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CUTTING FLUID

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This invention relates to coolants for use in metalworking operations such as grinding, cutting and turning.

Coolants for metalworking operations have the primary functions of cooling the tool and the workpiece and lubricating the zone of contact between the tool and the workpiece. Heat and friction, which cause distortion of the work and excessive tool wear must be minimized. In addition, a coolant should possess to as great a degree as possible the following important qualities: It should be usable on all metals, both ferrous and nonferrous, for all types of cutting and grinding operations. It should make possible the production of excellent surface finishes. It should not cause rust, corrosion or discoloration of either the machine or the workpieces. It should not have any damaging effects on the machine or workpieces and should not be subject to gumming. It should not emulsify oil or remove oil from the lubricated parts of the machine. It should keep the machine clean and not leave an objectionable residue on the machine or in the fluid passages of the machine. It should not become rancid. It should be non-foaming and clear so that the operator can see this work. It should be readily disposable by simply discharging into a sewer, and it should not cause dermatitis or present any other hazard to the health of the machine operators.

A general object of the present invention, therefore, is to provide improved metalworking coolants that embody the above described qualities and characteristics. Another object is the provision of such coolants which can be manufactured at reasonable cost. Other objects and advantages of the invention will become apparent from the following description of preferred forms thereof.

Briefly, I accomplish the objects of the invention and provide a superior coolant by producing a concentrate which contains as essential ingredients triethanolamine, an alkali metal nitrite (preferably sodium nitrite) and a small amount of one of the materials selected from the group consisting of benzotriazole and 4-nitrobenzotriazole; preferably, benzotriazole is employed because it is readily available commercially. To these I preferably add a chelating agent, such as an amino polycarboxylic acid chelating agent. Chelating agents manufactured by the Dow Chemical Company and sold under the name "Versene" are satisfactory; these are based on ethylenediaminetetraacetic acid (EDTA). The tetrasodium salt, sold under the name "Versene 100" is preferred; this may be indicated as Na_3HEDTA.

In the concentrate, the total percentage of the sodium nitrite and triethanolamine is preferably about 40%, but it may range from 20% to 60%. Throughout, the proportion of sodium nitrite to triethanolamine may vary widely. Preferably, there is not more than three to four times as much of one as of the other, but I have used successfully concentrates containing as much as forty parts of sodium nitrite to one part of triethanolamine and as much as forty parts of triethanolamine to one part of sodium nitrite. An excessive percentage of triethanolamine leaves a hygroscopic coating on the machine as well as on the workpieces and an excessive percentage of sodium nitrite may result in "salting out" or precipitation of the nitrite in the machine. The concentrate preferably contains about 2% benzotriazole; i.e., the benzotriazole is approximately one-twentieth (5%) of the total of the sodium nitrite and triethanolamine, but this proportion

may be varied considerably within the range of solubility of the benzotriazole. The percentage may vary from 0.025% to 25% of the total of the sodium nitrite and the triethanolamine. If 4-nitrobenzotriazole is employed instead of benzotriazole, the percentage is preferably of the same order, and if a mixture of benzotriazole and 4-nitrobenzotriazole is employed the percentage of the mixture is also preferably of the same order.

To these materials water is added to make 100%, thus producing the concentrate that is sold to the user. Obviously, more or less water can be used in making the concentrate, so long as enough is used to maintain the other ingredients in solution. The concentrate, then, depending upon the service, can be diluted very greatly, one part of the concentrate being employed with from five to as many as two hundred parts of water in the ultimate use of the compound.

As a typical example of an excellent coolant for grinding and producing commercial finishes as well as for cutting, the following is preferred (percentages are by weight throughout):

Example I

Typical:	Preferred range
Sodium nitrite, 28%	40% to 5%.
Triethanolamine, 10%	5% to 40%.
"Versene 100", 1%	0.1% to 5%.
Benzotriazole, 2%	0.01% to 10%.
Water to make, 100%.	

The concentrate is thinned by adding one part of concentrate to from about five to about two hundred parts of water, depending on the use to which it is to be put. The typical material and other materials made within the preferred ranges are excellent coolants and lubricants for ordinary cutting and grinding operations. They give good tool life and work excellently on cast iron, steel, copper, brass and aluminum. They are clear compounds that do not foam and that have no detectable corrosive or discoloring effect on either ferrous or nonferrous metals. The materials contain no fats or oils and do not turn rancid. The nitrite and triethanolamine provide corrosion protection to the ferrous materials. The benzotriazole gives corrosion protection to the nonferrous parts of the machine and prevents discoloration of non-ferrous workpieces while the chelating agent keeps the metallic ions produced in the coolant during use from precipitating or curdling and thus keeps the coolant free-flowing and non-clogging.

The formula given as typical in Example I is especially adapted as a grinding coolant where ordinary commercial finishes are desired. This formula contains a predominance of sodium nitrite as against the triethanolamine. A better finish for some types of operations can be obtained by utilizing a predominance of triethanolamine and a lesser amount of sodium nitrite. Triethanolamine, however, is more than twice as expensive as sodium nitrite and therefore, where surface finish is not a particular problem, and in particular where the compound is to be used primarily as a coolant in ordinary grinding operations, the proportions of sodium nitrite and triethanolamine in the typical formula given in Example I are entirely satisfactory, and in fact a greater proportion of sodium nitrite can be utilized. Also, where cost is of more importance than surface finish, it is possible to use a material of lesser purity than triethanolamine such as "Polyamine T," which is a product of Union Carbide Chemicals Company containing approximately 44% triethanolamine, the balance being monoethanolamine and diethanolamine and small amounts of impurities. This material may be substituted for all or part of the triethanolamine for less critical services.

For some purposes, it may be desirable to add a small percentage of pelargonic acid ($C_8H_{17}COOH$) to the material. This reduces the pH and imparts lubricity. Preferably, the pelargonic acid is present in the amount of about one percent, but from about five-tenths of one percent to about twenty-five percent may be employed.

The concentrate, as noted above is diluted in use. The amount of dilution depends upon the service. For example, in sawing operations, one part of the concentrate may be diluted with ten parts of water. In ordinary machining operations, such as turning, milling, drilling, broaching, reaming and the like, dilutions of from twenty to fifty parts of water to one part of concentrate give good results. For grinding dilutions of from fifty to one hundred fifty to one are used, with about one hundred to one being preferred for many grinding operations.

In services such as grinding where surface finish is important, I have found that the addition of a small percentage of a cationic surface active agent, preferably an amphoteric aliphatic amine such as an alkali metal salt of N-coco beta amino butyric acid, gives unexpectedly advantageous results. The sodium salt of N-coco beta amino butyric acid marketed by Armour Industrial Chemical Company under the name "Armeen SZ" is a preferred material for this purpose. Preferably, when "SZ" or other similar material is used, pelargonic acid is also added. Both the pelargonic acid and the "SZ" increase the solubility of benzotriazole in the mixture. With these materials added, the pH can be reduced by the pelargonic acid to about seven without producing any gelatinous precipitate or curdling in the coolant.

Unexpectedly, and for reasons that are not understood by me, the addition of the "SZ" makes a radical improvement in the quality of the finish obtained, particularly in grinding operations. For example, in one grinding operation the micro-finish obtained on identical workpieces using the same grinder was reduced from a root mean square value of fifty microinches to a root mean square value of nineteen microinches when a composition having substantially the formula given in Example II below was employed. In another case, using substantially the same coolant, the micro-finish was reduced from 53 microinches to 9 microinches by the use of the coolant of Example II in substitution for the best coolant previously known to me.

Example II

Typical:	Preferred Range
Sodium nitrite, 6%	2% to 10%.
Triethanolamine, 25%	10% to 40%.
"Versene 100", 1%	0.1% to 5%.
Benzotriazole, 2%	0.2% to 5%.
"SZ", 0.2%	0.02% to 20%.
Pelargonic acid, 5%	1% to 20%.
Water to make, 100%.	

This material has all of the advantages of the coolants previously described and in addition gives the amazing improvement in micro finish obtained in ordinary grinding operations mentioned above. Thus, this material is particularly useful where finish specifications are important, the simple substitution of the typical material given in Example II for best material within the ranges given in Example I making a radical improvement in the micro finish obtained.

Perfumes and coloring materials can be added to any of the formulation if desired. Also, when used in rather concentrated form, coolants containing pelargonic acid leave a residue on the workpieces in the form of a very thin film that feels greasy to the touch. Ordinarily, this is not objectionable and it gives protection against corrosion and has lubricating qualities. However, if it is desired to eliminate this residue, a liquid glycol, such as ethylene glycol, diethylene glycol or other polyethylene glycols having molecular weights up to 400, may be added to the formulations given in Examples I and II in percentages approximating the percentage of pelargonic acid employed; the addition of the glycol makes the residue a liquid and eliminates the greasy film.

Coolants made according to the present invention can be produced at competitive cost as compared to previously known coolants. They are usable on both ferrous and non-ferrous metals and corrode neither the work nor the machine. Because they are clear and non-foaming, the operator can observe the work, and problems caused by splashing and overflowing of the material are minimized. The materials do not have any damaging effects on the machine or the workpieces and are not subject to gumming. They do not wash off the lubricant from the machine nor do they leave a residue on the machine or in the fluid passages of the machine. The coolants do not become rancid because they contain no oils or fats. They are readily disposable by simply discharging them into a sewer, their non-foaming characteristics also being advantageous from this standpoint. The coolants do not cause dermatitis and since the pH can be kept at a reasonably low value, they are nonirritating to the hands of the operators. In addition, the coolants of the type given in Example II have the unexpected advantage of providing greatly improved surface finishes in grinding operations. All of these advantages are coupled with good tool life with both cutting and grinding tools.

I claim:

1. A metal working coolant composition containing as essential ingredients, in addition to water: an amine compound selected from the group consisting of triethanolamine, diethanolamine and monoethanolamine and mixtures thereof; alkali metal nitrite; and an aryltriazole compound selected from the group consisting of benzotriazole, 4-nitrobenzotriazole, and mixtures thereof, each of said amine compound and said alkali metal nitrite being present in an amount that is at least 1/40 of the weight of the other, and the aryltriazole compound being from .025% to 25% of the total weight of the amine compound and the alkali metal nitrite.

2. A metal working coolant composition containing as essential ingredients, in addition to water: an amine compound selected from the group consisting of triethanolamine, diethanolamine and monoethanolamine and mixtures thereof; alkali metal nitrite; an aryltriazole compound selected from the group consisting of benzotriazole, 4-nitrobenzotriazole, and mixtures thereof; and the tetrasodium salt of ethylene diamineacetic acid as a chelating agent, each of said amine compound and said alkali metal nitrite being present in an amount that is at least 1/40 of the weight of the other, the aryltriazole compound being from .025% to 25% of the total weight of the amine compound and the alkali metal nitrite, and the chelating agent being present in a small but effective amount.

3. A metal working coolant composition containing as essential ingredients, in addition to water: an amine compound selected from the group consisting of triethanolamine, diethanolamine and monoethanolamine and mixtures thereof; alkali metal nitrite; an aryltriazole compound selected from the group consisting of benzotriazole, 4-nitrobenzotriazole, and mixtures thereof; and N-coco beta amine butyric acid, each of said amine compound and said alkali metal nitrite being present in an amount that is at least 1/40 of the weight of the other, the aryltriazole compound being from .025% to 25% of the total weight of the amine compound and the alkali metal nitrite, and the N-coco beta amino butyric acid being present in a small but effective amount.

4. A metal working coolant composition containing as essential ingredients, in addition to water: an amine compound selected from the group consisting of triethanolamine, diethanolamine and monoethanolamine and mixtures thereof; alkali metal nitrite; an aryltriazole compound selected from the group consisting of benzotri-

azole, 4-nitrobenzotriazole, and mixtures thereof; and pelargonic acid, each of said amine compound and said alkali metal nitrite being present in an amount that is at least 1/40 of the weight of the other, the aryltriazole compound being from .025% to 25% of the total weight of the amine compound and the alkali metal nitrite, and the pelargonic acid being present in a minor but effective amount.

5. The composition of claim 2 containing N-coco beta amino butyric acid in a small but effective amount.

6. The composition of claim 4 containing N-coco beta amino butyric acid in a small but effective amount.

7. A metalworking coolant consisting essentially of the following materials in substantially the following proportions:

	Parts by weight
Sodium nitrite	28
Triethanolamine	10
Tetrasodium salt of ethylenediaminetetraacetic acid	1
Benzotriazole	2
Water	Bal.

8. A metalworking coolant consisting essentially of the following materials in substantially the following proportions:

	Parts by weight
Sodium nitrite	40 to 5
Triethanolamine	5 to 40

Benzotriazole	0.01 to 10
Water	Bal.

9. A metalworking coolant consisting essentially of the following materials in substantially the following proportions:

	Parts by weight
Sodium nitrite	6
Triethanolamine	25
Benzotriazole	2
Sodium salt of N-coco beta amino butyric acid	0.2
Pelargonic acid	5
Water	Bal.

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