United States Patent

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[54] TRACTIVE FLUID COMPOSITIONS

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[51] **Int. Cl.** **C09k 3/00**

[58] **Field of Search** ..... 252/73, 75; 74/200; 260/666 P

[56] **References Cited**

UNITED STATES PATENTS

3,440,894 4/1969 Hammann et al.

OTHER PUBLICATIONS

Pines et al., " Phenyl Migration During Decomposition of Peroxides in Alkyl-Benzenes," J. American Chemical Society, Vol. 82, 1960, p. 2922

Shelton et al., " Chemistry of Diarylazoalkanes II. Effect of Para-substituents on the Thermal Decomposition of Azocumenes," J. American Chemical Society, Vol. 90, 1968, p. 356

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[57] **ABSTRACT**

A composition consisting essentially of a mixture of 30–60 percent hydrogenated dicumyl, 30–60 percent tercyclohexyl and 5–20 percent of dicyclohexyl or alkyl dicyclohexyl. The properties of this fluid composition make it particularly well suited for use as a tractant in tractive drive apparatus intended for low temperature service.

6 Claims, No Drawings

TRACTIVE FLUID COMPOSITIONS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to functional fluids particularly adapted for use in tractive drives, and to particular fluid compositions comprising mixtures of alicyclic hydrocarbons having good phase stability at low temperatures.

2. Description of Prior Art

Traction is broadly defined as the adhesive friction of a body on a surface on which it moves. A tractive drive is a device in which torque is transmitted from an input element to an output element through nominal point or line contact, typically with a rolling action, by virtue of the traction between the contacting elements.

While tractive elements are commonly spoken of as being in contact, it is generally accepted that a fluid film is provided there between. Almost all tractive drives require fluids to remove heat, to prevent wear at the contact surfaces, and to lubricate bearings and other moving parts associated with the drive. Thus, instead of metal to metal rolling contact there is a film of fluid introduced into the load zone. The nature of this fluid determines to a large extent the limits in the performance and in the capacity of the drive. Desirable properties for a tractive fluid are (1) high coefficient of traction, (2) viscosity in the range of about 4 to 2000 centistokes over a temperature range of 210° to 0° F., (3) good phase stability at low temperatures, (4) good thermal and oxidative stability, (5) noncorrosive to common materials of construction and (6) good load-bearing and low wear rate properties.

A detailed discussion of tractive drives and fluid properties is given in U.S. Pat. No. 3,440,894. That patent defines certain classes of fluids characterized by high coefficients of traction and preferred molecular structures which were found to be superior for tractive drives. The discovery of these fluids increased the torque capacity of tractive drives and permitted a reduction in the size of the drive required for a given power requirement.

Although fluids of the type described in U.S. Pat. No. 3,440,894 are among the best of any fluids known for tractive drives with respect to torque transmitting ability, there are certain problems associated with the use of these fluids in certain applications. In low temperature applications for example, some fluids tend to crystallize when subjected to temperatures of 0° C. or less for extended periods. The formation and growth of crystals is obviously undesirable for an application which depends upon maintaining a liquid film under high pressure on the surfaces of the tractive members. This invention is directed primarily toward providing a solution to the problem of phase stability at low temperature.

It is accordingly an object of the present invention to provide a composition suitable for use as a tractive fluid and particularly well suited for use in low temperature applications.

SUMMARY

The compositions of this invention are mixtures of alicyclic hydrocarbons consisting essentially of from about 30 to 60 percent hydrogenated dicumyl, 30 to 60 percent tercyclohexyl, and 5 to 20 percent of dicyclohexyl or a C_{1-4} alkyl dicyclohexyl such as isopropyl dicyclohexyl.

These fluid mixtures possess good coefficients of traction, operable viscosity ranges over temperatures of 0° to 210° F., and show no significant amount of crystal growth when held at low temperatures for extended periods.

These fluid compositions can be used alone or in combination with additives designed to improve other fluid properties, as for example, antioxidants, load-carrying agents, etc.

DESCRIPTION OF PREFERRED EMBODIMENTS

Hydrogenated dicumyl, tercyclohexyl, dicyclohexyl and isopropyl dicyclohexyl are all high tractant hydrocarbons and mixtures of these materials retain a high coefficient of traction

which is substantially a proportional average of the individual components. The effect of mixing tractive fluid compositions is discussed at length in U.S. Pat. No. 3,440,894 where the relationship between the coefficient of traction of the mixture and the coefficient of traction of the individual components is given as

$$ft = ft_1C_1 + ft_2C_2 \ldots + ft_nC_n$$

where ft is the coefficient of traction of the mixture; ft_1, ft_2 and ft_n are individual coefficients of traction of the components; and C_1, C_2 and C_n are the respective weight concentrations of the components within the mixture.

The coefficients of traction for the individual components of mixtures encompassed by this invention are as follows:

Hydrogenated Dicumyl	0.070
Tercyclohexyl	0.069–0.073
Dicyclohexyl	0.074
Isopropyl Dicyclohexyl	0.070

These data were determined on the "Thrust Bearing Test Machine" described in "Effect of Lubricant Composition on Friction as Measured With Thrust Ball Bearings" by F. G. Rounds [J. Chem. and Eng. Data, vol. 5, No. 4 pp. 499 (1960)]. The fluid temperature was at 200° F., the Hertz stress was 500,000 p.s.i., and the linear ball velocity was 800 feet per minute.

It is apparent that the coefficient of traction of any mixture of these particular components must necessarily be greater than 0.069, and the fluid mixtures are accordingly well suited for use as a tractant in this respect. For example, a fluid with a 45:45:10 weight ratio of hydrogenated dicumyl, tercyclohexyl, and dicyclohexyl has a coefficient of 0.072.

The tercyclohexyl component is preferably a mixture of 1,2- and 1,3-tercyclohexyl isomers which have a lower melting point than p-tercylohexyl, a solid melting at about 150° C. A 60/40 mixture of 1,2/1,3-tercyclohexyl is found to melt over a range of about 10°–20° C. Hydrogenated dicumyl melts at 19°–21 C.; dicyclohexyl, melts at 1°–3° C.; and isopropyl dicyclohexyl melts over the range −50° C. to −25° C.

The low temperature phase stability of various fluid mixtures was evaluated in a test which consisted of maintaining a small vial of fluid at 0° F. for 30 days and observing the fluid for the formation and/or growth of crystals after 5 days and at the conclusion of the test period. Tests were run with both seeded and unseeded samples. Seeding was done with tercyclohexyl and with hydrogenated dicumyl crystals.

In the phase stability test, none of the unseeded samples showed any crystal formation even when held several months at 0° F. The test results were accordingly based solely on crystal growth in seeded samples. Crystal growth was determined subjectively by a visual appraisal of the seeded samples and an estimation of the percent by volume of the crystallized portion of the fluid. By this test, crystallization was considered significant when more than about 10 percent of the fluid volume crystallized.

The samples were also evaluated for viscosity over a temperature range of −20° to 210° F. Any sample which had a viscosity in excess of 50,000 centistokes at −20° F. was considered to be unsatisfactory for use as a low temperature tractive fluid.

The alkyl dicyclohexyl used in the test sample formulations was isopropyl dicyclohexyl, a preferred compound. It is understood, however, that other alkyl substituents having from one to about four carbon atoms can also be used, as for example methyl, ethyl, n-propyl, n-butyl, iso-butyl, t-butyl, etc.

Table I below shows crystal growth in seeded samples and viscosity test data for various mixtures of hydrogenated dicumyl (HDC), tercyclohexyl (TCH), and dicyclohexyl (DCH).

TABLE I

	Fluid composition			Viscosity, centistokes			Significant crystal growth	
	HDC	TCH	DCH	210° F.	100° F.	−20° F.	5 days	30 days
Experiment No.:								
1	50	50	0	4.5	33	70,000	Yes	Yes.
2	47.5	46.5	5	4.0	27	34,000	No	Yes.
3	45.0	45.0	10	3.7	22	17,000	No	No.
4	42.5	42.5	15	3.4	19	9,000	No	No.
5	40	40	20	3.1	16	5,000	No	No.
6	63	27	10	3.7	22	12,000	Yes	Yes.
7	54	36	10	3.7	22	14,000	No	Yes.
8	36	54	10	3.6	23	22,000	No	No.
9	27	63	10	3.6	23	28,000	Yes	Yes.
10	60	40	0	4.5	33	55,000	No	Yes.
11	40	60	0	4.4	33	100,000	Yes	Yes.

Experiments 1 to 5 illustrate the effect of steadily increasing the amount of DCH in the fluid which HDC and TCH remain present in equal proportions. The data demonstrate that at least 5 percent and preferably 10 percent DCH should be present to impart low temperature phase stability to the mixture.

Experiments 6 to 9 illustrate the effect of varying the relative proportions of HDC and TCH while holding the DCH concentration constant at 10 percent. These data show that the 54:36 proportions of experiments 7 and 8 are practical concentration limits for these components and that the 63:27 ratio of experiments 6 and 9 are outside the satisfactory performance area.

Experiments 10 and 11 illustrate the necessity of having DCH present in combination with HDC and TCH in order to achieve satisfactory low temperature viscosity.

Table II below presents a similar series of experiments wherein isopropyl dicyclohexyl (IDCH) was substituted for DCH. Similar results were obtained and the comments made in regard to the data in Table I apply equally to the corresponding data in Table II.

TABLE II

	Fluid Composition			Viscosity, Centistokes			Significant Crystal Growth	
	HDC	TCH	IDCH	210° F.	100° F.	−20° F.	5 days	30 days
Exp. No.								
12	50	50	0	4.5	33	70,000	Yes	Yes.
13	47.5	47.5	5	4.2	30	46,000	No	Yes.
14	45	45	10	4.0	26	36,000	No	No.
15	42.5	42.5	15	3.8	24	21,000	No	No.
16	40	40	20	3.6	22	15,000	No	No.
17	63	27	10	4.1	27	22,000	Yes	Yes.
18	54	36	10	4.0	27	26,000	No	Yes.
19	36	54	10	4.0	27	41,000	No	No.
20	27	63	10	3.9	27	56,000	Yes	Yes.
21	60	40	0	4.5	33	55,000	No	Yes.
22	40	60	0	4.4	33	100,000	Yes	Yes.

The preceding data illustrate properties obtained with the basic fluids of this invention. It is understood that special additives designed to enhance specific properties of these fluids can be added without departing from the spirit of the invention. Such additives can include, for example, V.I. improvers, antioxidants, antiwear agents, corrosion inhibitors, dispersants, dyes and the like. Accordingly, the scope of the present invention is not to be limited except as defined in the appended claims.

The embodiments in which an exclusive property or privilege is claimed are defined as follows:

1. A tractive fluid composition consisting essentially of 30–60 percent by weight hydrogenated dicumyl, 30–60 percent by weight tercyclohexyl, and at least 5 percent by weight dicyclohexyl or a C_1 to C_4 alkyl dicyclohexyl.

2. A tractive fluid composition of claim 1 wherein the tercyclohexyl is a mixture of 1,2-tercyclohexyl and 1,3-tercyclohexyl.

3. A tractive fluid composition of claim 1 wherein the alkyl dicyclohexyl is isopropyl dicyclohexyl.

4. A tractive fluid composition consisting essentially of 36–54 percent by weight hydrogenated dicumyl, 36–54 percent by weight tercyclohexyl, and at least 5 percent by weight dicyclohexyl or isopropyl dicyclohexyl.

5. A tractive fluid composition of claim 4 wherein the tercyclohexyl is a mixture of 1,2-tercyclohexyl and 1,3-tercyclohexyl.

6. A tractive fluid composition of claim 4 wherein the tercyclohexyl is a 40 of about 4 parts 1,2-tercyclohexyl and 60 parts 1,3-tercyclohexyl.