

1

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CUTTING OIL COMPOSITIONS

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5 Claims

ABSTRACT OF THE DISCLOSURE

Cutting oil composition:

- (1) mineral oil
- (2) hydrogenated butadiene-styrene copolymer
- (3) sulfur-containing organic extreme pressure agent
- (4) chlorine-containing organic extreme pressure agent.

BACKGROUND OF THE INVENTION

This invention is related to lubricating compositions. Specifically this invention is related to improved compositions for cutting oils. In one of its aspects, this invention relates to the reduction of friction between a cutting tool and a workpiece.

In one of its concepts the invention relates to the preparation of a cutting oil composition of improved high load performance by addition of a hydrogenated butadiene/styrene copolymer to a conventional cutting oil formulation.

The purpose of a cutting oil is to lubricate the surfaces of the cutting tool and the workpiece in a cutting operation. A cutting oil reduces the friction caused by removing material from the cut surface of the workpiece allowing a cooler temperature in both the cutting surface and the cut surface and reducing the torque on the cutting tool. Cutting oil compositions are subjected to widely varying conditions of use, among which are always included extreme agitation and high pressure applications which break down the oil composition. Usually one of the objections to a cutting oil is smoking caused by breakdown of the oil under operating conditions.

It is therefore an object of this invention to provide a lubricating composition with improved friction reducing properties. It is another object of this invention to provide a cutting oil composition which permits lower temperature and lower cutting torque in cutting operations. Still another object of this invention is to provide a cutting oil composition producing a reduced amount of smoke in cutting operations.

Other aspects, concepts and objects of the invention are apparent from a study of this disclosure and the appended claims.

SUMMARY OF THE INVENTION

According to the present invention there is provided a lubricating oil composition suitable as a cutting oil of superior high load performance comprising (1) a mineral base oil, (2) a hydrogenated butadiene/styrene copolymer, (3) a sulfur-containing multifunctional additive, and (4) a chlorine-containing multifunctional additive.

In one embodiment of the invention, additional compatible nonessential materials of special functions can be added to the lubricating compositions as rust inhibitors, neutralizing aids, and the like.

The hydrogenated copolymers of butadiene and styrene suitable for use in the composition of matter of this invention are disclosed in copending application Ser. No. 686,825, filed Nov. 30, 1967 now U.S. Pat. 3,554,911. These copolymers have a molecular weight, calculated as kinetic molecular weight values, within the approximate range of 25,000 to 125,000 or preferably within the range of about 30,000 to about 75,000. The copolymer can contain from about 30 to about 44 parts by weight butadiene

2

per hundred parts by weight of total polymer with less than 35 percent vinyl unsaturation and about 20 percent trans-unsaturation before hydrogenation. After hydrogenation, the polymer contains virtually no vinyl unsaturation and between 0.5 and 5 percent trans-unsaturation based on total polymer. The hydrogenated butadiene/styrene copolymer component of the cutting oil composition of this invention can comprise in the range of about 0.01 to about 8 weight percent of the cutting oil mixture. The preferred range is about 1 to about 5 weight percent of the cutting oil mixture. The hydrogenated butadiene/styrene copolymers are oil soluble within the levels of concentration proposed above so that no special blending technique is needed for incorporating this additive into a mineral base oil composition.

The mineral oil base stock which is employed according to the process of this invention in amounts ranging from about 99.9 to about 72 weight percent of the total mixture, and preferably in a range of about 99.5 to about 90 weight percent of the total mixture, can be any paraffinic and/or naphthenic base stock having a viscosity in the range of about 50 to about 500 SUS at 100° F. The preferred mineral oil feedstock has a viscosity in the range of 75 to 250 SUS at 100° F.

The hydrogenated butadiene/styrene copolymer containing cutting oils of this invention also contain a sulfur-containing multifunctional additive as essential ingredients. Sulfur- and chlorine-containing additives suitable for this invention are widely used in the art and can be described as those materials, generally mixtures, which contain a substantial amount of chlorine or sulfur, which have substantial solubility in oil, which have at least some chemical reactivity under the conditions of metal cutting, which are effective in reducing the friction experienced in a metal cutting operation, and which do not substantially contribute to the corrosion of tool or workpiece.

Sulfur-containing multi-functional additives are generally formed by reacting elemental sulfur with various organic materials such as fats, oils, or other hydrocarbon materials at elevated temperatures such that the sulfur is combined with the organic material. Such materials have a generally high sulfur content, usually greater than 30 weight percent and in some cases even greater than 40 weight percent. Sulfur-containing additives can be effectively used in concentrations up to about 5 percent by weight of the total composition weight. Preferably, up to about 3 percent sulfur-containing additive is employed in the composition of this invention. An effective sulfur-containing additive for use in the cutting oil compositions of this invention is Anglamol 32, made by the Lubrizol Corporation.

Chlorine-containing additives are similarly prepared. Organic materials such as oils or waxes can be reacted with elemental chlorine to chemically combine a substantial amount of the chlorine with the material. Generally at least 30 and frequently at least 40 weight percent of the material consists of chlorine. Up to 10 percent by weight of the total composition of this invention can be a chlorine-containing additive, but in the more preferred embodiments up to about 5 percent by weight is used. An effective chlorine-containing additive for use in the composition of this invention is Anglamol 40 made by the Lubrizol Corporation.

In addition to the essential ingredients, the cutting oils of this invention can also contain one or more of: anti-acids, organic phosphates, phosphites, metal salts of organic thiophosphates, metal salts of organic thiocarbamates, lead soaps, organic compounds containing phosphorous. Excluding the hydrogenated butadiene/styrene copolymer component, the total proportions of the cutting oil which is comprised of both essential and nonessential additives can be in the range of 0.1 to 20 weight percent.

The preferred range is 0.5 to 5 weight percent. Such additives are useful to promote oiliness, anti-wear properties, and extreme pressure lubrication qualities. These properties reduce friction and prevent wear, dulling, scoring, and seizure of metal surfaces in sliding.

Since, as previously stated, the hydrogenated butadiene/styrene copolymer additive is soluble in oil in the concentration ranges of this invention the blending of this additive with the base mineral oil can generally be accomplished at room temperatures. Concentrates of the sulfur- and chlorine-containing additives can also be blended readily with light oils at room temperatures. Generally, however, heavier oils should be warmed to about 100° F. (38° C.) before these additives are introduced to the mixture. The additives may be incorporated into the mixture in any order. The only requirement for satisfactory blending is a thorough agitation of the entire mixture.

The following are examples showing the preparation of the cutting oil composition of this invention and data presenting the improvement in temperature and cutting tool torque realized by the addition of a hydrogenated butadiene/styrene copolymer to a cutting oil composition. The examples are meant to be illustrative and are not to be taken as exclusive.

Example I

A cutting oil was prepared from 95 percent naphthenic oil, 1 percent of a sulfur containing extreme pressure (EP) agent, and 4 percent of a chlorine-containing EP agent. The naphthenic base oil was a refined, lubricating fraction derived from a naphthenic coastal oil. The lubricating oil fraction had a viscosity of 100 SUS at 100° F. The sulfur-containing material was a commercial EP agent (Anglamol 32, Lubrizol Corp., Cleveland, Ohio) containing about 46 weight percent sulfur and having a viscosity, at 210° F., of about 10.2 cs. The chlorine-containing EP agent was a commercial material (Anglamol 40) containing about 42 weight percent chlorine and having a viscosity at 210° F. of 36.1 cs. The two EP agents were blended with the base oil with sufficient agitation at about 100–110° F. to provide a homogeneous dispersion.

Example II

Two other samples of cutting oil were made according to the process of the present invention by the addition of 3 weight percent and 5 weight percent, respectively, of a hydrogenated copolymer of butadiene and styrene which was added to the composition obtained in Example I with sufficient agitation to provide a homogeneous mixture. The hydrogenated polymer used in this example was a solution-polymerized butadiene/styrene copolymer prepared using the following recipe and conditions:

Parts by weight	
Butadiene	35
Styrene	65
Cyclohexane	800
Tetrahydrofuran	1.5
Sec-butyllithium	0.154
Initiation temperature, 122° F.	
Initiation pressure, 20 p.s.i.g.	

Charge order was cyclohexane, reactor purged with nitrogen, butadiene, styrene, tetrahydrofuran, and sec-butyllithium. Essentially quantitative conversion was obtained in 3 hours. At that time the undetermined product was transferred to a hydrogen reactor, 0.13 g. of nickel (as nickel octoate) and 1.05 g. of triethylaluminum in cyclohexane were added, the reactor was pressured to 50 p.s.i.g. with hydrogen, the temperature was increased slowly to 350° F., the hydrogen pressure was increased to 400 p.s.i.g., and the temperature rose quickly to 395° F. and fell to 350° F. in about 30 minutes. Reaction was continued for 1.5 hours at 350° F. and 400 p.s.i.g., the reactor was cooled to 170° F., and the essentially completely hydrogenated polymer was recovered. This polymer con-

tained less than 35 weight percent vinyl unsaturation before hydrogenation, virtually no vinyl unsaturation and from 0.5–5 percent trans-unsaturation after hydrogenation.

Example III

Both the copolymer-free oil of Example I and the copolymer-containing oils of Example II were then subjected to test for suitability as cutting oils on a Falex lubricant tester (Faville-Le Valley Corp., Chicago, Ill.). The Falex wear test can simply be described as a shaft rotating between two half bearings in a lubricant bath wherein the load on the half bearings can be varied and wherein the temperature of the lubricant bath and the torque required to rotate the shaft can be measured. The test sequence employed consisted of: 5 minutes break-in at 300 pounds load and 200° F. temperature, 1 minute running at 500, 750, 1000, etc., load levels up to 2750 pounds maintaining a constant load during one minute running time at each load level, and measuring torque and oil temperature at each load condition.

The results of these comparison tests are shown in the table below.

COMPARISON OF CUTTING OILS

Load (pounds)	Torque (pound-inches)			Temperature		
	Copolymer-free	Copolymer-containing—		Copolymer-free	Copolymer-containing—	
		3 wt. percent	5 wt. percent		3 wt. percent	5 wt. percent
500	19	13	16	212	210	230
750	26	18	20	245	210	235
1,000	29	20	22	255	213	245
1,250	69	25	45	335	220	260
1,500	65	44	46	335	250	280
1,750	63	44	48	360	267	295
2,000	64	50	50	380	290	310
2,250	68	56	53	395	217	320
2,500	72	59	56	420	342	335
2,750	75	63	60	440	365	350

The data in the above table clearly show that the cutting containing the hydrogenated copolymer of butadiene/styrene exhibited considerably less friction as shown by the lower torque values and lower temperatures compared with the identical but copolymer-free cutting oil composition. It was also observed that the oil without copolymer smoked severely compared to only slight smoking for the oil containing the copolymer. This was not solely an effect of temperature since the copolymer-free oil at 1250 pounds load smoked considerably more than the 5 percent by weight copolymer-containing oil at 2500 pounds load, which as seen in the table above are equal temperature conditions.

Reasonable variation and modification are possible within the scope of the foregoing disclosure and the appended claims to the invention, the essence of which is that there has been provided a lubricating oil composition suitable as a cutting oil which comprises the addition of a hydrogenated butadiene/styrene copolymer to a cutting oil comprised of a mineral base oil, a sulfur-containing multi-functional additive, and a chlorine-containing multi-functional additive whereby the friction reducing properties of the lubricating oil are improved.

I claim:

1. In a cutting oil composition comprising a mineral base oil, up to 5% of a sulfur-containing organic extreme pressure agent, and up to 10% of a chlorine-containing organic extreme pressure agent, the improvement comprising the additional presence of from about 0.01–8% of a hydrogenated butadiene-styrene copolymer having a molecular weight of from 25,000 to about 125,000.

2. The cutting oil of claim 1 wherein the butadiene-styrene copolymer contains from 30 to about 44 parts by weight of butadiene per hundred parts by weight of total copolymer with less than 35 percent vinyl unsaturation before hydrogenation.

3. The cutting oil of claim 1 which is comprised of 0.01 to 5 percent of hydrogenated butadiene-styrene co-

5

polymer, 0.5 to 5 percent of sulfur-containing and chlorine-containing extreme pressure agents, and 72 to 99.9 percent mineral base oil.

4. The cutting oil of claim 1 wherein additional components are included comprising up to 20 percent by weight of the total composition excluding the hydrogenated butadiene-styrene copolymer and mineral base oil, which components are selected from among one or more of antiacids, organic phosphates, organic phosphites, metal salts of organic thiophosphates, metal salts of organic thiocarbamates, and lead soaps.

5. The cutting oil of claim 1 which is comprised of 95 percent by weight naphthenic oil, 1 percent by weight of a sulfur-containing extreme pressure agent, 4 percent by weight of a chlorine-containing extreme pressure agent, and 1 to 5 percent by weight of hydrogenated butadiene-styrene copolymer.

6

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5

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