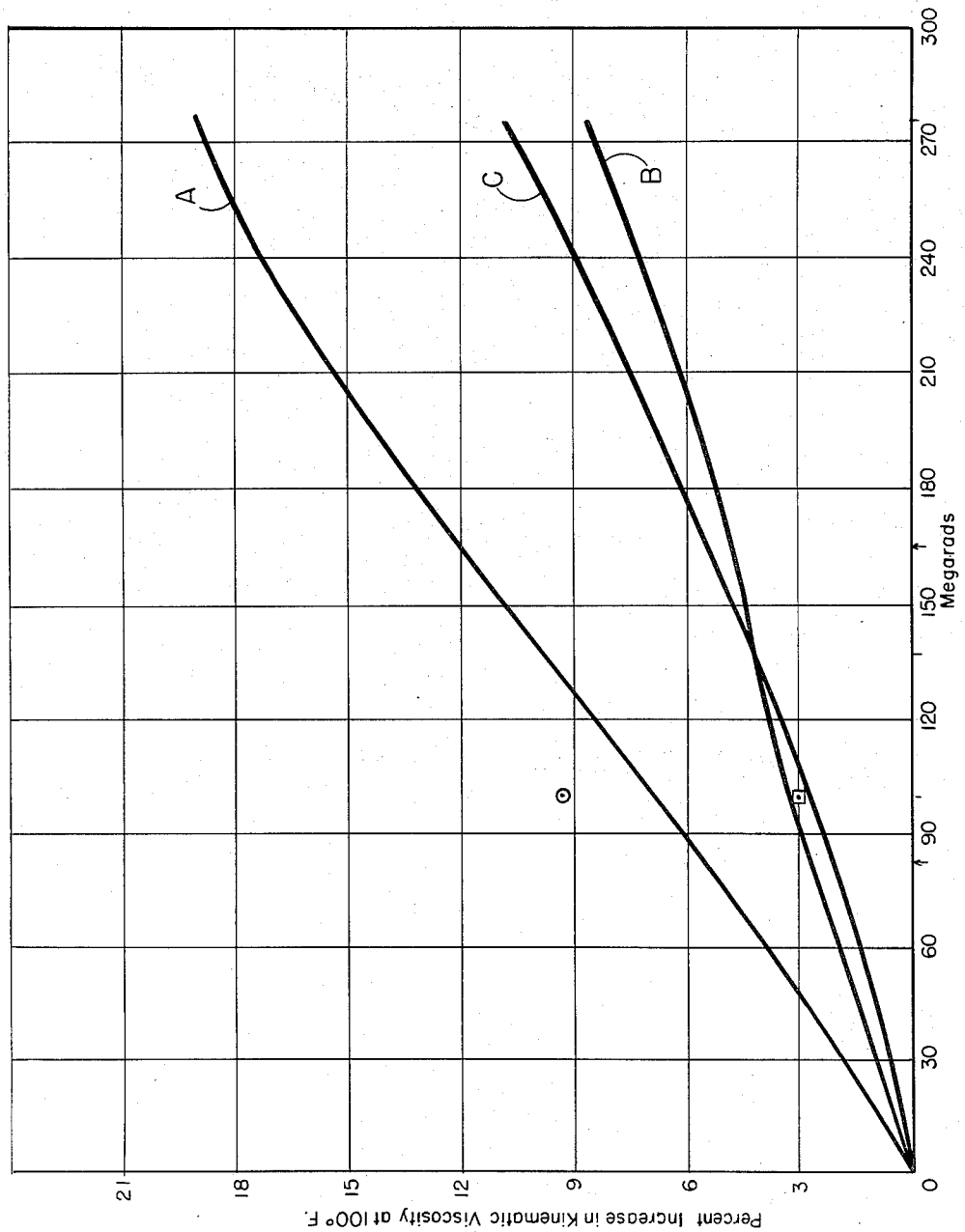
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RADIATION RESISTANT LUBRICATING OIL

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RADIATION RESISTANT LUBRICATING OIL

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This invention relates to the field of lubrication. It is more particularly concerned with the lubrication of machinery that is exposed to atomic radiation.

New and unusual problems are encountered in the lubrication of machinery that is exposed to radiation emitted from an atomic reactor or from atomic ordnance. Such radiation causes physical and chemical damage to the lubricating oil, because of ionization effects resulting from bombardment, such as from neutron and gamma ray bombardment. A most noticeable change that takes place in the oil is an increase in viscosity. Indeed, the increase becomes so marked that the lubricant is usually no longer suitable for its intended purpose.

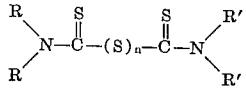
It will be appreciated, therefore, that the afore-described deterioration in lubricating oil gives rise to operational problems. Thus, for example, proposed atomic power plants will require pumps, compressors, turbines, and the like, that will be exposed to radiation, at least to some extent. A method of lubrication that will resist the deleterious effects of radiation will be a necessity. Shielding, of course, may be effective to some extent, but stray radiations may still persist in sufficient intensity to present problems. Likewise, in the event of atomic warfare, machinery, such as military vehicles and guns, can be exposed to radiation. If the effects of radiation in the lubrication thereof are not controlled, such machinery would be in danger of becoming immobilized or, at least, having impaired operability.

It has now been found that the harmful effects of radiation on lubricating oils can be retarded simply and economically. It has been discovered that machinery can be operated in the presence of radiation, with retarded lubrication failure, by lubricating the relatively moving surfaces thereof with a lubricant that comprises mineral lubricating oil that contains certain oil-soluble thiuram sulfides.

Accordingly, it is an object of this invention to retard the deterioration of lubricants that are exposed to atomic radiation. Another object is to provide novel mineral oil compositions. A further object is to reduce lubrication failure of machinery that is operated in the presence of radiation. A specific object is to provide a method for operating machinery in the presence of atomic radiation that comprises lubricating the relatively moving surfaces of said machinery with a lubricant comprising mineral lubricating oil containing certain oil-soluble thiuram sulfides.

Other objects and advantages of this invention will become apparent from the following detailed description in conjunction with the drawing, which shows the graphic relationship between the dosage of radiation and the per cent increase in kinematic viscosity of a base mineral lubricating oil and of typical lubricants utilizable in the present invention.

In general, the present invention provides a mineral lubricating oil containing a small amount, sufficient to substantially prevent viscosity increase thereof under the influence of atomic radiation, of an oil-soluble compound having the formula:

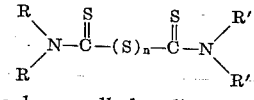


wherein R is a lower alkyl radical, R′ is a lower alkyl radical or an ethoxy lower alkyl radical, and *n* is an integer 1 or 2.

In this specification the amount of radiation that is absorbed by a lubricant is measured in "rad" or "megarad" (1,000,000 rads). A rad is defined as the amount of radiation that will deposit 100 ergs per gram of substance bombarded. The units are used to measure the quantum of radiation absorbed from bombardment by any particle, i.e., electrons, neutrons, gamma rays, and beta rays.

The mineral lubricating oils contemplated for the lubrication of machinery exposed to atomic radiation are any petroleum hydrocarbon fractions ordinarily used for lubrication. Accordingly, there are contemplated gear oils, motor oils, pump oils, turbine oils, and the like. These oils can be petroleum fractions that have been subjected to one or more of the usual treatments applied to lubricating oil production, such as dewaxing, solvent extraction, acid extraction, and mild hydrogenation. The lubricating oil, dependent upon its use, will have a kinematic viscosity falling within the range varying between about 32 centistokes and about 600 centistokes measured at 100° F. The lubricant can also contain other materials adapted to impart specific properties thereto, such as E.P. agents, antirust additives, anti-oxidants, etc.

As mentioned hereinbefore, the lubricant used to lubricate machinery operated in the presence of atomic radiation contains a minor amount of a compound having the formula:



wherein R is a lower alkyl radical, R′ is a lower alkyl radical or an ethoxy lower alkyl radical, and *n* is an integer 1 or 2. In the specification and claims, the term "lower alkyl" signifies alkyl radicals containing between one and five carbon atoms. Illustrative of the substituted thiuram sulfides and disulfides defined by the formula set forth hereinbefore are asym. dimethyl diamyl thiuram disulfide, tetraethyl thiuram sulfide, tetrapropyl thiuram disulfide, tetrabutyl thiuram sulfide, asym. dipropyl di(ethoxypropyl) thiuram disulfide, asym. diamyl di(ethoxyethyl) thiuram sulfide, asym. diethyl di(ethoxyethyl) thiuram disulfide, and tetraamyl thiuram sulfide.

The amount of substituted thiuram sulfide or disulfide, as aforedescribed, necessary in the lubricant to be operable in the presence of atomic radiation will vary between about 0.5 percent and about 5 percent, by weight of the lubricant. Preferably, the thiuram sulfide or disulfide will vary between about 1 weight percent and about 4 weight percent.

The stability of lubricants to radiation was determined by exposing samples to high energy electron bombardment and noting the change of viscosity with increased dosage. Kinematic viscosities were measured in accordance with ASTM procedure D445–53T. The following examples illustrate the effect of radiation on a lubricant and a method for minimizing the effect in accordance with the present invention.

EXAMPLE 1

The oil used in the runs of this example was a solvent refined paraffinic neutral oil having a Saybolt viscosity of 150 seconds at 100° F., a typical light turbine oil. Three portions of this oil were exposed to a high energy electron beam from a 2 mev. (million electron volts) Van de Graaff accelerator adjusted to give each oil 2.28 megarads of radiation per pass, at an exposure time of 9 seconds per pass. Each oil portion was exposed to radiation for a different number of passes, namely, 30, 60, and 100 passes. Thus, the portions were subjected to total

radiation of, respectively, 68.5 megarads, 137 megarads, and 228 megarads. The kinematic viscosities at 100° F. and at 210° F. were determined for each portion of oil. The viscosities were compared with that of the original oil and the percent increase in viscosity over the original was calculated in each case. These percentages are set forth in the table.

EXAMPLE 2

To another batch of the lubricating oil described in Example 1 was added one percent, by weight, of tetrabutyl thiuram disulfide. Three portions of this lubricant blend were subjected to varying dosages of radiation, exactly as described for the three samples in Example 1. Viscosities were determined for the unexposed blend and for each of the three portions after exposure. The viscosities of each portion were compared with the unexposed blend and percent increase in viscosity over the unexposed blend was calculated in each case. The data are set forth in the table.

EXAMPLE 3

To another batch of the lubricating oil described in Example 1 was added 3 percent, by weight, of asym. diethyl di(2-ethoxyethyl) thiuram sulfide. Three portions of this lubricant blend were subjected to varying doses of radiation, exactly as was described in Example 1. The kinematic viscosities of each portion thus exposed were compared with those of the unexposed blend and percent increase in viscosity over the unexposed blend was calculated in each case. The data are set forth in the table.

TABLE

Example	None	68.5 megarads	137 megarads	275 megarads
Example 1:				
Percent kv. increase at 100° F	0	5.5	12	19
Percent kv. increase at 210° F	0	3.3	8.1	12
Example 2:				
Percent kv. increase at 100° F	0	2.8	4.9	8.5
Percent kv. increase at 210° F	0	1.5	3.6	5.6
Example 3:				
Percent kv. increase at 100° F	0	2.2	----------	11
Percent kv. increase at 210° F	0	1.8	----------	7.8

From the data set forth in the table, it will be apparent that the lubricants of Examples 2 and 3 are resistant to radiation. They are not, however, equivalent to each other.

The curves in the drawing are based upon the data set forth in the table. They present the graphic relationship between the percent increase in kinematic viscosity at 100° F. under radiation and the dosage of radiation for a base mineral lubricating oil (Curve A) and for typical lubricants utilizable in the present invention. Curve B shows this relationship for the lubricant containing tetrabutyl thiuram disulfide. Curve C shows the relationship for the lubricant containing asym. diethyl di(ethoxyethyl) thiuram sulfide. It will be noted that the base oil (Curve A) undergoes an increase in viscosity

at a relatively rapid rate, whereas the thiuram disulfide-containing lubricant (Curve B) is more stable. When a thiuram sulfide is used (Curve C), the stability is somewhat less. In both cases, stability is considerably improved over that of the base oil alone.

EXAMPLE 4

A sample of the base mineral oil (Example 1) was exposed to a dosage of 100 megarads of gamma radiation from cobalt-sixty source. The oil had an increase of kinematic viscosity at 100° F. of 9.2% and at 210° F. of 6.8%.

EXAMPLE 5

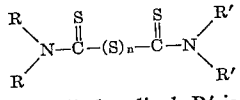
A blend of the base oil containing 3 weight percent of asym. diethyl di(2-ethoxyethyl) thiuram sulfide was subjected to a 100-megarad dosage of gamma radiation from cobalt-sixty. It had an increase of kinematic viscosity at 100° F. of 2.9% and at 210° F. of 2.5%.

The kinematic viscosities at 100° F. for the exposed oils of Examples 4 and 5 are plotted on the figure. It will be noted that the base oil (open circle) had a greater viscosity increase when subjected to gamma radiation, than when subjected to the electron beam (Curve A). Yet, the base oil containing asym. diethyl di(2-ethoxyethyl) thiuram sulfide showed the same resistance to gamma radiation (open square) as to the electron beam (Curve C).

Although the present invention has been described with preferred embodiments, it is to be understood that modifications and variations may be resorted to, without departing from the spirit and scope of this invention, as those skilled in the art will readily understand. Such variations and modifications are considered to be within the purview and scope of the appended claims.

What is claimed is:

1. A mineral lubricating oil containing a small amount, sufficient to substantially prevent viscosity increase thereof under the influence of atomic radiation, of an oil-soluble compound having the formula:



wherein R is a lower alkyl radical, R′ is an ethoxy lower alkyl radical, and *n* is an integer from the Groups 1 and 2.

2. The mineral lubricating oil defined in claim 1 wherein the amount of said oil-soluble compound is between about 0.5 percent and about 5 percent, by weight.

3. A mineral lubricating oil containing between about one percent and about 4 percent, by weight, of asym. diethyl di(ethoxyethyl) thiuram sulfide.

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