogen:carbon atomic ratio (H/C) of the naphthenic oil is in the range of 1.70 to 1.78.
3. A composition as claimed in Claim 1 or Claim 2, characterised in that the amount of antioxidant incorporated in the composition is in the range of 0.3 to 3% by weight.
4. A process for operating traction drives having an area of point or line contact between rolling solid bodies, characterised by lubricating the area of contact with a naphthenic oil having as a main component a condensed polycyclic alicyclic hydrocarbon resulting from the hydrogenation of a hydrocarbon oil obtained by decomposing a coal type raw material oil, in which the sum of the carbon atoms of the condensed polycyclic alicyclic hydrocarbon and the carbon atoms directly bonded to the polycyclic moiety accounts for not less than 80% of the total number of carbon atoms of the naphthenic oil and the hydrogen:carbon atomic ratio (H/C) of the naphthenic oil is in the range of 1.68 to 1.80.
5. A process as claimed in Claim 4 characterised in that sum of the carbon atoms of the condensed polycyclic alicyclic hydrocarbon and the carbon atoms directly bonded to the polycyclic moiety account for a proportion in the range of 85 to 95% of the total number of carbon atoms of the naphthenic oil and the hydrogen:carbon atomic ratio (H/C) of the naphthenic oil is in the range of 1.70 to 1.78.
6. A process as claimed in Claim 4 or Claim 5 characterised in that the naphthenic oil contains an antioxidant.
7. A method for manufacturing a composition for lubricating traction drives, characterised by: decomposing a coal-based oil; removing any excess of sulphur and/or nitrogen; removing residual impurities by washing with sulphuric acid and/or by treatment with a solid absorbent; fractionally distilling the oil; optionally blending the fractions; and mixing the resulting material with an anti-oxidant; thereby producing a composition having the properties outlined in any of Claims 1 to 3.

8. A method as claimed in Claim 7 characterised in that the coal-based oil is coal-tar, coal-tar pitch, coal-tar oil, liquefied coal oil or liquefied coal pitch, and the decomposition is by hydrogenolysis and/or pyrolysis.

9. A method as claimed in Claim 7 or Claim 8 characterised in that excess sulphur and nitrogen are
5 removed by catalytic hydrogenation and catalytic nuclear hydrogenation.

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