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TURBINE LUBRICATING OIL COMPOSITIONS

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The present invention relates to improved turbine lubricating oil compositions and, more particularly, to a novel liquid lubricant composition possessing a combination of properties that adapt it for usage under severe rust-inducing conditions such as are generally encountered in lubrication of steam turbines in naval and other marine operations.

As those skilled in the art are aware, the requirements of a turbine lubricating oil are very exacting and are particularly so for contemplated usage thereof under conditions wherein the lubricant may come into contact with condensed steam and/or sea water such as due to steam leaks through shaft seals as well as water from oil coolers of steam turbine lubricating systems.

Among the desired requisites for a lubricant for such usage are (1) that it separate readily from water without formation of troublesome emulsions and (2) that it protect metal components of the turbine against rusting.

Since the art is well aware of the importance attached to the aforesaid requisites of a lubricant for turbine operation, it is not deemed essential to discuss the importance thereof in more detail herein. For purposes of illustration, however, the importance thereof is evidenced by the rigid specifications for steam turbine lubricants set forth in Navy Department specification pamphlet 14–0–15, Symbol 2190–T, as amended March 1, 1948. That specification describes a corrosion test for determining the ability of a lubricant to prevent metal corrosion in the presence of synthetic sea water. Briefly, the test provides that polished cylindrical steel specimens be partially immersed for 48 hours in a bath maintained at 140° F. and composed of 300 ml. of the lubricant under test and 30 ml. of synthetic sea water. In order to pass that test, the immersed portions of the steel specimens must show no corrosion at the completion of the 48-hour period. The aforesaid specification also describes a test for determining the emulsion characteristics of the lubricant. Briefly, in that test, 40 ml. of the lubricant under test and 40 ml. of 1% aqueous sodium chloride are stirred together for five minutes at 1500 R. P. M. in a 100 ml. graduate at 130° F. The test is repeated with the exception that distilled water is used instead of synthetic sea water. In order to pass those tests, the oil must separate from the aqueous phase within 30 minutes.

In the operation of a properly lubricated steam turbine, certain metal components of the system are continually wetted by the lubricant whereas other metal components thereof are wetted only occasionally. In the operation of a turbine, it is highly desirable that a lubricant therefor should not only protect against rusting of metal components of the system continually wetted by the oil but also those corrodible metal parts of the system that are not continually flooded by the lubricant, the corrosion of which, for purposes of convenience, is hereinafter termed "vapor phase corrosion." The capability of a lubricant to protect against vapor phase corrosion is determinable by use of the aforedescribed rusting test and observation

of that portion of the steel specimen subjected to said test which is not immersed in the bath. Generally speaking, occurrence of vapor phase corrosion, if any, in operation of steam turbines is most potent at the start of the turbine operation as, at that time, condensation normally occurs more extensively than during subsequent operation. It is desirable, therefore, that in such operation a lubricant should be so effective in inhibiting vapor phase corrosion as to protect the metal parts of the system not continually wetted against vapor phase corrosion during the initial operation of the turbine as well as on extended operation thereof. Thus, in summary, a lubricant for steam turbine operation, especially under severe rust-inducing conditions, should possess the ability to readily separate from water without formation of troublesome emulsions and prevent rusting of metal parts of the system continually wetted by the lubricant as well as those parts which are not continually wetted by the lubricant.

Many additives have been considered for or actually are used in lubricants for use in steam turbine operation. Among such additives are saturated long chain fatty acids as described in U. S. Patent No. 2,281,676. With reference thereto, the long chain fatty acids, as exemplified by stearic acid, impart a certain degree of rust-preventive characteristics to oils whereby such oils find usage in operation of steam turbines that are subjected to mild rust-inducive conditions but such acids do not consistently, if at all, provide adequate protection against rusting under the condition of the aforedescribed synthetic sea water rusting test, or against vapor phase corrosion, or both. Other patents relate to the use of alkyl acid phosphates in turbine oils and although such phosphates impart certain desired properties to many oil compositions, the acid phosphates per se do not, as far as I am aware, impart to oil compositions containing same the ability to effectively inhibit vapor phase corrosion. In Patent No. 2,452,321, rust-preventive compositions are disclosed that contain a base oil blended with small amounts of a dicarboxylic acid and an acid phosphate, such a combination being set forth therein as having highly effective rust-preventive properties in the synthetic sea water test. However, and although such compositions may impart rust-preventive properties to a lubricant for steam turbine operation, use of a dicarboxylic acid, as exemplified by alkenylated succinic acid, in combination with an alkyl acid phosphate generally imparts to the oil compositions a decided tendency to emulsify whereby such compositions do not consistently, if at all, pass the emulsion test set forth in the aforedescribed Navy specification or the vapor phase corrosion test. Although the aforesaid patents represent only certain specific illustrations of additives suggested in the prior art for use in turbine lubricants, they serve to illustrate the preparation of oils for certain requirements by addition thereto of a fatty acid, or of an alkyl phosphate, or of an alkyl phosphate in combination with a dicarboxylic acid. However, and as is apparent from the disclosure set forth hereinafter, such compositions fail to consistently, if at all, possess the three-fold desired combination of properties discussed hereinbefore, i. e., rust protective ability under severe rust-inducing conditions for metal components of the turbine continually flooded by the lubricant, protection of the metal components not continually flooded against vapor phase corrosion, and the ability to readily separate from water that comes into contact with the oil without formation of troublesome emulsions.

The present invention relates to liquid lubricant compositions comprising a lubricating oil of turbine grade having dissolved therein a combination additive that imparts to said oil the three-fold desired combination of properties aforediscussed.

For use as the lubricant oil, the invention contemplates use of mineral oil base lubricants having viscosity characteristics suitable for turbine lubricants. Illustrative thereof are low viscosity oils suitable for preparation of light turbine oils, e. g., having a viscosity of about 150–165 SUS at 100° F., and high viscosity oils suitable for preparation of heavy turbine oils, e. g., having a viscosity of about 400–500 SUS at 100° F. Particularly suitable as the lubricant base are highly refined mineral oil fractions, of turbine lubricating viscosity, such as solvent refined oils obtained by use of solvent extraction processes such as are well known to the art. In the illustration thereof, but without intent of limitation, are oils of turbine lubricating grade prepared by solvent extraction of lube oil distillates by use of furfural.

One component of the combination additive is an oil-soluble substantially water-insoluble alkyl acid phosphate and, in particular, acid phosphates that contain an alkyl grouping of from about 8 to 18 carbon atoms. In illustration thereof are alkyl acid phosphates such as the di-2-ethylhexyl acid phosphates, lauryl acid phosphates, and the like. The other component of the combination additive is an oil-soluble substantially water-insoluble fatty acid that contains a lesser number of carbon atoms than stearic acid. For purposes of convenience, the fatty acids contemplated for use herein, which are oil-soluble but substantially water-insoluble and possess a lesser number of carbon atoms than stearic acid are referred to hereinafter as low molecular weight fatty acids. As is apparent from the disclosure set forth hereinafter, the use of acid phosphates in combination with a low molecular weight fatty acid as aforedescribed provides a combination additive that is so effective in imparting the aforediscussed three-fold properties to turbine oils that turbine oil compositions possessing such properties can be prepared by use of very small amounts of the acid phosphate and fatty acid.

In order to further describe the invention, the following tabulation sets forth data pertaining to numerous turbine oil compositions and the performance characteristics thereof with respect to ability to resist emulsification and prevent rusting and vapor phase corrosion, the latter being determined by observing at the completion of 24 hours the portion of the steel specimen that is not submerged in the synthetic sea water bath when the specimen is subjected to the conditions of the aforedescribed rusting test. In the tabulation, example No. 1 relates to the performance characteristics of a highly refined light turbine oil per se, said oil having a viscosity of 164 SUS at 100° F. and prepared by solvent extraction of a predominantly paraffinic light lube distillate with furfural. The remaining examples relate to such a turbine oil but to which has been added an amount or amounts shown of "Ortholeum 162," various fatty acids, "Ionex," and phenyl alpha-naphthylamine as an aromatic amine antioxidant. "Ortholeum 162" is a product marketed by the E. I. du Pont de Nemours Co., Inc., and is understood to comprise a mixture of mono- and di-lauryl acid phosphates and "Ionex" is a product marketed by the Shell Co. and understood to be a 3% solution of alkenylated succinic acid in oil.

Example No.	Composition, Percent by weight in Light Turbine Oil						Emulsion Test		Rusting Test in Synthetic Sea Water	Vapor Phase Corrosion
	"Ortholeum 162"	Stearic Acid	"Ionex"	Lauric Acid	Caprylic Acid	Phenyl Alpha-Naphthyl-amine	Distilled Water	Synthetic Sea Water		
1							Pass	Pass	Fail	Fail.
2		0.10					Pass	Pass	Fail	Fail.
3	0.015						Pass	Pass	Pass	Fail.
4	0.015					0.250			Fail	Fail.
5	0.015	0.01							Fail	Fail.
6	0.015	0.01				0.25			Fail	Fail.
7	0.015	0.02							Fail	Fail.
8	0.015	0.05							Pass	Fail.
9	0.015		0.35				Fail	Pass	Pass	Fail.
10	0.015		0.65				Fail	Pass	Pass	Fail.
11	0.015			0.02			Pass	Pass	Pass	Pass.
12	0.015			0.05			Pass	Pass	Pass	Pass.
13					0.05		Pass	Pass	Fail	Fail.
14	0.015				0.02		Pass	Pass	Pass	Pass.
15	0.015				0.03		Pass	Pass	Pass	Pass.
16	0.015				0.05		Pass	Pass	Pass	Pass.
17	0.015				0.01	0.25	Pass	Pass	Pass	Pass.

In the tabulation, Example No. 1 illustrates the inadequacy of the base oil itself to adequately protect metal surfaces against rusting and vapor phase corrosion; and Examples Nos. 2 to 10, inclusive, and 13 illustrate that the oil containing fatty acids per se (stearic and caprylic), or an alkyl acid phosphate per se ("Ortholeum 162"), or stearic acid in combination with the alkyl acid phosphate, or the alkyl acid phosphate in combination with a dicarboxylic acid ("Ionex") failed to perform satisfactorily with respect to one or a plurality of the aforedescribed tests. On the other hand, Examples Nos. 11, 12 and 14 to 17, inclusive, relate to compositions as embodied herein and, as shown in the tabulation, performed satisfactorily in all of the tests. Example No. 17 further illustrates that compositions as embodied herein may also contain ingredients, in addition to the acid phosphate and low molecular weight fatty acid, for imparting additional desired properties to the lubricant, the usage of such other ingredients being illustrated by use of the aromatic amine anti-oxidant with obtainment of compositions that possess the aforedescribed desired properties evidenced by passage of the emulsion, rusting and vapor phase corrosion tests. As is further illustrated by Examples Nos. 11, 12 and 14 to 17, inclusive, in each instance wherein the compositions contained a combination of the alkyl acid phosphate and low molecular weight fatty acid and were imparted with vapor phase corrosion-inhibiting properties, satisfactory performance in the rusting and emulsion test was also obtained.

As is apparent from the foregoing description of the invention, the compositions embodied herein comprise the base oil in major amount and, for most purposes, the compositions comprise the base oil in an amount of at least about 99% based on the weight thereof. Although the amount of the combination additive employed may be varied depending upon the properties desired in the turbine oil with respect to chartecirstics such as its ability to inhibit formation of stable emulsions with water, protection against rusting and vapor phase corrosion, neutralization number, and so forth, the amount of the combination additive employed is usually within the range of about 0.01 to 1.0% by weight and, for most instances, highly satisfactory compositions are prepared by use of the combination additive in amounts of about 0.01 to 0.1%. The relative proportion of alkyl acid phosphate to low molecular weight fatty acid in the combination addi-

tive may also be varied depending upon particular requirements, the actual proportion employed being such that for a particular turbine oil the combination additive comprises a proportional amount of alkyl phosphate to fatty acid such that the resulting composition is satisfactory with respect to emulsification characteristics and provides adequate protection against both rusting and vapor phase corrosion. Although, as aforesaid, the proportion of acid alkyl phosphate to low molecular weight fatty acid may be varied to meet particular requirements, an illustration of a suitable proportion is use in combination of one part by weight of the acid alkyl phosphate to about one to about five parts of the low molecular weight fatty acid.

Although the present invention has been described in conjunction with certain preferred embodiments thereof, those skilled in the art will readily recognize that variations and modifications can be made. Such modifications and variations are to be considered to be within the purview of the specification and scope of the appended claims.

I claim:

1. A lubricating composition comprising a mineral oil of turbine lubricating grade in major amount based on

the weight of the composition having dissolved therein from about 0.01 to about 1.0 percent by weight of a combination additive consisting essentially of a mixture of mono- and di-lauryl acid phosphate and a fatty acid from the group consisting of caprylic acid and lauric acid in a weight ratio of one part of said mixture of phosphates to from about one to about five parts of the fatty acid.

2. A composition, as defined in claim 1, which contains about 0.015 percent by weight of the mixture of phosphates and from about 0.01 to about 0.05 percent by weight of the fatty acid.

3. A composition as defined in claim 2 which, in addition, contains a small amount of an oil-soluble aromatic amine anti-oxidant.

4. A composition, as defined in claim 3, wherein the anti-oxidant is phenyl alpha naphthylamine.

References Cited in the file of this patent

UNITED STATES PATENTS

2,281,676	Cook	May 5, 1942
2,452,321	Kluge et al.	Oct. 26, 1948
2,481,372	Fuchs et al.	Sept. 6, 1949