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Figiel

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[54] **COOLANT-LUBRICANT COMPOSITION COMPRISING FLUOROCARBON-CYCLOHEXANONE MIXTURES**

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[58] **Field of Search** 252/11, 15, 52, 54, 58

[56] **References Cited**

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[57] **ABSTRACT**

Certain fluorocarbons, particularly 1,1,2-trichloro-1,2,2-trifluoroethane in admixture with cyclohexanone are useful as evaporative coolant-lubricant compositions. These mixtures are useful in the machining of metals because of their stability, chemical inertness, non-flammability and non-toxicity.

10 Claims, No Drawings

COOLANT-LUBRICANT COMPOSITION COMPRISING FLUOROCARBON-CYCLOHEXANONE MIXTURES

BACKGROUND OF THE INVENTION

The fabrication, and more specifically the machining or cutting of metals and metal alloy parts of lathes, planers, threaders, and the like, is a well known and common operation in the metal-forming industry. The operations involving the cutting and shaping of metal and alloys such as titanium, stainless steels, aluminum and beryllium, are extremely difficult and give rise to many problems such as work-hardening during light cuts, short tool life and slow machining speeds, due primarily to the generation of heat at the point of contact of the cutting tool and the work piece.

It is known to improve the life of the cutting tool by cooling the surfaces of the cutting tool and work-piece by employing lubricants containing relatively large amounts of an evaporative coolant. The usual coolant-lubricants or cutting oils, generally contain a petroleum-derived substance such as mineral oil, kerosene, mineral lard oil, sulfurized-chlorinated mineral oil, and sulfurized mineral lard oil. Synthetic coolant-lubricants are also in common use and such include polyglycols, esters, polycarbonates, imines, amines, amides, silicones, halogenated hydrocarbons and mixtures thereof.

Many coolant-lubricants used in the art or tested for use in the prior art suffer from one or more of the following disadvantages. For example most petroleum derived lubricants leave residues which form coatings on the work-piece so that markings on the work-piece or cutting tools are obliterated. The residues or coatings are often difficult to remove and when removed, by use of abrasive substances, can result in marring of the surfaces of the object being machined. Other lubricants, such as kerosene and light mineral oil fractions, are extremely flammable and thus present hazards. Amines and nitrogenous oils are toxic and may present health hazards to the operating personnel. Silicone oils often leave residues which are difficult to remove. It is essential that a work-piece, after the maching operation, be free of contaminants which might affect the adhesion or appearance of paints or sealants to be applied subsequently to the work-piece.

It is a major object of this invention to provide novel solvent compositions which cool and lubricate metal work-pieces during the machining thereof.

It is another object to provide coolant-lubricant solvent compositions which are non-flammable, non-toxic and which do not discolor the work-piece nor leave difficult to remove residues thereon.

A particular object of this invention is to provide novel solvent mixtures possessing the non-flammable and non-toxic characteristics of 1,1,2-trichloro-1,2,2-trifluoroethane and providing significantly better lubricating and cooling properties while in use during the machining of metals than previously used lubricants.

Other objects and advantages of the invention will be apparent from the following description.

SUMMARY OF INVENTION

In accordance with the present invention, it has been found that mixtures comprising a fluorocarbon coolant having a boiling point from 0°–100°C./760 mm and cyclohexanone ($C_6H_{10}O$) as lubricant, in which mixture

the weight percent of the cyclohexanone does not exceed about 2, provide excellent evaporative coolant and lubricating characteristics when applied to metal parts during machining operations, and do not leave hard to remove residues on the work-pieces or cutting tools.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Examples of suitable fluorocarbon coolant lubricants are trichloromonofluoromethane, dichloromonofluoromethane, monochloromonofluoromethane, dichlorotetrafluoroethane (sym- or asym-), tetrachlorodifluoroethane (sym- or asym-), 1,1,1-trichloro-2,2,2-trifluoroethane, 1,1,2-trichloro-1,2,2-trifluoroethane, dibromotetrafluoroethane, dichlorotrifluoroethane, monochlorotrifluoroethane, and dichlorohexafluorocyclobutane. Mixtures of these coolants may also be employed.

The preferred coolant is 1,1,2-trichloro-1,2,2-trifluoroethane.

Mixtures according to the invention in which the weight percent of cyclohexanone is within the range of from about one-half to about 2 are preferred.

The compositions of this invention are essentially free of inorganic contaminants, light in color, inert to chemical reactants and stable.

The coolant-lubricant compositions of my invention may be applied to the work-piece in any convenient manner as will be apparent to those skilled in the art. One illustrative method is by gravity flow, that is the compositions may be applied dropwise or in a steady stream to the area around the point of contact of the cutting tool and work-piece. Preferably, the novel compositions are mixed with a conventional propellant in the amount of from about 5 to about 40% by weight of the composition, preferably 15–25% by weight of the composition, and the resultant mixture applied to the point of contact of the cutting tool with the work-piece, using conventional aerosol equipment. Propellants such as fluorocarbons, carbon dioxide, nitrogen, and mixtures thereof are typical of suitable propellants which can be used. The preferred propellants are fluorocarbons which have vapor pressures between about 0–71 p.s.i.g. at 70°F. Illustrative are dichlorotetrafluoroethane (sym- and asym-), monochlorodifluoroethane and dichlorodifluoromethane. The latter is the preferred propellant. As can be seen, the propellant may be the same or different than the coolant compound.

We have found that the presence of relatively small, i.e., up to about 2% by weight, of cyclohexanone in the compositions of this invention, provides sufficient lubrication character to extend the tool-life and provides excellent work-piece finish. The propellants serve not only to facilitate the application of the cyclohexanone $CCl_2F—CClF_2$ mixture to the work-piece but also may improve the coolant properties of the mixture. Moreover the presence of a propellant in amounts of up to about 40 weight percent does not noticeably affect the lubricant properties of the mixtures. Preferably the weight percent of propellant used is within the range of about 15 to 25.

The following examples illustrate the principles and practice of my invention. Parts and percentages are by weight unless otherwise specified.

EXAMPLE 1

Cascade steel coupons, annealed to 32–35 Rockwell hardness, and containing 4.1% nickel were machined on a 14 inch Sheldon Engine Lathe, having a standard feed of 0.003 in. and a cut dept of 0.01 in. The lathe was operated at various speeds, from 45 rpm to 200 rpm.

Various coolants and/or lubricant compositions were applied through a nozzle mounted at a point above the lathe so as to direct a spray of coolant and/or lubricant against the work-piece at the point of contact of the cutting tool and the work-piece. The duration of each test was five minutes. The lathe speed, composition of the coolant and/or lubricant under test, and the results of the test are set out in tabular form in Table I, below.

TABLE I

Speed	Coolant/lubricant	Results
45 rpm	Cutting Oil[5]	Good[1]
45 rpm	Genetron 113/12[2,4]	Good
120 rpm	Cutting Oil[5]	Turnings hot
120 rpm	Genetron 113/12[4]	Turnings hot
160 rpm	Cutting Oil[5]	Smog, discoloration of turnings
160 rpm	Genetron 113/12[4]	Discoloration or turnings
160 rpm	1% $C_6H_{10}O$, Genetron 113/13[3,4]	Good-surface clean
160 rpm	2% $C_6H_{10}O$, Genetron 113/12[3,4]	Good-some lubricant visible on work-piece
200 rpm	Cutting Oil[5]	Much discoloration of turnings. Tool attacked.
200 rpm	1% $C_6H_{10}O$, Genetron 113/12[3,4]	Good

Legend:
Genetron-Registered trademark of Allied Chemical Corp. for halogenated hydrocarbons.
[1]Good result indicated by clean appearance of surface and turnings, no residue or one which is easily wiped clean.
[2]Genetron 113 = 1,1,2-trichloro-1,2,2-trifluoroethane
Genetron 12 = Dichlorodifluoromethane (Propellant) (ratio 75%/25%, Genetron 113/12)
[3]Ratio 75% Cyclohexanone, Genetron 113 mixture, 25% Genetron 12
[4]About 180 parts of the mixture used.
[5]About 75 parts of cutting oil, Grade BR-112, product of American Oil and Supply Co., Newark, N.J.

These results indicate that the turning of cascade steel coupons, presents little or no problem at slow speeds but does at the higher, i.e., 120 rpm and higher. The turning can be readily accomplished at high speeds without damage to the cutting tool and/or work-piece by use of a composition of this invention to provide cooling and lubrication of the work-piece and cutting tool.

EXAMPLE 2

When, instead of the cascade steel coupons machined in Example I above, aluminum (AL 6061TG) coupons were used with the same equipment and conditions, the lathe could be efficiently operated at speeds up to 1,250 rpm. As was the case in Example 1, the finish of the work-piece was the cleanest and free from residue only when a coolant-lubricant composition containing 1 to 2% cyclohexanone and 1,1,2-trichloro-1,2,2-trifluoroethane with dichlorodifluoromethane as propellant was employed. Use of oil or fluorocarbon (without cyclohexanone) resulted in a finish which was slightly marred by residue or heat distortion effects. Use of cyclohexanone (without oil or fluorocarbons) results in a work-piece contaminated with residue.

EXAMPLE 3

One inch thick cascade steel coupons, annealed to 32–35 Rockwell hardness and containing 4.1% nickel, were drilled in about 2 minutes with a ¼ inch drill at a feed rate of 0.004 inch/revolution, and a speed of 1500 rpm. When using 12 parts of 1,1,2-trichloro-1,2,2-trifluoroethane as the coolant, the bit was rapidly attacked. However, when a mixture of 3 parts of a 1% solution of cyclohexanone in 1,1,2-trichloro-1,2,2-trifluoroethane and 1 part of dichlorodifluoromethane was used to cool and lubricate the bit and work-piece, the performance of the drill was excellent, that is the chips were not discolored nor was any tool build-up noted, and the surface of the work-piece was smooth.

EXAMPLE 4

Repetition of the above drilling test, but using a ½ inch drill rotating at 810 rpm gave the following results:

a. When 14 parts of a 3:1 mixture of 1,1,2-trichloro-1,2,2-trifluoroethane and dichlorodifluoromethane were used to cool the piece and drill, there was considerable discoloration of the chips and extensive tool build-up was noted.

b. When the coupon and drill were lubricated with a commercially available cutting oil, an unsatisfactory result similar to that obtained in (*a*) above was obtained.

c. When 15 parts of a 3:1 mixture of a solution of 1% cyclohexanone in 1,1,2-trichloro-1,2,2-trifluoroethane and dichlorodifluoromethane was used to cool and lubricate the coupon and drill, no discoloration of the chips or tool build-up was noted.

d. When 14 parts of a 3:1 mixture of a solution of 1.5% of cyclohexanone and 1,1,2-trichloro-1,2,2-trifluoroethane and dichlorodifluoromethane were used as the coolant-lubricant no discoloration of the chips or tool build up was evident.

EXAMPLE 5

Cascade steel coupons, annealed to 32–35 Rockwell hardness and containing 4.1% nickel were milled on a Bridgeport Milling Machine using a feed rate of nine-sixteenth inch per minute, a depth of 0.02 inch, spindel speed of 80 to 210 rpm. The area around the point of contact of the spindle and work-piece was cooled and lubricated with 40 parts/minute of operation of coolant-lubricant composition.

When a solution of 1.5% cyclohexanone in 1,1,2-trichloro-1,2,2-trifluoroethane was used as coolant-lubricant an exceptionally good finish was achieved, that is no discoloration of, or residue was left on the surface of the piece even at the high spindle speed of 210 rpm. Cutting oil, when used at that high speed, rapidly decomposed and left a hard residue on the piece. When 1,1,2-trichloro-1,2,2-trifluoroethane alone was used, a very coarse finish developed on the work-piece.

It will be apparent to those skilled in this art that for specialized purposes, various additives could be incorporated with the compositions of the invention, for example, co-lubricants, antioxidants, co-propellants and the like. Such additives will be chosen so as not to adversely affect the essential properties of the basic composition for a given purpose.

The invention therefore is not intended to be limited by any specific embodiments dislosed herein, but only by the scope of the claims appended hereto.

I claim:

1. Mixtures comprising a fluorocarbon which is trichloromonofluoromethane, dichloromonofluoromethane, monochloromonofluoromethane, dichlorotetrafluoroethane, tetrachlorodifluoroethane, 1,1,1-trichloro-2,2,2-trifluoroethane, 1,1,2-trichloro-1,2,2-trifluoroethane, dibromotetrafluoroethane, dichlorotrifluoroethane, monochlorotrifluoroethane, or dichlorohexafluorocyclobutane, and cyclohexanone in which mixtures the weight percent of cyclohexanone does not exceed about 2.

2. Mixtures according to claim **1** containing 1,1,2-trichloro-1,2,2-trifluoroethane.

3. Mixtures consisting essentially of a fluorocarbon which is trichloromonofluoromethane, dichloromonofluoromethane, monochloromonofluoromethane, dichlorotetrafluoroethane, tetrachlorodifluoroethane, 1,1,1-trichloro-2,2,2-trifluorothane, 1,1,2-trichloro-1,2,2-trifluoroethane, dibromotetrafluoroethane, dichlorotrifluoroethane, monochlorotrifluoroethane, or dichlorohexafluorocyclobutane, and cyclohexanone in which mixtures the weight percent of cyclohexanone does not exceed about 2.

4. Mixtures according to claim **3** in which the weight percent of cyclohexanone is within the range of about one-half to about 2.

5. Mixtures according to claim **3** in which the fluorocarbon is 1,1,2-trichloro-1,2,2-trifluoroethane.

6. Mixtures according to claim **1** containing a propellant.

7. Mixtures according to claim **6** in which the propellant is a fluorocarbon having a vapor pressure between about 0–71 p.s.i.g. at 70°F.

8. Mixtures according to claim **7** in which the fluorocarbon having a boiling point from 0°–100°C./760 mm is 1,1,2-trichloro-1,2,2-trifluoroethane.

9. Mixtures according to claim **8** in which the propellant is dichlorodifluoromethane.

10. Mixtures according to claim **9** in which the weight percent of the propellant based on the weight of the mixture does not exceed about 40.

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