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LUBRICANT

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This invention relates to an improved turbine oil. It relates more particularly to a lubricating oil composition consisting principally of a petroleum lubricating oil, the characteristics of the oil being modified by the addition thereto of a relatively small proportion of (di-ethanolaminomethyl)-di-tert.-amylphenol.

A lubricating oil composition to be used as a turbine oil, and especially in modern marine steam turbines, is subject to very exacting requirements. Not only must it perform the ordinary function of lubricating the turbine over prolonged periods without interruption but usually it must serve as a coolant, to lubricate the gearing mechanism and to operate oil-actuated governors or control mechanisms having very nice tolerances and lubricate other auxiliary equipment.

Many lubricating oil compositions highly satisfactory for the lubrication of other mechanisms have been found wholly unsuitable for use as a turbine oil. This is probably due primarily to the fact that in normal use turbine oils rapidly become contaminated with water. Whatever the cause, it is generally recognized that the performance of a turbine oil is not predictable from conventional tests applicable to other oil lubricants.

An essential characteristic of a satisfactory turbine oil is the avoidance of rusting of the metal parts within the oil system of the turbine and auxiliary apparatus under operating conditions.

The use of many lubricating oil compositions, otherwise satisfactory as turbine oils, has resulted in the rusting of metal parts within the oil system with consequent serious interference with the operation of oil-actuated governors and other parts, depending upon close tolerances. The results of such rusting not only interfere with the operation of and tend to clog the delicate clearances of the oil system but the products of the rusting appear to catalyze oxidation of the oil with resultant sludge formation which may further aggravate such conditions. The products of such rusting also appear to act as emulsifying agents.

We have found that the previously experienced rusting of metal parts within the oil system in steam turbines may be substantially inhibited by incorporating in the oil a minor proportion of (di-ethanolaminomethyl)-di-tert.-amylphenol.

The herein referred to (di-ethanolaminomethyl)-di-tert.-ampylphenol used in compounding the improved turbine oil of our present invention can be prepared as follows: In a 1-liter 3-necked flask equipped with a thermometer, dropping funnel and a motor-driven stirrer there are placed 117 grams (0.5 mol.) of di-tert.-amylphenol, 60.9 grams (0.58 mol.) of diethanol amine and 120 c.c. of methyl alcohol. To this solution, maintained at a temperature of 68°–77° F., there is added, with constant stirring, 16.5 grams (0.55 mol.) of formaldehyde as a 35% formalin solution over a period of 40 minutes. The resultant solution is then permitted to stand for 1¾ hours at a temperature of 80° F., and is thereafter heated for 2 hours on a steam bath using a reflux condenser for returning volatile constituents. The reaction mixture is then topped to remove any moisture and unreacted ingredients present by heating at an absolute pressure of 0.6 mm. of mercury, using an oil bath temperature of 300° F. By this procedure, we have obtained as a crude product a yield of 181 grams of a very viscous red oil, analyzing 4.16% nitrogen as compared with the theoretical nitrogen content of 3.99% for pure (di-ethanolaminomethyl)-di-tert.-amylphenol. This yield was equivalent to 103% of the theoretical yield. The crude (di-ethanolaminomethyl)-di-tert.-amylphenol prepared as described above was found to be soluble in oil at normal temperatures in amounts in excess of 0.5% by weight. Its solubility in water was found to be below 0.02%.

In referring to (di-ethanolaminomethyl)-di-tert.-amylphenol herein and in the appended claims, we refer to the above-described product although, of course, we intend to refer by this term to the same material by whatever process it may be made. It will be understood that our invention is not predicated upon the identification of the addend as a matter of terminology.

The lubricating oil constituent of our improved turbine oil may consist of a petroleum lubricating fraction, such as ordinarily specified for turbine oils. It may with advantage be a highly refined lubricating oil, for instance an acid-treated petroleum lubricating oil fraction or one which has been subjected to solvent refining, such as a phenol-treated fraction from East Texas crude. The solvent-refined oils have generally been found more resistant to sludging. For example, phenol-treated East Texas neutrals having the following characteristics have been used with advantage:

	Sample I	Sample II
Gravity, A. P. I.	28.9	26.5
Flash, °F.	405	400
Fire, °F.	455	455
Viscosity at 100°F., S. S. U.	192.3	228.1
Viscosity at 210 °F., S. S. U.	45.3	46.9
Viscosity index (Dean & Davis)	87.1	79.2
Pour, °F.	+10	+5
Neutralization No.	0.025	0.05
Saponification No.	0.27	0.27
Carbon residue, (Conradson), percent	0.031	0.044
Ash, percent	0.000	0.002
Sulfur, percent	0.21	0.34
Steam emulsion No.	1	42
Demulsibility	1,620+	600

The "steam emulsion numbers" appearing in

the foregoing tabulation were determined in accordance with the method designated "Standard Method of Testing for Steam Emulsions of Lubricating Oils, A. S. T. M. D–157–36."

The "demulsibility" values appearing in the foregoing tabulation were determined in accordance with the method designated "Demulsibility Test for Lubricating Oils" prescribed by "Federal Standard Stock Catalog, Section IV, (Part 5), Federal Specifications for Lubricants and Liquid Fuels, General Specifications (Methods for Sampling and Testing), VV–L–791*a*, October 2, 1934, Method 320.32."

The unique requirements of a turbine oil have resulted in the formulation of special test methods for determination of the characteristics of the oil with respect to rusting. The results of rusting tests hereinafter noted were obtained in accordance with the method prescribed by the American Society of Testing Materials and designated "A. S. T. M. Specification D–665–42T for Turbine Oils."

We have discovered that substantial protection against rusting of the metal parts within the oil system of steam turbines may be obtained by incorporating in the turbine oil minor proportions of (di-ethanolaminomethyl)-di-tert.-amylphenol. By incorporating in the oil the crude material prepared as herein described in proportions even as small as 0.3% by weight of the oil, substantially complete protection against rusting, as determined by the previously-identified rusting test, has been obtained. Depending upon the severity of the rusting conditions involved, including temperature, access of air to the oil, amount of water present and the amount of salt or the like in the water, concentrations of this addend varying from about 0.05% to about 1% of the oil by weight may be used with advantage.

The ability of the addend of the present invention effectively to inhibit rusting is unexpected and not readily accounted for. This is particularly evident from the ineffectiveness of many somewhat similar chemical compounds with respect to rust prevention under conditions encountered by turbine oils. Examples of such compounds ineffective in preventing rust under such conditions are bis-(anilinomethyl)-p-tert.-amylphenol, bis-(di-amylamino-methyl)-p-tert.-amylphenol and bis-(butylaminomethyl)-p-tert.-amylphenol.

In the compounding of our improved turbine oil, a small amount of the above-identified addend is admixed with a suitable petroleum lubricating oil in the conventional manner of compounding such oil compositions. In addition to the lubricating oil constituent and the addend previously described, various other addition agents having the ability favorably to influence the characteristics of the turbine oil may be incorporated in the improved turbine oil of our present invention further to improve the properties thereof in various respects.

Our invention will be further illustrated by the following specific examples of its application: The East Texas phenol-treated neutral oil previously identified as Sample II, when subjected to the prescribed rusting tests for turbine oil, resulted in the rusting of 75% to 100% of the surface of the test specimen. When 0.1% of the addend of the present invention was incorporated in said oil and the oil composition tested as before, only a small portion of the surface of the test specimen showed any indication of rusting. Where 0.2% of the addend was incorporated in the oil and the oil composition tested as before, the rusting of the test specimen was confined to even a smaller area. Where the proportion of the addend was increased to 0.3% by weight of the oil, rusting of the test specimen was completely avoided. Similarly, the use of 0.5% of the addend provided complete protection against rusting.

As previously indicated, a further essential characteristic of turbine oils is that they do not form objectionable emulsions under conditions of use. Consequently in the compounding of such oils, it is necessary to avoid the use of addends which might deleteriously affect the emulsibility of the oil. A further advantage of our improved turbine oil is its satisfactory emulsifying characteristics.

For example, an accepted method for determining the emulsifying characteristic of turbine oils is that designated "Emulsion Test for Lubricating Oils" prescribed by "Federal Standard Stock Catalog, Section IV (Part 5), Federal Specifications for Lubricants and Liquid Fuels, General Specifications (Methods for Sampling and Testing) VV–L–791*a*, October 2, 1934, Method 320.12," conventionally known as "Navy emulsion test." The base oil, Sample II, used in the preceding specific illustrations of the invention, satisfactorily complied with the requirements of this test and the desirable emulsion characteristics of this oil were not destroyed by the addition of the (di-ethanolaminomethyl)-di-tert.-amylphenol.

A further notable characteristic of our improved turbine oil is its ability to withstand contamination by water without material separation of the addend from the oil or substantial deterioration of the addend itself.

As previously indicated, depending upon conditions of use, the addend may with advantage be used in proportions ranging from about 0.05% to 1% on the weight of the oil. Proportions even in excess of 1% may be used but such larger proportions have not been found necessary. Though proportions less than 0.05% may be used, such smaller proportions are usually not sufficiently effective. Accordingly, proportions ranging from about 0.05% to about 1% are generally recommended.

We claim:

1. An improved turbine oil which comprises a petroleum lubricating oil containing a proportion of (di-ethanolaminomethyl)-di-tert.-amylphenol effective to retard rusting.

2. An improved turbine oil which comprises a petroleum lubricating oil containing about 0.05% to about 1% of (di-ethanolaminomethyl)-di-tert.-amylphenol.

3. An improved turbine oil which comprises a petroleum lubricating oil containing about 0.3% to about 1% of (di-ethanolaminomethyl)-di-tert.-amylphenol.

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