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(71) Applicant: MASTER CHEMICAL CORPORATION
501 West Boundary P.O. Box 220
Perrysburg Ohio 453551(US)

(72) Inventor: Twining, Thomas F.
P.O. Box 220
Perrysburg Ohio 43551(US)

(74) Representative: Hands, Horace Geoffrey et al
GEORGE FUERY & CO Whitehall Chambers
23 Colmore Row
Birmingham B3 2BL(GB)

(54) **Method of cooling and lubricating work pieces during grinding and severe machining operations by means of cubic boron nitride.**

(57) A method of cooling and lubricating work pieces during grinding and severe machining operations by means of cubic boron nitride comprises the step of supplying to the work pieces, as a coolant and lubricant, a copolymer of an alkylene oxide having from 2 to 3 carbon atoms with an alkylene glycol having from 2 to 3 carbon atoms, having an average molecular weight from 190 to 400, and having a flash point over 340 degrees F.

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METHOD OF COOLING AND LUBRICATING WORK PIECES DURING GRINDING AND SEVERE MACHINING OPERATIONS BY MEANS OF CUBIC BORON NITRIDE

The invention relates to a method of cooling and lubricating work pieces during grinding and severe machining operations by means of cubic boron nitride.

Cubic boron nitride is used as an abrasive in grinding wheels in place of commonly used aluminum oxide. Its advantage over aluminum oxide is that it does not wear down and become blunt like aluminum oxide. Thus surfaces which have been ground with cubic boron nitride are left in a state of compression. In contract, surfaces which have been ground with aluminum oxide are left under tension and therefore are more susceptible to stress corrosion cracking.

Cutting tool tips made of cubic boron nitride also have the advantage that they stay sharp even during severe machining operations.

Both the hardness and durability of cubic boron nitride approach that of diamond. However, cubic boron nitride is superior to diamond for machining exotic alloys which commonly contain metals of group XIII of the periodic table, because cubic boron nitride does not appreciably react with such metals as diamond does.

Cubic boron nitride is made by subjecting hexagonal boron nitride to pressures of about 750,000 pounds per square inch and temperatures from 1700 to 1800 degrees C.

Reference is made to U.S. patents 4590034 and 4619698 for procedures for making cubic boron nitride and making cutting tools having tips made of cubic boron nitride.

For reasons hereinbefore described, cubic boron nitride is of great potential value for use as an abrasive in a grinding wheel or as a cutting tip in a cutting tool.

The potential value of cubic boron nitride as an abrasive or a cutting tip lies in its ability to remain sharp during high speed grinding and severe machining operations are highly advantageous because they enable the output of a plant to be increased with no addition to machinery or manpower.

The limitation on the use of cubic boron nitride abrasive or cutting tips in high speed grinding or machining operations has been the inability to conduct away the increased amount of heat, when not conducted away, raises the temperature of the work piece so as to damage the work piece, or to cause the work piece to expand so that its dimensions are not held.

The coolants heretofore used for conducting away heat during grinding or machining operations are not suitable for use in high speed grinding or machining operations by means of cubic boron nitride.

Hydrocarbon oils are not suitable because of insufficient cooling ability, fire hazard, smoke or mist generation and difficulty of removal from the finished work piece.

Aqueous coolants are not suitable because water tends to react with cubic boron nitride at the high pressure and temperature prevailing at the point of contact of the cubic boron nitride with the work piece and because of rapid evaporation of water, tendency to foam and low lubricity.

It is an object of the invention to obviate the existing limitation on the use of cubic boron nitride abrasives or cutting tips in high speed grinding or machining operations.

This object is achieved in the practice of the invention by cooling and lubricating work pieces, during grinding and machining operations by means of cubic boron nitride, by supplying to each work piece, as a coolant and lubricant, a copolymer of an alkylene oxide having from 2 to 3 carbon atoms with an alkylene glycol having from 2 to 3 carbon atoms, said copolymer having an average molecular weight from 190 to 400, and having a flash point over 340 degrees F.

Said copolymer, when so used as a coolant, has the following advantages:

1. It has high lubricity.
2. It has a relatively low fire hazard.
3. It does not smoke.
4. It can be used in a substantially anhydrous condition, but is miscible with water and therefore is easily washed off the finished work piece.

The copolymers, including block copolymers, of ethylene oxide or propylene oxide with ethylene glycol or propylene glycol are known materials, prepared by reaction of ethylene or propylene oxide with the glycol.

The copolymer used in the practice of the invention has an average molecular weight from 190 to 400, preferably from 240 to 315. Its flash point is over 340 degrees F as tested by ASTM Method D93, using a Pensky-Martens closed cup.

A typical general formula of the copolymer is $HOCH_2(CH_2OCH_2)_nCH_2OH$.

The average value of n varies with the molecular weight.

The material actually used in the practice of the invention is a mixture of copolymers, and may contain block copolymers of ethylene oxide or propylene oxide with both ethylene glycol and propylene glycol.

In order to increase the resistance of the coolant to high pressures, it is desirable to incorporate one or more of the known extreme pressure additives such as a phosphate ester, a chlorinated hydrocarbon or a sulfurized fat, oil or ester.

The phosphate ester may have a phosphorus content of 1 to 10% by weight.

A suitable phosphate ester may be prepared by reacting phosphorus pentoxide, polyphosphoric acid or phosphorus oxychloride with a mid-range nonionic surfactant such as oleyl alcohol ethoxylate.

The chlorinated hydrocarbon may have an average carbon chain length of C12 to C24 and a chlorine content of 10 to 70%.

The sulfurized fat, oil or ester may have a sulfur content of 1 to 20%, and may be prepared by adding molten sulfur to an unsaturated fatty acid such as oleic acid or an ester thereof, and holding at about 280 degrees F for one to two hours.

The general formula for the coolant is as follows:

Copolymer 80 to 90%
Phosphate ester 0 to 10%
Sulfurized material 0 to 5%
Chlorinated hydrocarbon 0 to 5%

If necessary to bring the pH of the coolant above 7.0, an alkaline substance such as sodium hydroxide, potassium hydroxide or an alkanolamine should be added. A pH below 7.0 would tend to cause corrosion.

Example

The following ingredients were mixed thoroughly with 81.5 parts by weight of a copolymer of ethylene oxide with ethylene glycol having an average molecular weight of 300:

Triethanolamine 1.0
Phosphate ester of oleic acid 5.0
50% aqueous solution of potassium hydroxide 2.5
Sulfurized oleic acid (10-12% sulfur) 5.0
Chlorinated alpha-olefin (60% chlorine) 5.0

The resulting fluid was then used as the coolant in 13 successive high speed grinding operations in which a 5 inch diameter grinding wheel was driven at 6574 rpm. The workpiece was of 52100 (Rc60) steel and was 4 inches in diameter at the beginning of the first grinding operation. In each of the grinding operations the workpiece was driven at 215 rpm and the diameter of the workpiece was reduced by 0.100 inch. The abrasive in the grinding wheel was cubic boron nitride.

For comparison, three tests were conducted in each of which 13 successive grinding operations were performed. In each of these three tests the procedure was identical to that in the test first described, except that a different coolant was used in each of the three tests. In one test the coolant was a conventional hydrocarbon oil; in the other two tests the coolants were conventional aqueous cutting fluids.

In the test first described, the power consumed during the cutting operations was substantially less than the power consumed during each of the three tests, showing that the cutting fluid used in the first test had superior lubricity. The lower power consumption in the first test meant that there was less heat generation.

Claims

1. A method of cooling and lubricating work pieces during grinding and severe machining operations by means of cubic boron nitride wherein the improvement comprises the step of supplying to the work pieces, as a coolant and lubricant, a copolymer of an alkylene oxide having from 2 to 3 carbon atoms with an alkylene glycol having from 2 to 3 carbon atoms, said copolymer having an average molecular weight from 190 to 400, and having a flash point over 340 degrees F.