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PNEUMATIC TOOL LUBRICANT

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## ABSTRACT OF THE DISCLOSURE

A pneumatic tool lubricant comprising a major amount of hydrocarbon lubricating oil and minor amounts of molybdenum disulfide, zinc dialkyldithiophosphate, organic sulfur compound composed only of carbon, hydrogen, sulfur, and oxygen, and a rust inhibitor selected from the group consisting of aliphatic monocarboxylic acids, sulfonic acids, and metal salts thereof.


## BACKGROUND OF THE INVENTION

### Field of the invention

This invention relates to pneumatic tools and similar apparatus.

Pneumatic tools, usually compressed air-driven, are quite common and widely used. The largest group of pneumatic tools consists of those that are operated by one man and are either hand-held or mounted on a small movable carriage. Typical examples of this kind of tool are the jackhammer, rock drill, and pneumatic wrench.

Because of the severe impact operating conditions of pneumatic tools, lubricants for such tools have been formulated to attempt to meet demands not required of lubricants for other services. The pneumatic tool lubricants should lubricate the pneumatic tools without being substantially affected by the presence of large amounts of dust and water, and they should also serve to keep the dust and water out of the operating parts of the tool. Since water vapor and often aqueous acids are present in the compressed air supplied to the tool or in the immediate vicinity of the work site, the lubricant should also protect the tool from rusting and acid corrosion. In addition, the lubricant should, of course, not itself adversely affect the tool.

Lubricants for pneumatic tools, particularly lubricants designed to be used in the hot and poorly ventilated confines of mines, should also have properties not ordinarily required of lubricants. First, the lubricant and its byproducts should not contribute significantly to fouling of the atmosphere in the vicinity of the tool. The lubricant should also be capable of being injected into the air supply line to the air-driven tool and carried from the remote supply point to the lubrication points of the tool. Finally, the lubricant should minimize the occurrence of "dieseling." This is an explosion phenomenon similar to the compression ignition that occurs in a diesel engine and is caused in pneumatic tools by the oil/air mixture exploding in the compression chamber of the air-driven tool.

Prior art lubricants, however, have all failed to meet one or more of these stringent demands. Users of pneumatic tools have experienced high breakdown rates of their tools, requiring frequent and costly overheauls and cutting production by removing needed tools from service, and have been plagued by the problems of dieseling, rusting, and stray misting.

### Description of the prior art

A pneumatic tool lubricant containing a sulfurized fatty oil is described in U.S. Pat. 2,734,868. The use of molybdenum disulfide as a compound of a lubricating oil is disclosed in a large number of patents, among them U.S.



Pats. 2,156,803 and 3,078, 227. The other components of the claimed lubricant are also individually described in the art. A lubricant containing mixed base oil, zinc dialkyldithiophosphate, and a sulfurized fatty oil has been sold commercially for use in pneumatic tools.

## SUMMARY

I have now invented a lubricant composition which successfully meets all the stringent requirements described above and which provides the effective lubrication of pneumatic tools which has been heretofore unobtainable. This lubricant composition is prepared by combining a major portion of an 80+ viscosity index hydrocarbon lubricating oil and minor effective amounts each of (1) molybdenum disulfide, (2) an organic source of sulfur providing the composition with at least 0.5 weight percent sulfur, (3) a zinc dialkyldithiophosphate, and (4) an organic polar-nonpolar rust inhibitor.

## DETAILED DESCRIPTION OF THE INVENTION

The lubricant of this invention is formulated to provide long-term lubrication to pneumatic tools while reducing the occurrence of dieseling, stray misting, and rusting. In field tests, the lubricant has been shown to extend service life of rock drills between overhauls by factor of seven or more, while reducing dieseling, rusting, and stray misting to insignificant levels.

The lubricant of this invention will have a viscosity index of 80 or higher, and in the multigrade forms defined below the viscosity index may be as high as 140–150. Viscosities at 100° F. may range from 100 to 2,200, depending on the grade desired; excellent service has been obtained with lubricants having viscosities in the range of 300–1,000 SUS at 100° F. The lubricant will contain approximately 0.17–0.25 weight percent zinc, 0.83–1.0 weight percent organic sulfur, and 0.18–0.25 weight percent phosphorus. It also contains molybdenum, which is incorporated from the $MoS_2$ described below. The lubricant has a flash point of at least 300° F. and a pour point dependent on the viscosity and viscosity index.

The lubricant of this invention is produced by blending together a major portion of a hydrocarbon lubricating oil having a natural viscosity index of at least 80 and (1) 0.001 to 15.0 parts by weight of molybdenum disulfide, (2) 0.5–10.0 parts by weight of an organic source of sulfur providing the total composition with a sulfur content of at least 0.5 weight perecnt, (3) 0.1 to 5.0 parts by weight of a zinc dialkyldithiophosphate, and (4) 0.1 to 4.0 parts by weight of an organic polar-nonpolar rust inhibitor. In narrower embodiments which will be discussed below, the lubricant may also contain additives such as an oiliness agent, a tackiness agent, a colorant, a viscosity index improver, etc.

One component of the blend is molybdenum disulfide, a mineral which resembles graphite in appearance. In the compositions of this invention, the molybdenum disulfide is used in a finely divided form and is dispersed throughout the lubricating oil. The molybdenum disulfide ($MoS_2$) will be present in the amount of 0.001–15.0 parts by weight. (All contents herein are by weight, and all are measured on the basis of the total lubricant composition, as though each component wholly retained its individual identity. The actual form in which the materials exist after blending is as a complex mixture of initial components and reaction products, whose exact composition is unknown.) The preferred concentration is 10–2,000 p.p.m. $MoS_2$. The particles of molybdenum disulfide will have diameters in the range of one to 5 microns and normally will not exceed three microns in diameter. Finely divided molybdenum disulfide is commercially available and is generally sold as concentrations of molybdenum disulfide particles suspended in diluent oil. These may be blended directly with the other materials to form the compositions of this invention when the diluent oils are not incompatible with the other components of the composition.

The blend will also include an organic source of sulfur containing sufficient sulfur to provide the finished lubricant with a sulfur content of at least 0.5 weight percent. The organic source of sulfur will be present as 0.5–10.0, preferably 1.5–6.0, parts by weight of the composition.

"Organic source of sulfur," as used herein, refers to compounds or mixtures of compounds containing only carbon, hydrogen, oxygen, and sulfur. The oxygen present will be in the form of ether linkages or in carbonyl, carboxylate, or hydroxyl groups. Each sulfur atom will have at least one bond to a carbon atom or to another sulfur atom. The number of sulfur atoms in the organic source of sulfur will average in the range of 2–20, preferably 2–8, per molecule. The number of carbon atoms will average in the range of 10–70 per molecule. The compounds will normally have molecular weights not exceeding about 1,000 and preferably not exceeding 700. It is preferred that the compounds be selected from the group consisting of aliphatic polysulfides, sulfurized fatty oils and more preferably, mixtures of these two materials. "Aliphatic polysulfide" as used herein refers to a mixture of compounds each of which consists of two monovalent alkyl radicals and on the average of 2 to 8, preferably 3 to 6, sulfur atoms. The alkyl radicals are linked through one or more sulfur atoms. All sulfur atoms except the one or two bonded to the alkyl groups will be bonded only to other sulfur atoms. The alkyl radicals may be the same or different and are of from 1 to 30 carbon atoms, preferably 10 to 25 carbon atoms. The total number of carbon atoms in each compound must equal 10 to 60. It is preferred that the alkyl radicals be alike; i.e., that the compounds be dialkyl polysulfides. Representative aliphatic polysulfide structures are illustrated in U.S. Pats. 2,153,-973; 2,237,526; 2,398,415; and 3,013,969.

Typical aliphatic poly-sulfides which may be used include didodecyl polysulfide, dieicosyl polysulfide, dipentacosyl polysulfide, dodecylheptadecyl polysulfide, mixtures of polysulfides produced by sulfurizing mixed $C_{15}$–$C_{18}$ olefins derived from cracked wax, etc. Typical sulfurized fatty oils which are useful in this composition include sulfurized lard oil, sulfurized sperm oil, sulfurized fish oil, sulfurized palm oil, sulfurized peanut oil, sulfurized corn oil, sulfurized cottonseed oil, sulfurized rosin oil, sulfurized tall oil, etc.

Also included in the blend is a zinc dialkyldithiophosphate. These are well-known compounds widely described in the prior art. The alkyl components may be straight- or branched-chain, and will generally each have 4–18, preferably 4–12, carbon atoms. They may be the same or different.

The zinc dialkyldithiophosphate will be present as 0.1–5.0, preferably 0.1–2.0 part by weight of the composition. Typical compounds which may be used include the zinc salts of the reaction products of $P_2S_5$ and any one or two alcohols such as sec.-butyl alcohol, 4-methyl-2-pentanol, 1-butanol, 1-hexanol, 2-butanol, 3-ethyl-1-hexanol, 1-octanol, 1-dodecanol, etc. The alcohols are normally primary and secondary alcohols.

Another component of the blend will be an organic polar-nonpolar rust inhibitor. This may be a single type of material which itself has rust inhibiting properties, or, more usually, it will be a synergistic mixture of about two or three components which together provide rust and corrosion inhibition. "Organic polar-nonpolar rust inhibitors" are described in detail by Zisman et al. in Advances in Petroleum Chemistry and Refining, vol. 2, (Interscience Publ., Inc. 1959) beginning on page 94. Typical of these rust inhibitors are high molecular weight organic acids such as naphthenic, oleic, and sulfonic acids; salts of these acids, such as neutral and overbased petroleum and mahogany sulfonates of alkali and alkaline earth metals, especially calcium and barium; and the neutralized products of the reaction of these acids and organic bases such as substituted amines. Preferred in this invention are the sulfonate salts, and more preferably the alkaline earth metal petroleum sulfonates, especially the neutral calcium salt. If desired, the neutral calcium salt may be combined with 0.001 to 0.02 part by weight per part by weight of total rust inhibitor of synergistic enhancing materials, such as a polyalkylene glycol of 1,800–2,300 number average molecular weight and a polyalkylene glycol alkyl ether of 950–1,150 number average molecular weight. The organic polar-non-polar rust inhibitor will be present in 0.1–4.0 parts by weight preferably 0.5–1.5 parts by weight of the composition.

The major portion of the lubricant of this composition consists of a hydrocarbon lubricating oil. This oil will be present as 65–95 parts by weight of the lubricant composition, preferably as 80–95 parts by weight. It is preferred that the oil be "paraffinic." This is a general definition which normally refers to the type of crude oil from which the lubricating oil has been derived, and differentiates the oil from those derived from "mixed base" and "naphthenic" crude oils. The definitions of these oils do not involve specific composition limits; rather, they are based on a number of factors and properties which are believed to characterize different types of oils. These are discussed in Nelson, Petroleum Refinery Engineering (4th ed., McGraw-Hill Book Co., Inc., 1958), beginning on page 80.

The oil must have a high natural viscosity index, i.e., of at least 80. It will generally be found that those oils which have the high natural viscosity index are paraffinic oils. The oil may also be selected on the basis of natural viscosity index to provide an inherent minimization of the effects of wide fluctuations in ambient temperature. (This ability, which is analogous to the multigrade properties of automotive oils as defined by Society of Automotive Engineers standards, will be referred to herein as "multigrade capability" and the oils with this ability as "multigrade oils" for convenience, even though there are no comparable official standards for industrial oils.)

In certain services, it will be advantageous to include a small amount of a detergent-dispersant in the lubricant composition; i.e., on the order of 0.25–1.0 part by weight. Typical detergent-dispersants which are suitable for use in these lubricants include the alkyl-substituted succinimides of the type described in U.S. Pat. 3,202,678; petroleum sulfonates; alkyl phenates; polar/nonpolar polymers such as alkylmethacrylate/vinylpyridine copolymers, alkylmethacrylate/polyalkylene glycol methacrylate copolymers; etc.

Another additive which may be present in the composition is a metal deactivator. Bronze is often used for various parts of pneumatic tools, and is quite susceptible to corrosion by certain components of lubricants. A metal deactivator prevents corrosion of the bronze by forming an inert film on the metal and preventing its contact with the corrosive lubricant components. Metal deactivators are generally present in very small amounts; normally they will comprise only 0.01–0.05 part by weight, preferably about 0.02 part by weight of the composition. Typical of the metal deactivators which may be used is quinizarin. The lubricant compositions may also contain tackiness or stringiness agents such as long-chain polymers, e.g., polybutene and polyethylene. Tackiness agents aid the lubricant in adhering to the metal surface to be lubricated. Another type of optional additive is in an oiliness agent. These include fatty oils and acids and synthetic esters of fatty acids. If desired, one may select as the source of organic sulfur a compound or mixture of compounds which provides oiliness as well as sulfur. The composition may also contain additives such as antifoaming agents, colorant, and other additives described in the art. The total amount of these additives will generally not exceed 5.0 parts by weight of the composition, and will usually be in the range of about 1.0–3.0 parts by weight.

When a lubricant with broader multi-grade capabilities than available merely by the choice of the lubricating oil base is desired, a viscosity index improver may be added. A number of viscosity index improvers have been described in the art. In general, these are either isobutene polymers or acrylate e.g. methacrylate polymers. Several satisfactory materials are commercially available under various trade names. Viscosity index improvers are generally used in concentrations of about 3.0–15.0 parts by weight of the composition, generally about 4.0–10.0 parts by weight.

The lubricant compositions of this invention are normally produced simply by mixing the various components together with the base oil. The components may be added to the base oil neat or may be present as concentrations in diluent oils where the diluent oils are compatible and miscible with the base oil. If desired, various groups of individual components may be separately mixed, and these mixtures blended together to produce the finished lubricant. Mixing times may be from 1 minute to 24 hours; the components are mixed until a homogeneous composition is obtained. Mixing can be done at room temperatures or at temperatures up to about 200° F.; use of elevated temperatures will often aid in the dispersion of the components.

The following examples will illustrate the compositions of this invention. Amounts of components are described in parts by weight.

EXAMPLE 1

A base oil having a viscosity index of 85 for a single grade pneumatic tool lubricant was formulated by blending 78 parts of a paraffinic neutral oil having a viscosity at 100° F. of about 480 SUS and a gravity of approximately 28.5° API with 15 parts of a paraffinic bright stock having a viscosity at 210° F. of 180 SUS and a maximum pour point of 15° F. To this base oil were added 2 parts of an aliphatic polysulfide produced from cracked wax olefins and containing approximately 17.5 weight percent sulfur, 2 parts of zinc di(1-methylpropyl/1,3-dimethylbutyl) dithiophosphate containing approximately 7 weight percent phosphorus and 15 weight percent sulfur, 1 part of a mixture of 93 parts of a neutral calcium sulfonate and 0.7 part each of polypropylene glycol and polypropylene glycol butyl ether, 0.5 part of a molybdenum disulfide dispersion commercially available under the trade name "Molykote M," and 0.3 part of a high molecular weight polyisobutene commercially available under the trade name "Paratac." To this mixture were added 2 parts of a blend of sulfurized lard oil and quinizarin in a ratio of 50:1. A minor amount of an antifoaming agent was also added. The resulting pneumatic tool lubricant composition was found to have a viscosity at 100° F. of 656 SUS and a viscosity index of 95.

This lubricant was used in a field test in various pneumatic tools, including rock drills, operated in a hard rock copper mine in Arizona. In previous service using a commercial pneumatic tool oil, the rock drills had operated for an average of approximately 1–10 days before the combined effects of overheating, dieseling, and water-washing of the lubricant required overhauls. With the lubricant of this example, however, the average time between overhauls was extended to approximately 2–3 months of operation. By using the oil of this invention, oil feed rate was decreased by up to 50 percent with no sticking or binding of the rock drills. Oil fog or mist in the vicinity of the drill, smoking, and dieseling were all substantially eliminated. No rusting of the tools was observed over an extended period.

EXAMPLE 2

A base oil having a viscosity index of 96 for a multi-grade pneumatic tool lubricant was prepared by blending 61 parts of a paraffinic neutral oil having a viscosity at 100° F. of a 125 SUS and a gravity of approximately 31.2° API with 20 parts of the neutral oil described in Example 1, and 2 parts of the bright stock described in Example 1. To this mixture were added 10 parts of a polyisobutene viscosity index improver commercially available under the trade name "Paratone N" and the components described in Example 1 in the same amounts as stated above. This lubricant composition had a viscosity at 100° F. of 447 SUS and a viscosity index of 145. In field tests in the same mine, this lubricant was found to have the same high performance qualities as the single grade lubricant described in Example 1.

It is apparent from these data that the pneumatic tool lubricants of this invention have superior lubricating properties, in the extremely severe service environments common to hard rock mining tools. They provide substantially increased tool life, accompanied by a reduced fouling of the atmosphere in the vicinity of the operating tool. The former property substantially improves the economics of mining, for the replacement and overhaul cost of tools is substantially reduced. The latter property reduces the health hazards faced by miners working with or in the vicinity of pneumatic tools.

The above examples are meant for illustrative purposes only. It is apparent that many embodiments of this invention may be compounded without departing from the scope and spirit of the invention.

I claim:

1. A lubricant composition for pneumatic tools which is formulated by combining 65–95 parts by weight of a hydrocarbon lubricating oil having a viscosity index of at least 80 and (1) 0.001 to 15.0 parts by weight of molybdenum disulfide; (2) 0.5 to 10.0 parts by weight of an organic source of sulfur containing only carbon, hydrogen, sulfur and oxygen; wherein each of said sulfur atoms is bonded to carbon or at least one other sulfur atom, and said oxygen is present only in the form of ether linkages or carbonyl, carboxylate, or hydroxyl groups; and capable of providing said lubricant composition with a sulfur content of at least 0.5 weight percent; (3) 0.1 to 5.0 parts by weight of a zinc di($C_4$–$C_{18}$ alkyl) dithiophosphate; and (4) 0.1 to 4.0 parts by weight of an organic rust inhibitor selected from the group consisting of aliphatic monocarboxylic acids, sulfonic acids, and metal salts thereof.

2. The composition of claim 1 wherein said molybdenum disulfide is present as 10 to 2,000 p.p.m. of said composition.

3. The composition of claim 1 wherein said organic source of sulfur is selected from the group consisting of aliphatic polysulfide, sulfurized fatty oil, and mixtures thereof.

4. The composition of claim 1 wherein said zinc di($C_4$–$C_{18}$ alkyl) dithiophosphate is a zinc di($C_4$–$C_{12}$ alkyl) dithiophosphate.

5. The composition of claim 1 wherein said organic rust inhibitor comprises a neutral alkaline earth metal salt of a petroleum sulfonic acid.

6. The composition of claim 1 wherein said hydrocarbon lubricating oil is a paraffinic oil.

7. The composition of claim 1 formulated by combining the materials of claim 1 and 3.0 to 15.0 parts by weight of a viscosity index improver selected from the group consisting of acrylate polymers and isobutene polymers.

8. The composition of claim 1 formulated by combining 80–95 parts by weight of a paraffinic hydrocarbon oil having a viscosity index of at least 80, and (1) 10 to 2,000 p.p.m. of molybdenum disulfide; (2) 1.5 to 6.0 parts by weight of an organic source of sulfur selected from the group consisting of aliphatic polysulfide, sulfurized fatty oil, and mixtures thereof; (3) 0.1–2.0 parts by weight of a zinc di($C_4$–$C_{12}$ alkyl) dithiophosphate, and (4) 0.5 to 1.5 parts by weight of an organic rust inhibitor selected

from the group consisting of neutral calcium petroleum sulfonate and neutral barium petroleum sulfonate.

**9.** The composition of claim **8** formulated by combining the materials of claim **8** and 4.0 to 10.0 parts by weight of a viscosity index improver selected from the group consisting of acrylate polymers and isobutene polymers.

**10.** A process for lubricating a pneumatic tool which comprises applying to a lubrication point of said tool the composition of claim **1**.

**11.** A process for lubricating a pneumatic tool which comprises applying to a lubrication point of said tool the composition of claim **8**.




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