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Inventor(s)	Chen; Zhuojun et al.

Environmentally friendly metal cutting oil with high load-bearing and high anti-wear properties

Abstract

An environmentally friendly metal cutting oil with high load-bearing and high wear resistance, belonging to the technical field of metal cutting fluids. The cutting fluid is composed of diisooctyl sebacate, phosphate amine salt extreme pressure additives, borate series additives and sulfurized extreme pressure additives, the sulfurized extreme pressure additives are sulfurized fatty acid esters and dialkyl pentasulfide (Rc2540). The load-bearing capacity (Pb) of the cutting oil can reach more than 920N, and the low-load long-wear wear spot diameter (Db) can be less than 0.35 mm.

Inventors: **Chen; Zhuojun (Shenfu Demonstration Zone, CN), Xu; Hongchao (Shenfu Demonstration Zone, CN), Yang; Kaitao (Shenfu Demonstration Zone, CN), Ma; Hongyang (Shenfu Demonstration Zone, CN), Liu; Yuting (Shenfu Demonstration Zone, CN), Fan; Liyan (Shenfu Demonstration Zone, CN)**

Applicant: **Shenyang Peite Technology Co., Ltd** (Shenfu Demonstration Zone, CN)

Family ID: **1000008627802**

Assignee: **Shenyang Peite Technology Co., Ltd (Shenfu Demonstration Zone, CN)**

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to Chinese Patent Application No. 202510236505.6, filed on Feb. 28, 2025 before the China National Intellectual Property Administration, the disclosure of which is incorporated herein by reference in entirety.

TECHNICAL FIELD

[0002] The present invention relates to the field of metal cutting oil technology, and specifically to an environmentally friendly metal cutting oil with high load-bearing and high anti-wear properties.

BACKGROUND

[0003] Cutting oil is widely used in modern metal cutting processing and has become an indispensable and important supporting material for mechanical processing. Frost and Sullivan's research report on the current status of the metal processing industry shows that companies that consume metal cutting oil (such as factories producing engines, etc.) have begun to shift their investment locations. For example, companies in North America have begun to build their factories in China, India and Mexico, and European manufacturers have begun to shift from Western Europe to Eastern Europe, providing a very good opportunity to start to use synthetic oil to replace mineral oil as a base oil. In some developed regions such as the United States and Europe, plant-based cutting oils have begun to receive widespread acceptance. The rapid development of the metal processing industry provides great opportunities for the widespread application of new metal cutting oils, such as UNIST environmentally friendly plant-based quasi-dry cutting oil UNIST MIST OIL310, which is mainly used in stainless steel processing. As a non-mineral lubricating cutting oil, the French Scalan ZW vegetable cutting oil is made of moderately refined vegetable oil and synthetic high-tech special additives, and is formulated to high specifications. The product has the advantages of being biodegradable and not causing environmental damage. In Japan, the utilization rate of environmentally friendly metal cutting oil has increased more significantly. At the same time, most developed countries in the world are also actively carrying out research and production of environmentally friendly metal cutting oil.

[0004] Since the 1970s and 1980s, following the rapid growth of the world's industrial economy, China's metalworking fluid consumption has also increased steadily. From the mid-1990s to the early 21st century, the demand for water-based cutting fluids has grown slowly, and the demand for cutting oils has gradually recovered and grown rapidly. The domestic Chinese market also attaches great importance to the research and application of environmentally friendly cutting oils. In recent years, the demand for cutting oils in the Chinese market has increased year by year, but the research on environmentally friendly cutting oils in China is still lagging behind that of developed countries. Some excellent companies have developed many environmentally friendly cutting oil additives, such as T-323 extrusion anti-wear agent (aminothioester) of Jinzhou Herun Lubricant Additive Co., Ltd. The research on green and environmentally friendly cutting oil is not only an urgent topic in China, but also a common goal pursued by many research institutions.

[0005] The base oil used in traditional cutting oil is mostly refined mineral oil, which is a well-known substance with low price, but also with poor biodegradability, prolonged soil and water water retention, and harmful ecological effects. The ester group contained in the molecular structure of synthetic esters is easy to adsorb on metal surfaces to form a firm lubricating film, providing good friction reduction and anti-wear effects, with good biodegradability. With the continuous improvement of the performance and environmental hygiene requirements of cutting oil, synthetic ester is used more and more widely in cutting fluid as an effective substitute for mineral oil.

[0006] Different types of synthetic esters have different applications in cutting oil products. Neopentyl polyol ester (NPE-3) has excellent performance. It refers to a type of synthetic ester with a quaternary carbon atom in the ortho position of the ester group in the molecular structure, including neopentyl glycol ester, trimethylolpropane ester and pentaerythritol ester. Among ester oils, polyol esters have the best performance and lubrication performance. The reason is that the β carbon atom in the molecular structure of neopentyl polyol ester does not contain hydrogen, and the huge neopentyl group provides a good spatial shielding effect on the ester group, which increases the activation energy required for the thermal decomposition of neopentyl polyol to generate free radicals. This makes its thermal decomposition temperature usually high relative to that of dibasic acid esters by about 50° C., and also makes its antioxidant performance better than general diesters; secondly, the lubricity of neopentyl polyol esters is better than diesters and mineral oils, and far better than polyalphaolefins (PAO), and the long- and short-chain mixed esters have minimal friction coefficient despite their low viscosity; thirdly, neopentyl polyol esters have good viscosity-temperature and evaporation properties. It is precisely because of the above advantages that neopentyl polyol esters have been widely used in the field of lubrication. For example, jet engine lubricants, automobile engine lubricants, precision instrument oils, grease base oils to protect machine parts, metalworking fluids (such as cutting fluids), etc.

[0007] Additives to metal cutting oils also pollute the environment in many ways. For example, chlorinated paraffin is used as an extreme pressure anti-wear agent in cutting fluid components. It is currently banned due to its carcinogenic risk and post-processing pollution. Sodium nitrite and other water-soluble rust inhibitors may also be added. They react with metals to form an insoluble dense oxide film on their surface to prevent the electrochemical corrosion process of metals. Most of these rust inhibitors are electrolytes, which are toxic, difficult to post-process, and tend to be chemically labile. Molybdate rust inhibitors are non-toxic and non-polluting, but they are expensive; organic phosphorus-containing rust inhibitors have a certain corrosive effect on copper and its alloys, and also cause eutrophication of water bodies. Therefore, the development of low-phosphorus or phosphorus-free rust inhibitors is the prominent area of development. Adding preservatives and fungicides to metal cutting fluids can effectively kill and inhibit microorganisms, but in recent years, due to increasingly stringent environmental regulations, commonly used phenolic and formaldehyde-releasing fungicides have been restricted.

[0008] Given that traditional cutting oils are facing the dual pressure of increasingly stringent process requirements and increasingly stringent environmental regulations, it is imperative to improve and upgrade technology in this area. This requires not only continuous improvement in the processing performance of cutting fluids, but also focusing on research, development and promotion of low-toxic, low-pollution, environmentally friendly cutting fluid products.

SUMMARY

[0009] In view of the above-mentioned shortcomings of the prior art, the purpose of the present invention is to provide an environmentally friendly metal cutting processing oil with high load-bearing and high wear resistance. The cutting oil has excellent high and low temperature high load-bearing and high wear resistance, and is non-toxic and suitable for a variety of metal cutting oils.

[0010] In order to achieve the above-mentioned purpose, the technical scheme adopted by the

present invention is as follows:
[0011] An environmentally friendly metal cutting oil with high load-bearing and high wear resistance, wherein the cutting oil is composed of a base oil, a phosphate amine salt extreme pressure additive, a borate additive and a sulfurized extreme pressure additive, wherein the sulfurized extreme pressure additive is a sulfurized fatty acid ester and a dialkyl pentasulfide (Rc2540), and wherein the base oil is diisooctyl sebacate.
[0012] In the cutting oil, the quantity of the phosphate amine salt extreme pressure additive is 0.12-0.80% of the base oil weight; the weight % of the borate additive is 0.05-1.60% of the base oil weight, the weight % of the sulfurized fatty acid ester is 0.10-0.85% of the base oil weight, and the weight % of the dialkyl pentasulfide (Rc2540) is 0.20-0.85% of the base oil weight.
[0013] Preferably, the addition weight ratio of the sulfurized fatty acid ester to the dialkyl pentasulfide (Rc2540) ranges from 0.23 to 5.
[0014] Preferably, the addition weight ratio of the phosphate amine salt extreme pressure additive to the borate additive is greater than 0.2.
[0015] Further, the borate additive is octadecyloxythio nano calcium borate (T365).
[0016] Furthermore, the phosphate amine salt extreme pressure additive is a fatty cluster phosphate amine salt (T6150), and the fatty cluster phosphate amine salt (T6150) is a mixture of phosphate amine salts, and its general structural formula is as shown in Formula (1):
##STR00001##
[0017] In formula (1), R is a C1-C4 aliphatic alkyl group, and NH2R′ is a C12-C14 aliphatic alkyl primary amine.
[0018] Furthermore, the formula of the cutting oil is: the addition amount of the phosphate amine salt extreme pressure additive, borate additive, sulfurized fatty acid ester and dialkyl pentasulfide (Rc2540) is 0.60-0.80%, 0.20-0.35%, 0.02-0.10% and 0.65-0.78% of the base oil weight, respectively, or the addition amount of the phosphate amine salt extreme pressure additive, borate additive, sulfurized fatty acid ester and dialkyl pentasulfide (Rc2540) is 0.25-0.42%, 1.2-1.65%, 0.50-0.75%, 0.03-0.15% of the base oil weight, respectively; the load capacity (Pb) of the cutting oil of said formula is greater than or equal to 920N, and the low load long wear spot diameter Db is less than 0.35 mm at a load F=294N and a loading time T=60 min.
[0019] Furthermore, the preparation process of the environmentally friendly cutting oil is as follows: adding phosphate amine salt extreme pressure additives, borate additives and sulfurized extreme pressure additives to the base oil in proportion, stirring evenly, and heating at 75-100° C. for 30-60 minutes to obtain the environmentally friendly cutting oil.
[0020] The design mechanism and beneficial effects of the present invention are as follows:
[0021] 1. The performance of the base oil directly affects the performance of the cutting oil, and the thermal stability of the cutting oil is closely related to its structure. The environmentally friendly metal cutting fluid of the present invention uses diisooctyl sebacate as the base oil, which has many advantages, such as perfect low temperature performance, strong solubility and clarity, suitable lubricity and low volatility, low viscosity, good fluidity, etc. The most important thing is that diisooctyl sebacate has excellent biodegradability.
[0022] 2. The amount of additives in the cutting oil is small, and their content usually does not exceed 2% of the overall cutting oil. Even so, relying solely on the small proportion of additives determines the performance of a cutting oil product. The amount of additives added should be appropriate. Too little will affect the physical and chemical properties of the cutting oil, and too much will make the physical and chemical properties of the cutting oil unsatisfactory. The present invention adds a specific proportion of fatty cluster phosphate amine salt (T6150), octadecyloxythio nano calcium borate (T365), sulfurized fatty acid ester and dialkyl pentasulfide (Rc2540) to the mixed base oil. The compounded additives and the base oil work synergistically to improve the tribological properties and physical and chemical properties of the cutting oil.
[0023] 3. The environmentally friendly metal cutting oil of the present invention has excellent anti-

wear performance and environmental protection performance, and its high and low temperature load-bearing capacity is excellent.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] FIG. **1** shows the SEM photo and energy spectrum of the steel ball wear spot in the four-ball test of sample D4 (F=294N, T=60 min); where: (a) and (b) are SEM photos of wear spots magnified 500 times and 2000 times respectively; (c) is a total spectrum distribution map.

[0025] FIG. **2** shows the typical position and energy spectrum of the steel ball wear spot in the four-ball test of sample D4; where: (a) Typical position on the wear spot SEM photo; (b)-(d) are the energy spectra of spectrum 69, spectrum 70, and spectrum 71 respectively.

[0026] FIG. **3** shows the eye photo of guinea pigs 15 minutes after the start of the eye drop test (female in the upper picture, male in the middle picture, and young rat in the lower picture).

[0027] FIG. **4** shows the eye photo of guinea pigs 1 hour after the start of the eye drop test (female in the upper picture, male in the middle picture, and young rat in the lower picture).

[0028] FIG. **5** shows the eye photo of guinea pigs 24 hours after the start of the eye drop test (female in the upper picture, male in the middle picture, and young rat in the lower picture).

[0029] FIG. **6** is a photo of the guinea pig's eyes 48 hours after the eye drop test began (female in the upper picture, male in the middle picture, and young mouse in the lower picture).

[0030] FIG. **7** is a photo of the guinea pig's back on the 4th day of the smear test (female in the upper picture, male in the middle picture), and young mouse in the lower picture).

[0031] FIG. **8** is a photo of the guinea pig's back on the 8th day of the smear test (female in the upper picture, male in the middle picture), and young mouse in the lower picture).

[0032] FIG. **9** is a photo of the guinea pig's back on the 12th day of the smear test (female in the upper picture, male in the middle picture), and young mouse in the lower picture).

DETAILED DESCRIPTION OF EMBODIMENTS

[0033] In order to further understand the present invention, the present invention is described below in combination with examples, but the examples are only for further elaboration of the characteristics and advantages of the present invention, rather than for limiting the claims of the present invention.

[0034] In the following examples and comparative examples, diisooctyl sebacate was purchased from Shandong Ruijie New Materials Co., Ltd., and the physical and chemical properties of diisooctyl sebacate are shown in Table 1.

[0035] Fatty cluster phosphate amine salt (T6150) is a mixture of phosphate amine salts, and its general structural formula is as shown in Formula (1):

##STR00002##

[0036] In formula (1), R is a C1-C4 aliphatic alkyl group, and NH2R′ is a C12-C14 alkyl primary amine.

[0037] The preparation process of the fatty cluster phosphate amine salt (T6150) is as follows:

[0038] A C1-C4 monohydric alcohol (such as isopropanol or n-butanol) is added to the reactor, and phosphorus pentoxide and/or white oil are added in batches under stirring at room temperature. After the addition of the materials, the mixture is reacted at 60-80° C. to obtain a mixture of phosphate esters. Then, C12-C14 alkyl primary amines (such as tertiary alkyl primary amines) are added in batches, and after the addition of the materials, the mixture is reacted at 75-85° C. to obtain a mixture of phosphate amine salts, which is the fatty cluster phosphate amine salt. The synthesis route is as follows:

##STR00003##

[0039] The physical and chemical properties of the fatty cluster phosphate amine salt T6150 are

shown in Table 2.
[0040] Octadecyloxythio nanoborate calcium (T365) was purchased from Qingdao Mosel Lubricant Co., Ltd., and the physical and chemical properties of T365 are shown in Table 3.
[0041] Sulfurized fatty acid ester: purchased from Cangzhou Yida Borun Petrochemical Co., Ltd., model YD-3015; as a light-colored, low-odor inactive sulfurized extreme pressure anti-wear agent, the sulfurized fatty acid ester has good viscosity and adhesion. At the same time, the oil film is also thick and has good wear resistance. The physical and chemical properties of the sulfurized fatty acid ester are shown in Table 4.
TABLE-US-00001 TABLE 1 Physical and chemical properties of diisooctyl sebacate Chemical Melting Boiling Density Flash Water Viscosity formula point ° C. point ° C. kg/m.sup.3 point ° C. solubility mm.sup.2/s C26H48O4 −55 248 0.914 215 Insoluble 11.8
TABLE-US-00002 TABLE 2 Physical and chemical properties of fatty cluster phosphate amine salt T6150 Kinematic Phosphorus Nitrogen Density viscosity Flash content content kg/m.sup.3 mm.sup.2/s point ° C. wt % wt % 968 34.9 106 8.27 2.0
TABLE-US-00003 TABLE 3 Physical and chemical properties of octadecyloxythio nano calcium borate (T365) Kinematic Phosphorus Nitrogen viscosity Flash point Pour content content Appearance (100° C.) (open) ° C. point ° C. wt % wt % Oily liquid 9.0-10.0 ≥205 ≤−20 0.52-0.83 1.0-1.2
TABLE-US-00004 TABLE 4 Physical and chemical properties of sulfurized fatty acid ester (YD-3015) Density Kinematic Sulfur Active sulfur (20° C.) viscosity Flash content content kg/m.sup.3 (40° C.) mm.sup.2/s point ° C. wt % wt % 0.9-0.98 About 60 ≥220 About 15.5% ≤1%
Examples 1-7 and Comparative Examples 1-3
[0042] In the following examples and comparative examples, the environmentally friendly metal cutting oil is obtained by adding phosphate amine salt extreme pressure additives, borate additives and sulfurized extreme pressure additives to diisooctyl sebacate base oil, stirring evenly, and heating at 85° C. for 50 minutes. Among them, the phosphate amine salt extreme pressure additive is a fatty cluster phosphate amine salt (T6150), the borate additive is octadecyloxythio nano calcium borate (T365), and the sulfurized extreme pressure additive is sulfurized fatty acid ester (YD-3015) and dialkyl pentasulfide (Rc2540). The amount of each additive added is shown in Table 5. The proportion of each additive in Table 5 refers to the weight ratio of the amount added to the base oil).
TABLE-US-00005 TABLE 5 Composition and performance of cutting fluids with diisooctyl sebacate as base oil and T6150, T365, YD-3015, and Rc2540 as additives Sulfurized fatty acid Sample No. T6150/% T365/% ester/% Rc2540/% Pb/N Db/mm D1 0.03 1.0 0.51 0.75 696 0.377 (Comparative Example 1) D2 (Example 0.15 0.7 0.15 0.63 755 0.373 1) D3 (Example 0.27 0.05 0.75 0.51 755 0.377 2) D4 (Example 0.39 0.35 0.39 0.39 784 0.360 3) D5 0.51 1.5 0.03 0.27 755 0.380 (Comparative Example 2) D6 (Example 0.63 1.2 0.63 0.15 784 0.369 4) D7 0.75 0.9 0.27 0.03 755 0.397 (Comparative Example 3) D8 0.63 0.2513 0.15 0.75 928.495 0.385 (Comparative Example 4) D9 0.3 1.2 0.53 0.03 668.066 0.3413 (Comparative Example 5) d1 (Example 0.75 0.27 0.51 0.75 834 0.367 5) d2 (Example 0.15 0.63 0.15 0.63 834 0.373 6) d3 (Example 0.5 0.4 0.75 0.51 755 0.376 7) d4 (Example 0.62 0.32 0.08 0.68 928.4947 0.3425 101) d5 (Example 0.35 1.20 0.50 0.13 951.0450 0.3393 102) d6 (Example 0.42 1.35 0.62 0.08 995.2058 0.3413 103)
[0043] The cutting oils prepared in Examples 1-7, Examples 101-103 and Comparative Examples 1-3 were tested as follows:
[0044] 1. Tribological performance test, the test indicators are: maximum non-seizure load Pb value and low-load long wear test. The four-ball friction and wear tester provided by Shenyang Great Wall Lubricant Manufacturing Co., Ltd. was used, and the manufacturer was Jinan Yihua Tribology Testing Technology Co., Ltd. in Shandong. The model of the four-ball tester is MRS-10P, the maximum test force is 10 KN, the factory number is 1507, and the factory date is 2015.11.
[0045] The test conditions for low-load long wear: load F=294N, loading time T=60 min;

[0046] The extreme pressure value Pb and long wear value Db (F=294N, T=60 min) of the cutting oil products tested in each embodiment and comparative example are shown in Table 5.
[0047] It can be seen that when the amount of additives added in samples D1, D5, D7, D8 and D9 does not meet the requirements or the proportion of additives is inappropriate, the cutting fluid PB value is low or the low-load long wear wear spot diameter (Db) value is high.
[0048] After optimizing the proportions of the components in the cutting oil, its load capacity (Pb) can reach more than 920N, and the long wear value Db (F=294N, T=60 min) is less than 0.35 mm, as shown in Examples 101, 102 and 103.
Sample Surface Morphology Analysis:
[0049] The SEM photo and energy spectrum of the wear spot of the steel ball in the four-ball test of sample D4 (Example 3) are shown in FIG. **1**. From the SEM photos of the wear spot in FIG. **1**(*a*)-(*b*), it can be clearly seen that there is corrosion on the wear spot surface, indicating that the elements in the additives in the cutting oil have a slight corrosive effect on the metal surface of the steel ball. This is because the fatty cluster phosphate amine salt T6150 has a corrosive effect on the wear spot of the steel ball; it can also be seen that the wear marks of the steel ball wear spot are small in size, shallow in depth, and the wear marks are distributed more evenly, indicating that the additives added to diisooctyl sebacate play a good friction reduction role. FIG. **1**(*c*) is the total energy spectrum of the steel ball wear spot surface, and FIG. **2** is the energy spectrum of the typical position. In the figure, it can be seen that there are P, S and other elements at each position on the steel ball wear spot, indicating that the additives play a good friction reduction role during low-load long-term wear.
2. Toxicity Test: Detect the Effect of the Cutting Oil in this Example on the Eyes of Guinea Pigs (Eye Drop Test):
(1) Preparation Before the Experiment
[0050] Three guinea pigs were used in this test, one female (242.5 g) and one male (251.4 g), 2 months old; one young mouse (210.2 g). The seller is Liaoning Changsheng Biotechnology Co., Ltd., with a quality certificate number of 210726221101483537. The sample oil selected was sample D4 cutting oil.
[0051] The control oil sample was Betis Spanish extra virgin olive oil, which is an edible vegetable blended oil. The formula is 88 wt % sunflower seed oil and 12 wt % extra virgin olive oil.
(2) Eye Drop Test Process and Results
[0052] The sample D4 cutting oil was dripped into the right eye of the guinea pig, 3˜5 ml each time, and the olive oil was dripped into the left eye of each guinea pig, 3˜5 ml each time as a control.
[0053] The time intervals for eye drops were 3 min, 5 min, 10 min, 15 min, 30 min, 1 h, 2 h, 24 h, and 48 h. Photos were taken before each eye drop.
[0054] At 3 min after the eye drops, the eyes of the guinea pigs that had been dripped with sample oil and olive oil squinted due to discomfort, and then gradually returned to normal.
[0055] As can be seen from FIG. **3**, 15 min after the start of the eye drop test, the state of the guinea pig's eyes improved compared to the initial squinting state, and the right eye gradually opened.
[0056] Compared with the 15 min photo, in FIG. **4**, at 1 h after the eye drop test, the guinea pig's eyes did not improve significantly, but it can be seen that the eyes are getting bigger and brighter.
[0057] As can be seen from FIG. **5**, at 24 h after the eye drop test, the eyes of the guinea pigs, whether the right eye dripped with sample oil or the left eye dripped with olive oil, have no obvious difference from the eyes of the guinea pigs in the normal state.
[0058] 48 h after the start of the eye drop test (FIG. **6**), the right eye of the guinea pig dripping with sample oil is bright and completely restored to normal.
[0059] The above eye drop test was performed on the cutting oils of other embodiments, and the test results were the same as those of sample D4.
[0060] The above analysis and test results show that the cutting oil of the present invention has

little effect on the eyes of guinea pigs and is non-toxic.
3. Toxicity Test: Detect the Effect of the Cutting Oil in this Example on the Skin of Guinea Pigs (Smear Test):
(1) Preparation Before the Experiment
[0061] A total of 3 guinea pigs were used in this test. The seller is Liaoning Changsheng Biotechnology Co., Ltd., with a quality certificate number of 210726221101483537. One adult female mouse (286 g), one adult male mouse (292 g) and one young mouse (206 g).
[0062] Sample D4 cutting oil was used as the sample oil.
[0063] The control oil sample was Betis Spanish extra virgin olive oil, which is an edible vegetable blended oil. The formula is 88 wt % sunflower seed oil and 12 wt % extra virgin olive oil.
(2) Smear Test Process and Result Analysis
[0064] Part of the hair on the back of the guinea pig was removed to apply the oil sample. The sample oil was applied to the right back of the guinea pig, 2˜3 ml each time, and the olive oil was applied to the left back of each guinea pig, 2˜3 ml each time as a control.
[0065] The duration of the smear test was fourteen days, and it was ensured that it was applied once a day. Photos were taken on the fourth, eighth, twelfth days, and two days after the end of the test. FIGS. **7-9** are smear photos (the order of the photos from top to bottom is female, male, and young mice).
[0066] FIGS. **7-9** can clearly show the changes in the guinea pig skin during the smear test. As can be seen from FIGS. **7-9**, during the entire smearing process, the guinea pig's skin remained intact and no adverse phenomena occurred. It can be seen that the sample D4 cutting oil, like olive oil, has no adverse effects on the guinea pig's skin.
[0067] During the entire smearing test, the weight of the guinea pig increased from 292 g for males, 286 g for females, and 206 g for young mice to 408.6 g for males, 337.8 g for females, and 282.6 g for young mice. The growth of each guinea pig was very good. It can be seen that the smearing test also had no adverse effects on the growth of guinea pigs.
[0068] Finally, it should be noted that the above embodiments are only used to illustrate the technical solutions of the present invention, rather than to limit it. Although the present invention has been described in detail with reference to the aforementioned embodiments, those skilled in the art should understand that they can still modify the technical solutions described in the aforementioned embodiments, or make equivalent replacements for some of the technical features therein. However, these modifications or replacements do not deviate the essence of the corresponding technical solutions from the spirit and scope of the technical solutions of the embodiments of the present invention.

Claims

1. An environmentally friendly metal cutting oil with high load-bearing and high anti-wear performance, characterized in that the cutting oil is composed of a base oil, a phosphate amine salt extreme pressure additive, a borate additive and a sulfurized extreme pressure additive, wherein the sulfurized extreme pressure additive is a sulfurized fatty acid ester and a dialkyl pentasulfide Rc2540, and wherein the base oil is diisooctyl sebacate.
2. The environmentally friendly metal cutting oil with high load-bearing and high anti-wear performance according to claim 1, characterized in that: the weight % of the phosphate amine salt extreme pressure additive is 0.12-0.80% of the weight of the base oil; the weight % of the borate additive is 0.05-1.60% of the weight of the base oil, the weight % of the sulfurized fatty acid ester is 0.10-0.85% of the weight of the base oil, and the weight % of the dialkyl pentasulfide Rc2540 is 0.20-0.85% of the weight of the base oil.
3. The environmentally friendly metal cutting fluid with high load-bearing and high anti-wear performance according to claim 2, characterized in that the weight ratio of the sulfurized fatty acid

ester to the dialkyl pentasulfide Rc2540 is in the range of 0.23 to 5.

4. The environmentally friendly metal cutting oil with high load-bearing and high anti-wear performance according to claim 3, characterized in that the weight ratio of the phosphate amine salt extreme pressure additive to the borate additive is greater than 0.2.

5. The environmentally friendly metal cutting oil with high load-bearing and high anti-wear performance according to claim 1, characterized in that the borate additive is octadecyloxy sulfonated nano calcium borate T365.

6. The environmentally friendly metal cutting oil with high load-bearing and high anti-wear performance according to claim 1, characterized in that: the phosphate amine salt extreme pressure additive is a fatty cluster phosphate amine salt T6150, and the fatty cluster phosphate amine salt T6150 is a mixture of a class of phosphate amine salts, and its general structural formula is as shown in formula (1): ##STR00004## wherein, in formula (1), R is a C1-C4 aliphatic alkyl group, and NH2R′ is a C12-C14 fatty alkyl primary amine.

7. The environmentally friendly metal cutting oil with high load-bearing and high wear resistance according to claim 1, characterized in that: the formula of the cutting oil is: the addition amount of the phosphate amine salt extreme pressure additive, borate additive, sulfurized fatty acid ester and dialkyl pentasulfide Rc2540 is 0.60-0.80%, 0.20-0.35%, 0.02-0.10% and 0.65-0.78% of the base oil weight, respectively, or the addition amount of the phosphate amine salt extreme pressure additive, borate additive, sulfurized fatty acid ester and dialkyl pentasulfide Rc2540 is 0.25-0.42%, 1.2-1.65%, 0.50-0.75%, 0.03-0.15% of the base oil weight, respectively; the load-bearing capacity Pb of the cutting oil of said formula is greater than or equal to 920N, and the low-load long-wear wear spot diameter Db is less than 0.35 mm at a load F=294N and a loading time T-60 min.

8. The environmentally friendly metal cutting oil with high load-bearing and high anti-wear performance according to claim 1, characterized in that the preparation process of the environmentally friendly cutting oil is as follows: adding phosphate amine salt extreme pressure additives, borate additives and sulfurized extreme pressure additives to the base oil in proportion, stirring evenly, and heating at 75-100° C. for 30-60 minutes to obtain the environmentally friendly cutting oil.