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[54] **EXPLOSIVE COMPOSITIONS CONTAINING METALLIC FUEL PARTICLES AND METHOD OF PREPARATION THEREOF**

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[58] **Field of Search** 149/44, 41, 43, 46, 60, 149/61

[56] **References Cited**

UNITED STATES PATENTS

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[57] **ABSTRACT**

An explosive blasting composition of the gel or slurry type which retains its sensitivity to detonation after being agitated or worked and method of making such composition are provided wherein a small amount of collector is added to the composition comprised of a stable dispersion of a metallic sensitizer and/or fuel particle throughout a thickened solution or fluid phase containing at least one inorganic oxidizer salt. The collector remains in solution throughout the fluid phase of the composition.

12 Claims, No Drawings

EXPLOSIVE COMPOSITIONS CONTAINING METALLIC FUEL PARTICLES AND METHOD OF PREPARATION THEREOF

The present invention relates to method of obtaining explosive blasting compositions of the gel or slurry type which retain their sensitivity to detonation after being agitated or worked, and to the resulting explosive compositions. Particularly, it concerns the addition of a small amount of a collector to an explosive blasting composition comprised of a stable dispersion of metallic sensitizer and/or fuel particles throughout a thickened solution or fluid phase containing at least one inorganic oxidizer salt. The collector, which is in solution throughout the fluid phase, prevents wetting of the surface of the metallic particles by the solution. Prevention of wetting allows explosive compositions to retain their sensitivity with working as will be more fully explained below.

The use of metallic, notably aluminum, particles in explosive compositions or blasting agents of the viscous liquid gel or slurry type containing a thickened solution of at least one inorganic oxidizer salt and solid and/or liquid fuel has been common throughout the past 10 or 15 years with the advent of commonly termed "slurry explosives." U.S. Pat. No. 3,297,502 discloses slurry explosives or aqueous blasting agents comprising water and inorganic oxidizer salts and containing metallic fuel such as aluminum particles having a preformed coating. The aluminum particles disclosed in this patent function as fuel and have a preformed coating composed of a liquid oil and a monocarboxylic aliphatic acid. The coating is employed to prevent an aluminum-water reaction which evolves gas and liberates heat and thus can render an explosive dangerous for storage and handling.

In addition to preventing unwanted reaction of the metal with solution, coating metallic fuel particles prior to their incorporation into an aqueous solution of an explosive composition has also been found to provide other advantageous results. U.S. Pat. No. 3,249,474 discloses the use of aluminum particles having a preformed coating such as stearic acid that renders the aluminum surface lyophobic and thus repellant to the liquid component of the explosive composition. The coatings disclosed in U.S. Pat No. 3,249,474 are similar to those disclosed in U.S. Pat. No. 3,297,502. U.S. Pat. No. 3,249,474 discloses a method of regulating density and sensitivity of aqueous explosive blasting compositions whereby such coated fuel is used with an aqueous solution containing at least one dissolved inorganic oxidizer salt. As this patent describes, it was found that the incorporation of a coated lyophobic metallic fuel in this manner, coupled with mechanical or chemical aeration or gassing, results in the inclusion of air or gas bubbles which adhere to the surface of the metal particles thereby forming an interface between the metal surface and the aqueous solvent. This adherence of included gas bubbles lowers the bulk density of the composition and provides for significantly enhanced sensitivity in comparison to similar compositions not containing lyophobic, coated, metallic fuel.

Apparently, and as suggested in U.S. Pat. No. 3,249,474, the inclusion of gas bubbles and their adherence to the surfaces of lyophobic metallic particles in explosive compositions creates numerous, small voids or gas pockets which are compressible upon initiation

or detonation of the composition. When a detonation initiation shock wave caused by an initiator such as a blasting cap or booster travels through such a composition, apparently the resulting localized and extremely high pressure of the wave compresses these numerous gas pockets causing the gas entrapped therein to obtain an extremely high temperature. Such "hot spots" thus created can be sufficient in number and are high enough in temperature, owing to essentially adiabatic compression, to initiate rapid combustion or chemical reaction of the adjacent reactive material, i.e., oxidizer salt in solution and aluminum particles. When a sufficient number of such hot spots are simultaneously created, and due to the ability of a continuous fluid phase to transmit the detonation initiation shock wave at high velocity, a powerful explosion ensues. This loosely termed hot spot theory is an explanation of the significant sensitizing effect that a small amount of very fine, coated lyophobic aluminum particles having a relatively high surface area (for increased entrapment of gas bubbles in addition to kindling effect) have been found to have in a fluid-phase-based explosive blasting composition. Empirical data coupled with direct density measurements and visual observation substantiate that lyophobic, coated metallic fuel particles vastly increase slurry or viscous liquid explosive composition sensitivity due to the incorporation of small gas or air bubbles into the composition which adhere to the surfaces of the particles.

Gas bubbles are therefore preferably dispersed throughout an aqueous or fluid solution phase of a slurry explosive composition and can be formed either by chemical gassing or mechanical entrainment as is well known in the art. As indicated above, when metallic fuel particles are admixed into a liquid oxidizer salt solution exposed to air or gas, particularly one which has been prethickened by thickeners such as galactomannan gums, starches, etc., small gas or air bubbles are entrained or incorporated into the solution phase. Further, such bubbles will be stably held in place in a viscous, prethickened solution. Chemical gassing agents such as decomposing hydrogen peroxide and alkali salts or nitrous acid, which agents can be present in the solution, comprise an in situ gassing means for explosive compositions. A substantial proportion of bubbles formed either mechanically and/or chemically adhere to the surface of dispersed lyophobic metallic particles which can be considered somewhat as bubble attachment or collection centers. The smaller the bubble, theoretically, the better it functions as a reaction site or hot spot. The present invention relates to explosive compositions which contain a fine dispersion of air or gas bubbles.

Since composition sensitivity is greatly dependent upon adequate dispersion of the coated metallic particles containing attached gas bubbles throughout the aqueous or fluid phase, it is also greatly dependent upon the maintenance of these gas bubbles in this desired arrangement. It has been found that prolonged storage of explosive compositions containing finely dispersed gas bubbles, initially adhering to the surfaces of a coated metallic particle when first formed, has in some instances resulted in a loss of composition sensitivity and in many instances without a noticeable change in bulk density. Presumably, this phenomenon is a result of bubble separation from the metallic surface and possible subsequent migration and coalescence into larger, less sensitizing bubbles. Thus while

gas is still contained in the composition, the gas bubbles are no longer uniformly small and widely dispersed or in adherence to the metallic surfaces. Proper thickening and cross-linking of the fluid phase can, in most instances, prevent migration, coalescence and bubble separation to a significant degree.

An ever more deleterious phenomenon concerning loss or lowering of explosive composition sensitivity is observed when a onceformed composition of the coated, metallic fuel and/or sensitizer type is subsequently subjected to some type of agitation. For example, packaged slurry or aqueous explosive composition is oftentimes compactly loaded into boreholes by tamping which results in a "working" or agitation of the composition. Furthermore, a once-formed composition may be subjected to repumping, or in other words, pumping after initial formation. For instance, a composition may be formulated and loaded into a container and then subsequently pumped or "repumped" from the container into a borehole or other receptacle. This repumping constitutes another example of working.

Working is observed to result in significant desensitization of a composition containing fine, coated lyophobic metallic particles dispersed throughout an aerated or gassified fluid phase having dissolved therein at least one inorganic oxidizer salt. Apparently, such working results in a separation of the gas bubbles from the coated metallic surfaces, which results in loss of potential hot spots adjacent to the metallic fuel. In effect, the metallic surface becomes "wetted," i.e., the liquid solution is in direct contact with the metal surface and is therefore not separated therefrom by an interfacing air or gas bubble. Therefore, wetting of the metallic surface results in a direct loss of explosive sensitivity.

A possible explanation of this wetting phenomenon is that working results in a loss of the lyophobic coating (e.g. stearic acid, fatty acids, etc.) perhaps due to friction and consequential "rubbing off" of the coating. Without this coating, the metallic surface is no longer lyophobic and becomes wetted by the liquid solution which displaces the adhering gas bubbles.

It has now been discovered that loss of sensitivity from working of such explosive compositions containing coated metallic fuel and/or sensitizer particles can be prevented by providing, in solution, a liquid collector which is capable of flotation of metallic particles in a liquid menstruum. As will be shown in the examples below, a collector in solution results in compositions which after being worked will retain their sensitivity to a significantly greater extent than compositions not containing such an ingredient.

A possible explanation of the observed effect of the collector on sensitivity, which corresponds to that given for the desensitization upon working phenomenon described above, is that the collector in solution is free to actively seek out and adhere to exposed metallic surfaces which have lost their lyophobic coating due to working. Thus, liquid collectors in solution allow "self-healing" of exposed surfaces whereas solid or preformed coatings will not self-heal. Thus collectors allow such surfaces to retain their lyophobic nature thereby affording their retention of adhering, interfacing gas bubbles and thus retention of sensitivity.

The collector used in the present invention may be similar to the coatings heretofore described in the above referenced patents. However, the collector can be any substance which will cause the flotation of a metallic, preferably aluminum, particle in the liquid menstrum of the explosive composition. The only essential requirement of the collector is that it remain in solution, i.e., be a miscible liquid in the explosive composition solution at temperatures of working of the explosive. Liquidity and miscibility are necessary in order that the collector can actively seek out metallic surfaces as they become exposed and thereby continually prevent their wetting as working continues. Examples of collectors of the present invention which have been found to be effective in various degrees in preventing loss of sensitivity are as follows: oleic, caprylic, linoleic and other fatty acids; red, tall and cod liver oils; green soap (vegetable oil-potassium hydroxide soap); Fels-naptha; xanthogen ester; sodium sulfated fatty amide derivatives; anionic sulphonates; and sodium lauryl sulfates.

Some of the above collectors have been used heretofore as coatings for the metallic particle surfaces in explosive compositions. For instance, U.S. Pat. No. 3,297,502 discussed previously discloses the use of fatty acids including oleic acid as coatings that are particularly effective if used in conjunction with a liquid hydrocarbon oil such as fuel oil. As mentioned, this patent describes preforming such coating on the metal prior to the particle's introduction into the liquid menstruum. U.S. Pat. No. 3,249,474 discussed previously discloses the use of normally solid fatty acids such as stearic acid, palmitic acid, etc., among others as preformed lyophobic coatings to render the surfaces of the metal particles lyophobic. As discussed above, neither of these references disclose a means whereby desensitization due to working can be prevented. The present invention distinguishes from the disclosure in these two patents in that while preformed coated metal is preferably used in the compositions of the present invention, the compositions also contain, in solution and in addition, a collector which acts as an in situ, continuous coater or wetting inhibitor of the metal particles.

Thus the present invention has solved a problem which has been prevalent with the use of slurry or viscous liquid explosive compositions containing metallic fuel and/or sensitizer; that problem being loss of explosive sensitivity due to working. It has been discovered that the use of a collector in the liquid menstruum enables such compositions to retain their sensitivity upon working.

It also has been found in the present invention that the use of a frothing agent or frother as a gas bubble stabilizer in conjunction with the use of a collector allows for even increased composition sensitivity retention upon working. Frothers which limit bubble size and increase their stability afford this added effectiveness. Examples of frothers found effective for their conjunctive use with collector(s) are polypropylene glycol methyl ethers such as Dowfroth 250 and 1012 which are represented by the following formula:

$$CH_3-(O-C_3H_6)_x-OH$$

and which have an average molecular weight range of from about 200 to about 400. The Dowfroth frothers are further described in the booklet, "Flotation Fundamentals and Mining Chemicals," The Dow Chemical Company, 1970. Another frother found effective is 100% silicone resin having a specific gravity at 25°C of 1.06 – 1.08 and a viscosity at 25°C of 1,200 – 2,000 centistokes. This silicone resin is known commercially as Union Carbide R-23 and is further described in a Product Information Bulletin on Union Carbide R-23, R-230 and RE-231 Silicone Water Repellants. All of

the above three frothers appeared to reduce bubble size and increase bubble stability of all bubbles in a thickened liquid menstruum including those attached to and those separate from metallic particles. Moreover, all three frothers were found to increase both the stability and degree of flotation of aluminum particles in a liquid menstrum when used with a fatty acid collector such as oleic acid. Monocarboxylic acid collectors, i.e., oleic, caprylic, etc., have some inherent frother characteristics which enhances their use as collectors.

A procedure for determining the relative effectiveness of a collector in preventing wetting of metallic particles was devised wherein two solutions, one containing water and the other containing dissolved ammonium nitrate (AN) were admixed with atomized aluminum particles and a collector and the degree of subsequent flotation of the particles in the solutions was observed. The atomized aluminum tested did not contain a preformed coating. In this simplified test 200 ml of solution was placed in a 300 ml flask and 5 gms of atomized aluminum were added. Thereafter, each collector was added in an experimentally optimum amount which was about one-hundredth of the mass of the particles (0.05 gm) for the collectors tested (although each collector differed slightly). Soaps, however, were found to also be effective at a much lower concentration. After addition of the collector, the flask was stoppered and given ten hard vertical shakes. The subsequent degree of flotation of the atomized aluminum was then observed. As a standard reference point, oleic acid was found to provide 90% of all aluminum particles floated on top of the solution due to adhering gas bubbles and 10% of the particles fell to the bottom of the flask) in a 50/50 by weight AN/H_2O solution. When a collector was not used, no flotation (0%) was observed. A Hallimond-Ewers flotation cell was also used in similar testing, but it tended to over-rate the effectiveness of the collectors since it would not distinguish between momentary (an order of a second) and prolonged (an order of several seconds or longer) flotation.

Flotation results are shown in Table I. As is readily apparent from Table I, green soap was found to be the best collector in AN containing solutions. Fels-Naptha was equivalent to green soap, but, when tested, it was not compatible with solutions containing calcium nitrate (CN). The fatty acids tested and reported in Table I were liquid at room temperatures (oleic, caprylic and linoleic). Other fatty acids with greater chain length such as capric, lauric, myristic, palmitic and stearic were found to work equally well at temperatures above their solidification temperatures even through they are solids at room temperature. The degree of flotation was substantially lessened when these longer-chained fatty acids were used in solutions having temperatures below their solidification temperatures. These latter acids are therefore applicable for use as collectors in the present invention only if the explosive compositions are worked at temperatures above their respective solidification temperatures. Short chain length fatty acids such as caproic, valeric, butyric, isobutyric and propionic caused no noticeable flotation presumably because they are not sufficiently water repellant. Red oil (crude oleic acid), tall oil and cod liver oil were found to have flotation characteristics equivalent to oleic acid.

It was also found that the optimum quantity of oleic acid is about one-hundredth the mass of the atomized aluminum for maximum flotation and is further roughly proportional to the surface area of the aluminum particles used. The fraction of flotation obtained as well as its stability was found to increase with increasing fineness of the atomized aluminum. The finest atomized aluminum tested had a particle size distribution such that 62% was -325 Tyler mesh. It is possible that too fine of particles would not have sufficient surface for bubble contact; however, such an effect was not observed down to the particle size range tested.

A series of tests was accomplished to determine the effect of pH on flotation of atomized aluminum in water containing tall oil as the collector. Maximum flotation was found in the pH range of from 4 to 6 but was only slightly diminished over the pH range of from 3 to 7. Dilute nitric acid and ammonium hydroxide or acetic acid and sodium hydroxide were used for adjusting the pH. All other collectors tested were found to perform similarly in this pH range of from 3 to 7.

Hydrophilic colloid thickeners such as galactomannan gums, flours, starches, xanthomonas gums produced from the bacteria *Xanthomonas campestris*, etc., are commonly used in aqueous slurry explosive compositions. Such thickeners render the aqueous solution viscous thereby preventing segregation of dispersed solid ingredients such as metallic fuels and/or sensitizers, undissolved oxidiizer salts, carbonaceous fuels, etc., as well as preventing migration and coalescence of finely dispersed gas bubbles. Such thickeners also provide water resistance to the compositions to prevent breakdown of the compositions and leaching of oxidizer salts in the presence of water. In general, thickeners are almost essential for stability, homogeneity and water resistance of aqueous gel or slurry type explosive blasting compositions. For added stability thickeners can be cross-linked by cross-linkers such as metallic ions. Slurry explosive cross-linkers and thickeners are widely used and common in the art.

Thickeners are essential to compositions of the present invention particularly for preventing metallic particle segregation and gas bubble migration. Thus a series of tests was made in which atomized aluminum was found to have good flotation characteristics in water thickened with small quantities (concentrations were just below the values at which the viscosity of the solution would significantly interfere with particulate mobility and thus degree of flotation) of Brazilian tapioca flour, guar gum derivative of low molecular weight (Stein-Hall J-808) and xanthomonas gum (General Mills XB-23) and containing oleic acid as a collector. Other collectors were found to be similarly compatible with hydrophilic colloid thickeners.

When the collectors were tested for flotation of atomized aluminum in aqueous ammonium nitrate solutions it was found that a fraction of each of oleic, caprylic and linoleic acid and red, tall and cod liver oil formed a white insoluble product although good flotation was still observed. A similar product was not observed with solutions containing calcium and sodium nitrates. The white insoluble product is attributed to a reaction between the ammonium radical and the hydroxy fatty acid component present as an impurity in the collectors.

Combinations of different collectors and combinations of collectors with other ingredients were found to provide particularly good flotation. Fuel oil did not by itself cause flotation, but, when combined with oleic acid as the collector in solution, flotation was enhanced

over that obtained by oleic acid separately. This same effect was observed with ethylene glycol. A combination of green soap and oleic acid was found to cause better flotation than that obtained by either separately. Higher order combinations such as oleic acid, fuel oil, ethylene glycol and frother were also found to be very effective.

Table II summarizes test results obtained for slurry or gel type explosive blasting compositions using various collector/frother combinations. All percentages refer to weight percent based on the total composition. The CN refers to Norsk Hyro calcium nitrate which is a commercial grade CN consisting of about 80% CN, about 15% water (as water of crystallization) and about 5% AN. The thickener was General Mills XB–23, a biopolymer gum produced from the bacteria *Xanthonomonas campestris*.

The compositions of Table II were prepared by first dissolving the oxidizer salt(s) in an aqueous solution containing water, liquid fuels (if any), thiourea as a nitrate gassing agent accelerator (if used), the thickening agent, a collector or combination of collectors, and frother (if used). Such dissolution was accomplished at a temperature preferably of about at least 10°C higher than the fudge point or crystallization temperature of the solution. Thereafter, the remaining solid ingredients were added to the thickened solution (i.e., aluminum, gilsonite, ground AN) along with the nitrate gassing agent. The composition was subsequently mixed to provide a uniform, homogeneous dispersion of solid ingredients throughout an aqueous fluid phase.

The detonation results of Table II indicate the minimum booster required to detonate a 2-inch diameter explosive charge at 5°C. The symbol "F" stands for failure of the charge to detonate and "Det" stands for effective charge detonation. The "No." 5, 6, etc., stands for the size of a standard commercial blasting cap used as the booster with the larger the number corresponding to the greater the cap boostering power. A number such as "5" followed by a "g" represents that the charge would not detonate with a regular cap and thus stands for the amount of grams of a pentolite booster required for detonation. Minimum booster required for detonation is a direct measure of an explosive composition's relative sensitivity. The smaller the booster, the more sensitive the composition.

As shown in the table, the compositions were tested for relative sensitivity both before and after working. Working was accomplished by repumping an explosive composition through a Model H724 Viking pump at a rate of 80 pounds per minute. A 40-pound sample of slurry was used and thus was cycled through the pump two times per minute. A comparison of the detonation results of mixes A, B and C shows that oleic acid as a collector has little effect on sensitivity of a composition which has not been worked or repumped, but greatly enhances the sensitivity of a composition which has been worked relative to a composition not containing the collector. A comparison of the results of mixes E and F shows that when a frother is used with an oleic acid collector, the sensitivity of the composition after repumping or working is greater than if the frother is not used. A comparison of the results of mixes G and H shows that when fuel oil is used with oleic acid the sensitivity of the composition after working is greater than if the fuel oil is not used. In fact, the results for mixes H and I surprisingly show that sensitivity is even increased upon working. Furthermore, it is also greatly significant, as evident from the results of mixes H and I, that aqueous explosive composition sensitivity may be obtained at higher than normal slurry densities due to the control of bubble size and location by the use of frothers and collectors.

In example I, a soap was used as a collector which increased the composition's sensitivity upon working. Such result is significant since soaps have been generally regarded as desensitizing agents for slurries sensitized by paint grade aluminum.

All of the results shown in Table II are consistent with the results shown in Table I as well as the results of various flotation tests described previously.

The explosive compositions of the present invention are designed to retain their sensitivity after being subjected to working. They are also capable of stability over prolonged storage due in some respect to the ability of a collector to maintain adherence of fine gas bubbles to the surfaces of metallic fuels and/or sensitizers.

While the explosive compositions of the invention may, if desired, be used, i.e., detonated, immediately after being placed into a borehole, they also remain stable and this may be detonated even after encountering water in the borehole and/or being allowed to remain in the borehole for many days.

In addition to being used unpackaged, e.g., in large diameter borehole blasting operations, the compositions may also be packaged in any suitable container, for example, plastic bags or cardboard tubes, and thereafter detonated in either vertical or horizontal boreholes or any other desired location.

While the present invention has been described with reference to certain illustrative examples and preferred embodiments, various modifications will be apparent to those skilled in the art and any such modifications are intended to be within the scope of the invention as set forth in the appended claims.

Table I

Flotation of Atomized Aluminum With Various Collectors (Listed by descriptive name [brand, chemical or both] and commercial manufacturer in some instances)

	Flotation Rating*	
	Water	Aqueous Solution Containing AN
Green soap (Vegetable oil - potassium hydroxide soap)	1	1
Fels-Naptha	1	1
Oleic acid and other fatty acids	1	2
Sole - Fonate 101 (SO_3 derived, oil soluable amine, low salt DDB sulfonate Sole Chemical Corp.)	2	2
Minerec 27 Xanthogen ester Mineroc Corp.	2	3
Minerec B Xanthogen ester Minerec Corp.	2	3
Sole - Terge 8 Sodium sulfated fatty amide derivative Sole Chemical Corp.	2	3
Aero Promoter 801 Anionic sulphonate American Cyanamide	2	3
Sipex S/B Sodium lauryl sulfates Alcolac	2	3
Alamac 26 D. B-1 Acetate of distilled tallow amine General Mills	2	3
Amine D. acetate Hercules	2	4
Pine oil	2	4

Table I-continued

Flotation of Atomized Aluminum With Various Collectors (Listed by descriptive name [brand, chemical or both] and commercial manufacturer in some instances)	Flotation Rating*	
	Water	Aqueous Solution Containing AN
Cresylic acid	2	5

*A rating of 1 indicates flotation superior to that obtained with commercially coated (stearic acid) atomized aluminum and a rating of 5 indicates no flotation.

5. A method according to claim 1 wherein the collector is a soap.

6. A method according to claim 2 wherein the frother is selected from the group which consists of polypropylene glycol methyl ether and silicone resin.

7. A method according to claim 1 wherein the metallic particles are aluminum.

8. In an explosive composition comprising a thickened solution phase of at least one oxidizing salt and metallic particles as fuel and/or sensitizer dispersed throughout the solution phase the improvement comprising, in the solution phase, a small amount of a miscible, liquid collector, which is capable of causing flotation of the metallic particles in the solution phase when such solution phase is not thickened and which retains its liquidity and miscibility at intended temperatures of working, to prevent the metallic particles from becoming wetted upon working thereby causing the composition to lose its sensitivity.

Table II

	A	B	C	D	E	F	G	H	I
AN	27.1	27.1	27.1	27.1	24.2	24.2	23.1	23.1	23.1
SN	—	—	—	—	4.3	4.3	4.0	4.0	4.0
H_2O	8.0	7.9	7.9	8.0	10.2	10.2	9.3	9.3	9.3
Thiourea	0.2	0.2	0.2	0.2	—	—	—	—	—
Thickener	0.4	0.5	0.5	0.3	0.4	0.4	0.36	0.36	0.36
CN	35.0	35.0	35.0	35.0	46.1	46.1	43.8	43.8	43.8
EG	5.2	5.2	5.2	—	6.0	6.0	14.8	14.74	14.74
Oleic acid	—	0.1	0.5	0.1	0.1	0.1	0.1	0.1	0.1
Frother*	—	—	—	—	—	0.1	0.1	0.1	—
Green soap	—	—	—	—	—	—	—	—	0.1
Fuel oil	—	—	—	—	—	—	—	0.05	—
Paint grade aluminum (Alcoa's 2003)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Gilsonite	3.6	3.6	3.6	5.0	4.2	4.2	—	—	—
Ground AN	15.8	15.8	15.8	19.6	—	—	—	—	—
$NaNO_2$ gassing agent	0.04	0.04	0.04	0.04	—	—	—	—	—
Tests at 5°C of unrepumped slurry									
Density g/cc	1.10	1.11	1.10	1.20	1.22	1.23	1.48	1.45	1.45
Detonation Results (minimum booster for detonation in 2" diameter charge)	No.6 Det No.5 F.	No.6 Det No.5 F.	No.6 Det No.5 F.	5g Det No.8 F.	No.6 Det No.5 F.	No.6 Det No.5 F.	160g F.	160g F.	160g Det 35g F.
Tests at 5°C of slurry repumped for 1 minute									
Density g/cc	1.08	1.19	1.23		1.21	1.20	1.37	1.34	1.35
Detonation Results (minimum booster for detonation in 2" diameter charge)	160g F.	35g Det 5g F.	35g Det 5g F.		160g F.	5g Det No.8 F.	160g F.	No.8 Det	No.8 Det
Tests at 5°C of slurry repumped for 15 minutes									
Density g/cc	1.07	1.16	1.20	1.10	1.17	1.16	1.44	1.40	1.36
Detonation Results (minimum booster for detonation in 2" diameter charge)	160g F.	5g Det No.8 F.	5g Det No.8 F.	160g F.	160g F.	5g Det No.8 F.	160g F.	35g Det 5g F.	35g Det 5g F.

*Mix F used Union Carbide R-23, mixes G and H used Dow DFF-4082.

What is claimed is:

1. A method for preventing the loss of sensitivity of a gas-containing blasting composition upon being worked which composition comprises a continuous thickened solution phase having dissolved therein at least one inorganic oxidizer salt and metallic particles as fuel and/or sensitizer dispersed throughout the solution phase which method includes incorporating into the solution phase a small amount of a miscible, liquid collector, which is capable of causing floatation of the metallic particles in the solution phase when such phase is not thickened and which retains its liquidity and miscibility at intended temperatures of working.

2. A method according to claim 1 which includes the additional step of adding a frother to the fluid phase to stabilize and control bubble size.

3. A method according to claim 1 wherein the collector is a fatty acid.

4. A method according to claim 3 wherein the fatty acid is oleic acid.

9. A composition according to claim 8 wherein the collector is a fatty acid.

10. A composition according to claim 9 wherein the fatty acid is oleic acid.

11. A composition according to claim 8 containing, in addition, a small amount of a frother to stabilize and control bubble size.

12. A composition according to claim 11 wherein the frother is selected from the group which consists of polypropylene glycol methyl ether and silicone resin.

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