

UNITED STATES PATENT OFFICE

2,431,008

COOLING FLUID

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1

This invention relates to a novel cooling fluid, and more particularly to the use thereof in the machining of metals, especially for high speed grinding of threads and the like.

A relatively recent development in the machining of metals is the use of high speed grinding by a rotary grinding wheel instead of the more conventional cutting of threads, taps, etc. in the metal by special alloy cutting tools. High speed grinding of threads on a bolt, for instance, is considerably faster than the cutting operations required to produce the same threads. This high speed grinding has the additional advantage of eliminating the use of cutting tools made of special steel or other alloys which are either extremely expensive or difficult to secure, which are required to withstand the high temperatures to which the point of the cutting tool is exposed, particularly when cutting operations are speeded up in order to increase production.

However, it is apparent that even more heat is evolved during high speed grinding operations than during corresponding cutting operations and therefore the heat of abrasion must be removed very rapidly in order to prevent burning of the metal parts being machined. Attempts have been made thus far to solve this problem by feeding conventional cutting oil at the grinding point for the combined purpose of removing the heat of abrasion and to remove finely divided particles of metal taken out by the abrading wheel, together of course with any particles of abrading material which may incidentally be loosened from the abrading wheel during the operation. The lubricant or grinding oil must possess the ability adequately to cool the parts, to lubricate and not to build up on or to "load" the grinding wheel. These requirements are quite severe and most of the conventional cutting oils (mineral oil, fatty oil and sulfur) are not satisfactory as grinding oils because of failure to perform one or more of the necessary functions, chiefly because of inability sufficiently to cool the metal at the immediate point and instant of abrading.

One object of the present invention is to provide a cooling fluid which will be more efficient in the cooling operation. Another object of this invention is to accomplish this superior cooling without any attendant sacrifice of lubricating

2

properties or cleansing characteristics, i. e., washing away of metal or abraded particles. By the attainment of these objects, several advantages accrue, by avoiding burns or overheating it is possible to impart a finer finish and truer precision to the metal parts being machined, and by reason of the faster cooling the operation may be considerably accelerated with a resultant increase in production.

10 Broadly the invention comprises using as a cooling fluid a composition comprising a major proportion of a volatile organic liquid of relatively low viscosity and containing dissolved therein a minor proportion of a viscosity-increasing high molecular weight linear essentially aliphatic polymer which, upon subjection to elevated temperature, is capable of depolymerizing and vaporizing without substantial carbonization or tar formation. Although not essential, it is desirable also to add a minor amount of one or more oiliness or anti-sieze agents.

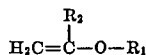
The volatile organic liquid to be used should be one boiling below about 750° F. and may suitably be a light petroleum distillate boiling below 25 the lubricating oil boiling range as, for instance, mineral seal oil or kerosene. For instance, it may be a mineral seal oil having a boiling range from about 510–670° F., or 500–700° F., or a kerosene boiling from about 350–500° F., or 355–510° 30 F., etc. Instead of using plain hydrocarbon liquid, one may use various oxygenated compounds, halogenated compounds, etc., or derivatives thereof.

The primary object in using the above described types of volatile liquid as the cooling fluid of this invention is to make use of the latent heat of evaporation rapidly to absorb the heat of abrasion. The substance to be used in this capacity should be substantially non-toxic and non-corrosive both in the liquid state and 40 vapor state, for of course during the grinding operations a substantial amount of this volatile liquid is vaporized at the point of grinding.

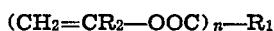
As the viscosity-increasing polymer it is preferred to use polyisobutylene having an average molecular weight above 800 and preferably about 2000, such as 5,000 or 10,000, although if desired isobutylene polymers having even considerably higher molecular weights may be used, such as 45 30,000, 60,000, 80,000, 100,000, etc. In general,

however, polymers having an average molecular weight between about 2,000 and 15,000 or 20,000 are available at lower cost than the higher molecular weight ones and serve at least as well for the purposes of this invention, or perhaps even better than polymers having molecular weights of 30,000 or above. Other polymerized iso-olefins having similar characteristics may be used, for instance, polymerized isoamylene, e. g., polymerized methyl 2 butene 1, etc. Other hydrocarbon polymers which may be used as thickeners include high molecular weight plastic or solid polyethylene, or similar plastic or solid copolymers such as a copolymer of isobutylene and ethylene, made for instance at 100–400° C. under high pressure of 500–2,000 atmospheres with the addition of a small amount of oxygen, or isobutylene-diolefin copolymers ranging, for instance, from 5,000 to 50,000 or more, such as made by copolymerizing a mixture of 90% of isobutylene and 10% butadiene at –103° C. using liquid ethylene as refrigerant and using a solution of aluminum chloride in ethyl chloride as catalyst.

In place of such hydrocarbon polymers, one may use high molecular weight oxygen-containing viscosity-increasing linear aliphatic polymers, preferably having a molecular weight of at least 1,000. One such oxygen-containing thickener is a high molecular weight polymer of an oxygen-containing compound having the group $-\text{C}=\text{CH}_2$ in its molecular structure. Such additives include polymers of vinyl ethers having the general formula:

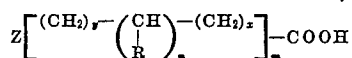


in which R_1 is an unsubstituted or substituted aliphatic, aromatic, or hydroaromatic radical, and R_2 is a hydrogen atom or a substituted or unsubstituted aliphatic radical, e. g., vinyl oleyl ether, vinyl isobutenyl ether, vinyl meta-cresyl ether, vinyl cyclohexyl ether, vinyl octadecyl ether, vinyl chloroethyl ether, vinyl amino propyl ether, α -ethylvinyl isohexyl ether, α -chloromethyl vinyl lauryl ether, etc.; polymers of vinyl esters having the general formula



in which R_1 and R_2 are as above and n is an integer having a value of 1 or more, e. g., vinyl stearate, vinyl ester of acids obtained by oxidation of paraffin wax, vinyl chloropropionate, vinyl aminopalmitate, vinyl adipate, vinyl citrate, etc.; polymers of acrylic acid esters having the general formula, $\text{R}-\text{OOC}-\text{C}(\text{X})=\text{CH}_2$, in which R is an unsubstituted or substituted aliphatic, aromatic, or hydroaromatic group, preferably containing at least 10 carbon atoms, and X is a H or a halogen atom, or a CH_3 group or a C_2H_5 group, e. g., lauryl acrylate, cetyl acrylate, octadecyl acrylate, amylphenyl methacrylate, isoheptyl cyclohexyl chloroacrylate, chlorodecyl methacrylate, etc., especially such polyacrylic esters having a molecular weight of 5,000 to 10,000.

Another case of high molecular weight, oxygen-containing substances which can be used for the purposes of this invention is the class of condensation products or polyesters of substituted fatty acids having the general formula,



in which R is a H atom or an unsubstituted or substituted aliphatic, aromatic, or hydroaromatic group, x and y may equal 0 or any integer pro-

vided that $x+y$ equals at least 5, and where n is 0 or an integer and m is a whole number and Z is a functional group which has one replaceable hydrogen atom, Z being capable of esterifying a carboxyl group. Some of these polyesters are described in U. S. Patent 2,147,647, and are typified by the polyester having a molecular weight of about 14,000 obtained by polyesterification of 12-hydroxy stearic acid in the presence of a small amount of adipic acid.

As an oiliness agent or anti-freeze agent, one may use various materials known to the art such as oleic acid, tricresyl phosphate, isopropyl esters of wax oxidation acids and soda.

In carrying out the invention it is desirable to use a sufficient amount of the viscosity-increasing polymer to raise the viscosity of the volatile liquid from a value in the range from about 30 to 50 seconds Saybolt at 100° F. up to a viscosity in the range of about 150–500 seconds Saybolt at 100° F., preferably about 200–300 seconds at 100° F. The amount of polymer or thickener required for this purpose will not only depend upon the exact viscosity desired in the finished blend, but will also depend upon the molecular weight of the polymer, as well as the individual thickening ability of the particular polymer used which varies slightly according to the chemical structure of the polymer. As a general guide, however, the following table is given to show the amount of high molecular weight polyisobutylene required to raise the viscosity of a mineral seal oil up to various values ranging from 150–500 seconds Saybolt at 100° F.; figures are given for two different molecular weights of polymer.

Viscosity, Sec./100° F.	Per Cent Polyisobutylene	
	18,000 M. W.	60,000 M. W.
150	6.0	2.5
200	7.0	3.0
300	8.0	3.5
400	9.0	4.0
500	10.0	4.5

This table shows that about 2.5% of 60,000 molecular weight polyisobutylene will raise the viscosity of mineral seal oil up to 150 seconds Saybolt at 100° F., and that 4.5% of such polymer will raise the viscosity up to about 500 seconds Saybolt, whereas, on the other hand, 6.0 and 10.0% of a lower molecular weight polyisobutylene (having an average molecular weight of about 18,000) will be required similarly to produce a blend having a final viscosity of about 150 seconds and 500 seconds Saybolt at 100° F.

As an example of the thickening ability of the oxygen-containing polymer it may be noted that a lauryl alpha methacrylate polymer having an average molecular weight of about 10,000 will be required in a concentration of about 11% to raise the viscosity of the mineral seal oil to 150 seconds Saybolt at 100° F., but only about 7% will be required of a 16,000 average molecular weight lauryl alpha methacrylate polymer.

It is thus obvious that the amount of polymer to be used will ordinarily range from about 1–20%, generally about 2–15% by weight.

The amount of oiliness agent to be used will depend primarily upon the type of such agent used, but will ordinarily range from about .02 to 10%, preferably about 1–5%. For instance, about 3–8% or so of oleic acid may be used,

5

whereas smaller amounts such as 0.5 to 2% of tricresyl phosphate may be used.

To show the practical application of the invention the following example is submitted:

A blend was prepared having the following composition:

	Per cent
Oleic acid-----	5.0
Mineral seal oil-----	92.45
Polybutene (average molecular weight about 60,000)-----	2.55
Total -----	100

This blend was used as a cooling fluid on a high speed tap grinding machine operating at a spindle speed of 2400 R. P. M. using a Norton abrading wheel 7" x 12" x 1/4", the tap of which had a diameter of 1.25 cm. (less than 0.500" diameter) and was made of special steel having a Rockwell hardness of C64-66, and was provided with a Whitworth full English thread. The oil blend had a viscosity of 202 seconds at 100° F. The room temperature was 72° F. and the temperature of the oil in the machine was 80° F. A thread grinding operation was accomplished in two passes, one a rough pass of 0.030", and one a finished pass of 0.003". After 40 hours of running on such operation, the oil was still light in color, the machine was clean, indicating good cleansing action and scarf deposition in the sump and not on the machine. Although during similar operations using a conventional cutting oil a steady stream of sparks were obtained, no sparking was obtained with the cooling fluid of this invention. A substantial amount of smoke was formed due to vaporization of the cooling fluid, but this is readily removed by a ventilation hood placed over the machine. The tap turned out by this high speed grinding machine during this test was considerably cleaner than obtained during use of a conventional cutting oil which permitted burns on both sides of the tap.

It is not intended that the invention be limited to any of the materials which have been mentioned merely as specific examples nor by the specific proportions given merely for the sake of illustration, but it is intended to claim all novelty inherent in the invention, as well as all modifications coming within the scope and spirit of the invention. To the extent that it discloses and claims common subject matter, this application is a continuation-in-part of copending application Serial No. 366,714, filed November 22, 1940, now Patent No. 2,356,367, dated August 22, 1944.

I claim:

1. The method of carrying out high speed grinding operations in which an abrading wheel rotates at high speed against metal stock which comprises applying to the metal at the point of abrasion a viscous lubricant comprising a major portion of a non-toxic, non-corrosive volatile,

6

relatively low viscosity petroleum hydrocarbon liquid, a substantial proportion of which is vaporizable by the heat of abrasion, and a minor portion up to about 20% by weight of an aliphatic polymeric thickener adapted to decompose at elevated temperatures without leaving any substantial residue, said thickener being a high molecular weight viscosity-increasing polymer having an average molecular weight of not less than 800.

2. The method of carrying out high speed grinding operations in which an abrading wheel rotates at high speed against metal stock and generates a large amount of heat which comprises applying to the metal stock at the point of abrasion a viscous lubricant comprising a major portion of a petroleum distillate boiling between about 350° and 750° F. a substantial proportion of which is vaporized by the heat of abrasion and a minor portion of about 1 to 20% by weight of a substantially saturated aliphatic polymer having a molecular weight of at least 1000 dissolved in said distillate to make a solution having a viscosity between about 150 and 500 seconds Saybolt at 100° F.

3. A method according to claim 2 in which the polymer is a polyisobutylene having an average molecular weight within the range of about 5000 to 80,000.

4. The method of carrying out high speed thread grinding operations by grinding a thread in a piece of steel stock by an abrading wheel rotating at high speed, which comprises applying to the steel at the point of abrasion a cooling fluid consisting essentially of about 92-93% of mineral seal oil, about 2.5% of polyisobutylene having an average molecular weight of about 60,000, and about 5% of oleic acid.

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