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3,288,661 AERATED AQUEOUS EXPLOSIVE COMPOSITION WITH SURFACTANT

Peter L. Swisstack, Bessemer, Ala., assignor to Hercules Incorporated, a corporation of Delaware
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This invention relates to inorganic oxidizer salt blasting compositions of the aerated aqueous slurry type.

In organic oxidizer salt blasting compositions of the aqueous slurry type have had rather wide use in the explosives industry in recent years. These compositions contain an oxidizer salt or a mixture of such salts as the basic explosive ingredient, together with water, and, as a sensitizer, a high explosive such as TNT, Tetryl, or PETN, a finely divided metal such as aluminum, or a magnesium alloy, or smokeless powder. Generally, a thickener is included to impart additional consistency to preclude settling of the individual ingredients and to facilitate handling. Such inorganic oxidizer salt blasting compositions of the aqueous slurry type are disclosed and claimed in the copending application U.S. Serial No. 67,513, now Patent No. 3,235,425 filed November 7, 1960, and in U.S. 2,930,685, U.S. 2,836,484, and others.

In accordance with the practice disclosed and claimed in the copending application of Ferguson and Hopler, Serial No. 473,380, filed July 20, 1965, inorganic oxidizer salt blasting compositions of the aqueous slurry type are provided which are aerated to a pre-determined degree to regulate the density and, accordingly, explosive strength of the finished slurry product. In accordance with the process of the said copending application, an admixture of the water, inorganic oxidizer salt, sensitizer, and thickener ingredients is formed, and a gas, e.g., air, is incorporated into the resulting slurry in an amount sufficient to cause a pre-determined lowering of the density thereof to regulate its explosive strength. The process of the said copending application, although applicable to any ordinary packaging procedure is particularly advantageously applied to direct loading of the slurry in a bore hole. In preferred operation the air ingredient is injected into the slurry mixture which is then passed to emplacement with final thickening action subsequently taking place to impart the necessary consistency for maintaining entrainment of the dispersed air over prolonged periods.

In carrying out process of the said copending application, the efficiency of air entrainment, i.e., based on the total amount of air introduced into the slurry, is in the order of about 10 to 15 percent, which is limiting as to the degree of regulation of product density that can be accomplished.

This invention is concerned with such aerated slurry type compositions, characterized by improved stability, and by densities, and hence explosive strengths, over a range broader than those obtained by aeration heretofore. The invention is also concerned with such aerated slurries characterized by a marked increase in sensitivity.

In accordance with the invention, an improved process is provided for the manufacture of aerated aqueous slurry inorganic oxidizer salt blasting compositions which comprises aerating a mixture of water, inorganic oxidizer salt sensitizer, and thickener ingredients of a slurry-type blast-

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ing composition in the presence of at least 0.3 weight percent of a water-soluble surfactant.

The compositions formed in accordance with the invention contain the air ingredient dispersed in form of particles manifold smaller than those dispersed in the absence of a surfactant. The aerated slurry blasting compositions of the invention are characterized by a stability markedly greater than that of aerated slurries that do not contain the surfactant which, it appears, may be due to the small size of the entrained air particles. Further, the efficiency of air entrainment in the compositions of the invention, i.e., the proportion held in entrainment based on the amount introduced into the slurry, is in the order of about 25 to 40 percent as compared with 10 to 15 percent in the absence of the surfactant. This additional entrainment of air provides for a broadened range of slurry densities for regulation of explosive strength.

This invention is based on the further discovery that at the lower density levels accomplished in the presence of the surfactant, the sensitivity of the slurry compositions of the invention, and particularly those of the nitrocarbonitrate (NCN) type, is greatly increased. The invention therefore provides novel inorganic oxidizer salt blasting compositions of the aerated aqueous slurry type, characterized by improved stability over the entire density range and by a broader range of available densities for regulation of explosive strength, and by improved sensitivity at the newly available density levels.

The base slurry mixture into which the air ingredient is incorporated comprises, on a weight basis, from 20 to 75 percent oxidizer salt, from 4 to 35 percent water, from 4 to 60 percent sensitizer, from 0.2 to 5 percent thickener, and at least 0.3 percent surfactant. More preferably, the said slurry mixture contains from 20 to 60 percent ammonium nitrate, with up to 30 percent sodium nitrate as the oxidizer salt, from 10 to 30 percent water, from 8 to 45 percent sensitizer, from 0.5 to 2 percent guar gum as the thickener, and from 0.6 to 5 percent surfactant. The slurry compositions of the invention, prepared as described, contain an amount of air sufficient to cause a predetermined lowering of the density of the slurry to thereby regulate its explosive strength, the said amount being preferably greater than that which can be supported in entrainment when no surfactant is present. The compositions, containing a greater amount of air than can be entrained without surfactant, are particularly preferred because of their sensitivities which are markedly higher at those air entrainment levels.

The compositions of the invention are, in preferred practice, columnar in form, i.e., having been formed by addition of air to the slurry mixture just prior to emplacement of the finished product in a borehole.

In preferred practice of process of the invention, the oxidizer salt, water, surfactant, and sensitizer ingredients are admixed in the proportions above described, together with a portion of the thickener for imparting a sufficient increase in consistency to prevent settling of the ingredients from the resulting admixture, and then, as the last step, the remaining portion of the thickener is added just prior to, or concurrently with, dispersion of the air ingredient throughout the charge, the latter being preferably by direct injection. The final thickening action imparts the necessary consistency for support of the dispersed air

ingredient over prolonged periods. However, it is sometimes advantageous to admix the total contemplated proportion of thickener with all other slurry ingredients, except for the air ingredient, in a single mixing step, particularly when charging the total air-containing slurry directly into bags at the plant site.

The sensitizer component, in the practice of the invention, can be any suitable secondary explosive such as composition B, PETN, TNT, RDX, Tetryl, or the like, a finely divided metal such as aluminum or a magnesium alloy, fuel oil or smokeless powder. Aluminum as a sensitizer is generally in flake form. However, the invention is generally most advantageously applied to the utilization of sensitizers other than high explosives or smokeless powder, inasmuch as at the lower density levels the increase in sensitivity of the high explosive, or smokeless powder, sensitized slurries is less pronounced, although in all cases the explosive strength of the slurry is clearly responsive to regulation of density.

The class of water-soluble surfactant materials, utilized in the practice of the invention, is well known in the art. See for example, *Encyclopedia of Chemical Technology*, vol. 13, page 513, *The Interscience Encyclopedia*, Inc., New York (1954). However, further exemplary of these materials are: coconut diethanolamide, lauric acid diethanolamide, coconut fatty acids of diethanolamide, triethanolamine salts, alkyl polyoxyethylenes, alkanolamide alkylarylsulfonates, ethoxylated alkylolamides, ammonium lauryl sulfate, cetyl dimethylamine oxide, lauryl dimethylamine oxide, and myristyl-cetyl dimethylamine oxide.

Suitable thickeners include carboxymethylcellulose, methyl cellulose, water-soluble starches, cereal flour, mannogalactans, and the like. Guar gum, as the preferred thickener, is present in crosslinked form to impart a plastic but easily deformable consistency for retaining the dispersed air ingredient over prolonged periods.

When adding the guar gum in two separate steps, the initially added guar gum is generally in natural form and, in all events, is readily hydratable. It is added in limited amount to provide hydration for sufficient increase in consistency to preclude settling of ingredients, but to permit uniform mixing and pumpability of same, prior to incorporation of the air ingredient, the latter generally added in close proximity to placement of the finished slurry composition. However, if desired, the initially added guar gum can be in inhibited form, by which term it is meant that it contains one or more agents which, alone or together, subsequent to hydration, promote crosslinking, and also alter the rate of hydration and crosslinking to meet the particular mixing and placement requirements. When the initially added guar gum is in inhibited form, it is desirable to adjust the mixing temperature upwardly to permit the desired degree of immediate hydration which might otherwise be delayed unduly by the particular agent or agents present.

The remaining portion of the guar gum ingredient is crosslinkable and is added to the slurry ingredient mixture at a time in close proximity to that at which dispersion of the air ingredient is initiated, being added for the most part substantially concurrently with, or prior thereto, to permit uniform dispersion of the air ingredient and pumpability of the slurry mixture which might otherwise be impaired by prematurely imposed increase in consistency due to crosslinking.

When the guar gum is charged in toto with the other slurry ingredients in a single mixing step, it is in inhibited form and adapted to undergo sufficient hydration for limited thickening to permit uniformity of mixing and pumpability of the total air-containing slurry without extensive crosslinking until after placement.

Various inhibited and crosslinkable guar gum formulations are available commercially and contain well-known inhibiting and crosslinking agents. pH and temperature

conditions for accomplishing inhibiting and crosslinking as above described, vary somewhat, dependent upon the particular agent or agents. For example, as is well known, sodium borate functions as both an inhibitor and a crosslinking agent, but under different pH conditions, while on the other hand, a combination of potassium antimonate and fumaric acid functions to promote crosslinking.

By the term "oxidizer salt," as is well known in the explosives art, is meant one which, under the conditions of the detonation, supplies oxygen for the oxygen balance required. Ammonium nitrate is in many instances the only oxygen-supplying salt component. However, other inorganic oxygen-supplying salts can be used alone or with ammonium nitrate as a supplementary oxidizer salt. Of these, the alkali metal nitrates are now preferred. Exemplary oxygen supplying salts that can be used alone or together with ammonium nitrate as supplementary oxidizer salts are alkali metal and alkali earth metal nitrates and perchlorates (including ammonium) as for example, sodium nitrate, magnesium nitrate, calcium nitrate, potassium nitrate, barium nitrate, sodium perchlorate, ammonium perchlorate, calcium perchlorate and magnesium perchlorate.

Often when ammonium nitrate is utilized with a supplementary salt, it comprises at least a major proportion, i.e., at least 50 percent of the total oxidizer salt component; however, weight ratios of ammonium nitrate to supplementary oxidizer salt, sodium nitrate now preferred, are generally in the range of from about 4:1 to 1:1.

Particle size of the oxidizer salt ingredients is not critical. For example, ammonium nitrate can consist of prills, such as used in the fertilizer industry, or it can be granular and in that form vary from coarse to fine. Other oxidizer salt ingredients are generally of comparable particle size.

The compositions of the invention are in most instances insensitive to detonating action of a commercial No. 8 blasting cap but detonatable by conventional "booster" charges of PETN (pentaerythritol tetranitrate), RDX (cyclotrimethylenetrinitramine), Pentolite (PETN-TNT), tetryl, Composition B (RDX-TNT), and the like. One booster advantageously employed is a dispersion of a crystalline high explosive, e.g., PETN or RDX, in a plastic carrier such as described in U.S. Patent 2,965,466, and which is detonated by either a commercial blasting cap or detonating fuse.

Example I

Each of the following formulations, was prepared by mixing the water, smokeless powder and surfactant (when utilized) ingredients together with about one fourth of the ammonium nitrate ingredient. A suspension of a hydratable guar gum in ethylene glycol was then added to resulting aqueous slurry admixture immediately after which the guar gum underwent hydration to form a sol imparting sufficient thickness to support the admixture ingredients in suspension. The remaining portion of the ammonium nitrate ingredient was then added, together with the sodium nitrate, to the sol-containing admixture with agitation to effect overall distribution of all ingredients. A suspension of a crosslinkable guar gum in ethylene glycol was then added to the resulting base ingredient mixture under agitation, and crosslinking, conditions, for 3 to 4 minutes, to concurrently whip air from the atmosphere into the admixture. The resulting aerated slurry was then stored to permit completion of crosslinking of the guar gum. Under these conditions the initially added guar gum subsequently underwent crosslinking due to the presence of the crosslinking agent in the subsequently added crosslinkable guar gum. Agitation conditions for the preparation of each formulation were identical so as to effect the same exposure of the system to air at all times.

TABLE 1

Formulation	Weight Percent	
	1	2
Water	22.5	22.5
Smokeless Powder ¹	25.0	25.0
Ammonium Nitrate ²	31.3	30.3
Sodium Nitrate ³	19.0	19.0
Ethylene Glycol	1.5	1.5
Guar Gum ⁴	0.7	0.7
Bis (2-hydroxyethyl) cocoamine oxide ⁵		1.0
	100.0	100.0
Ethylene Glycol ⁵	2.0	2.0
Guar Gum ⁵	1.0	1.0
Density, gm./cc. ⁷	1.31	0.93

¹ Ground, single base.² Prills.³ Granular.⁴ Initially hydratable.⁵ Pounds per 97 pounds of base ingredient mixture; crosslinkable guar gum; all guar ultimately crosslinked.⁶ Surfactant, 50 percent aqueous solution.⁷ After completion of crosslinking.

As demonstrated by the above formulations and their densities, viz. 1.31 vs. 0.93, when a surfactant is present, the amount of air entrained in the slurry composition is markedly greater than that when no surfactant is present. Thus the marked increase in efficiency in air entrainment obtained in the presence of the surfactant is demonstrated.

Example II

The following formulations were prepared using the procedure of Example I except that the final slurry admixture was pumped to emplacement, with the addition of the surfactant and the cross-linkable guar gum just prior to emplacement. Air was injected into the slurry mixture during pumping immediately subsequent to addition of the crosslinkable guar gum and surfactant components but prior to emplacement for completion of crosslinking.

TABLE 2

Formulation	Weight Percent	
	1	2
Water	22.5	22.5
Smokeless Powder ¹	25.0	25.0
Ammonium Nitrate ²	31.2	31.2
Sodium Nitrate ³	19.0	19.0
Ethylene Glycol	1.5	1.5
Guar Gum ⁴	0.7	0.7
Pine Oil	0.1	0.1
	100.0	100.0
Ethylene Glycol ⁵	2	2
Guar Gum ⁵	1.0	1.0
Bis (2-hydroxyethyl) cocoamine oxide ⁶		
Funnel Test ⁷ , seconds	4.0	4.0
Density, grams/cc. ⁸	1.39	1.43
Air injected, s.c.f.m. ⁹	6.8	6.1
Average density, grams/cc. ¹⁰	0.88	1.11
Efficiency of air entrainment, percent	29.4	10.8

¹⁻⁴ inclusive, See Example I.⁵ Approximately 5,000 grams of slurry is poured into an aluminum funnel having a 1/2" diameter x 1" orifice. When the orifice is opened to permit flow, the timing is begun. When light is visible through the orifice (looking down into the funnel), timing is stopped. The time difference is designated as the flow time.⁶ Before air injection.⁷ Injected at slurry flow of 250 pounds/minute.⁸ After air injection and completion of cross-linking of guar gum.

The formulations of this example, with reference to the densities shown, demonstrate the marked increase in efficiency of air entrainment accomplished in the presence of a surfactant in accordance with the invention.

Example III

The following formulations, were made up in accordance with the general procedure of Example I with addi-

tion of the pine oil, aluminum, and sugar ingredients in lieu of the smokeless powder ingredient of Example I.

TABLE 3

Formulation	Weight Percent			
	1	2	3	4
Water	18.0	18.0	18.0	18.0
Sugar	5.5	5.5	5.5	5.5
Ammonium Nitrate ²	44.6	43.6	43.6	43.6
Sodium Nitrate ³	15.0	15.0	15.0	15.0
Flaked Aluminum	12.0	12.0	12.0	12.0
Pine Oil	0.1	0.1	0.1	0.1
Ethylene Glycol	3.1	3.1	3.1	3.1
Guar Gum ⁴	0.7	0.7	0.7	0.7
Guar Gum ⁵	1.0	1.0	1.0	1.0
Bis (2-hydroxyethyl) cocoamine oxide ⁶			1.0	
Ethylene oxide adduct of straight chain fatty alcohol ⁷				1.0
Sodium Lauryl Sulfate ⁸				
	100.0	100.0	100.0	100.0
Funnel Test, seconds ⁹	3	3	3	3
Density, grams/cc. ¹⁰	1.34	1.10	1.08	1.14
Estimated minimum PETN booster for detonation, grams	480	80	80	320

²⁻⁴ See Example I.⁵ Crosslinkable. (All guar gum ultimately crosslinked.)⁶ Cationic. 50 percent aqueous solution.⁷ Nonionic.⁸ Anionic. 30 percent aqueous solution.⁹ See footnote of Example II (estimated).¹⁰ After completion of crosslinking.

This example demonstrates the three different types of surfactants; namely, cationic, nonionic, and anionic, utilized in the practice of the invention. Thus, when no surfactant was present, the density of the finished aerated slurry was 1.34 as compared with the corresponding densities in Runs 2-4 of 1.11, 1.08, and 1.14, respectively, which are the result of the higher air entrainment efficiency accomplished by the presence of the surfactant shown. The estimated minimum boosters for detonation, as shown, illustrate the increase in sensitivity that results from the presence of the increased proportions of air due to the higher air entrainment efficiencies accomplished in the presence of the surfactant.

Example IV

The following formulations were made up and are further illustrative of the invention:

TABLE 4

Formulation	Weight Percent	
	1	2
Water	22.5	22.5
Smokeless Powder ¹	25.0	25.0
Ammonium Nitrate ²	30.4	30.2
Sodium Nitrate ³	19.0	19.0
Ethylene Glycol	1.5	1.5
Guar Gum ⁴	0.7	0.7
Pine Oil	0.1	0.1
Bis (2-hydroxyethyl) cocoamine oxide	0.8	1.0
	100.0	100.0
Ethylene Glycol ⁵	2.0	2.0
Guar Gum ⁵	1.0	1.0
Funnel Test ⁶	3	2.5
Density, grams/cc. ⁷	1.34	1.36
Air Injection s.c.f.m. ⁸	2.7	2.7
Average Density ⁹	1.168	1.116
Efficiency of air entrainment, percent	27.3	33.9

¹⁻⁵ See Example I.⁶ See footnote 7, Example II.⁷ Before air injection.⁸ Slurry flow, 250 pounds/minute.⁹ After air injection and completion of crosslinking.

This example further demonstrates the marked increase in efficiency of air entrainment that is accomplished in the practice of the invention, viz., 27.3 percent and 33.9 percent vs. efficiencies in the order of 10-15 percent that are obtained under the same conditions except for the absence of a surfactant, particularly as illustrated with reference to Run 2 of Example II.

Example V

The invention is further illustrated with reference to the following formulations and data which demonstrate the lower densities obtained, in accordance with the invention, as compared with those in the absence of the surfactant component, and accompanying lowering of explosive strength and increase in sensitivity. These examples also demonstrate the control, and hence regulation, of explosive strength and sensitivity that can be accomplished in the practice of the invention.

TABLE 5

Formulation	Weight Percent									
	1	2	3	4	5	6	7	8	9	10
Water.....	17.6	17.6	9.0	9.0	21.9	21.9	18.0	18.0	24.4	16.0
Ammonium Nitrate.....	46.0	46.0	55.0	55.0	29.4	29.4	43.6	43.6	31.1	44.5
Sodium Nitrate.....	13.6	13.6	10.5	10.5	18.4	18.4	15.0	15.0	14.6	8.5
Guar Gum (crosslinked).....	1.7	1.7	1.0	1.0	1.7	1.7	1.7	1.7	1.5	1.0
Ethylene Glycol.....	3.2	3.2			3.4	3.4	3.1	3.1	3.0	
Surfactant:										
Bis (2-hydroxyethyl) cocoamine oxide ¹	1.0	1.0	1.0	1.0	1.0	1.0				
Ethylene Oxide adduct of straight-chain fatty alcohol							1.0			
Sodium Lauryl Sulfate ²								1.0		
Sensitizer ³	16.9	16.9	23.5	23.5			12.5	12.5		
Smokeless Powder					24.2	24.2			25.4	30.0
Density, Air-free basis, gm./cc.	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.45	1.50
Density after Aeration, gm./cc. ⁴	1.45	1.15	1.00	1.15	1.45	1.15	1.08	1.22	1.30	1.20
Sensitivity ⁵	10	1-3	1	1-3	2	2	1	3-5	2	2
Energy ⁶	1,270	1,080	970	1,120	1,010	775	1,000	1,200	870	980

¹ 50 percent aqueous solution.

² 30 percent aqueous solution.

³ Other than high explosives or smokeless powder.

⁴ And after completion of crosslinkings.

⁵ Arbitrarily based on factor "10" as minimum.

⁶ Calculated, calories per cc.

TABLE 6

Formulation	Weight Percent			
	1	2	3	4
Water.....	17.6	17.6	17.6	17.6
Ammonium Nitrate.....	46.0	46.0	46.0	46.0
Sodium Nitrate.....	13.6	13.6	13.6	13.6
Sensitizer ¹	16.9	16.9	16.9	16.9
Surfactant ²	1.0	1.0	1.0	1.0
Guar Gum ³	1.7	1.7	1.7	1.7
Ethylene Glycol.....	3.2	3.2	3.2	3.2
Air Addition, min. ⁴		1	2	3
Density, gm./cc.:				
Prior to addition of air ⁵	1.55	1.55	1.55	1.55
After addition of air and completion of crosslinking		1.35	1.25	1.15
Sensitivity, grams: ⁶				
480.....	F			
320.....		S		
200.....				
160.....				
80.....			S	
40.....			F	S

¹ Other than high explosives or smokeless powder.

² Bis(2-hydroxyethyl) cocoamine oxide.

³ Crosslinked to provide plastic but easily deformable mass.

⁴ Period of addition of air and crosslinkable gum.

⁵ Air-free basis (theoretical density).

⁶ Minimum grams Pentolite booster required for detonation; F=fail; S=shot.

As will be evident to those skilled in art, various modifications can be made or followed, in the light of the foregoing discussion and disclosure, without departing from the spirit or scope of the disclosure or from the scope of the claims.

What I claim and desire to protect by Letters Patent is:

1. A process for the manufacture of an inorganic oxidizer salt blasting composition of the aerated aqueous slurry type which comprises aerating a slurry type blasting composition containing water, inorganic oxidizer salt, sensitizer, and thickener ingredients in the presence of at least 0.3 weight percent of a water-soluble surfactant.

2. In the manufacture of an inorganic oxidizer salt type blasting composition, wherein water, an inorganic oxidizer salt, a sensitizer, and a thickener are admixed to form a

resulting thickened blasting composition of the aqueous slurry type, the improvement comprising incorporating at least 0.3 weight percent of a water-soluble surfactant into the resulting slurry together with a sufficient amount of air to cause a pre-determined lowering of the density of said slurry to regulate its explosive strength.

3. The improvement of claim 2 wherein said slurry on a weight basis is formed by admixing said surfactant with from 20 to 75 percent of said oxidizer salt, from 4 to 60 percent of said sensitizer, from 4 to 35 percent of said water, and from 0.2 to 5 percent of said thickener.

4. The improvement of claim 3 wherein said oxidizer salt is from 20 to 60 percent ammonium nitrate with up to 30 percent sodium nitrate.

5. The improvement of claim 3 wherein from 0.2 to 0.8 percent hydratable guar gum, as said thickener, is admixed with said inorganic oxidizer salt, sensitizer and water to form a slurry containing said guar gum as a sol, adding the said surfactant together with a crosslinkable guar gum under crosslinking conditions therefor in an amount providing a total guar gum content not exceeding about 2 percent, injecting air into said slurry containing the last said guar gum portion and storing the resulting aerated slurry under said crosslinking conditions.

6. The improvement of claim 5 wherein the said surfactant is selected from the group consisting of bis(2-hydroxyethyl) cocoamine oxide, an ethylene oxide adduct of a straight chain fatty alcohol, and sodium lauryl sulfate.

7. The improvement claim 6 wherein surfactant is bis(2-hydroxyethyl) cocoamine oxide.

8. The improvement of claim 2 wherein said surfactant is cationic.

9. An inorganic oxidizer salt blasting composition of the aqueous slurry type formed by effecting aeration of a slurry blasting composition containing the ingredients water, inorganic oxidizer salt, sensitizer and thickener, in the presence of at least 0.3 weight percent of a water-soluble surfactant.

10. A blasting composition of claim 9 formed by admixing water, an inorganic oxidizer salt, a sensitizer, said surfactant and a hydratable guar gum to form a resulting blasting composition of the aqueous slurry type containing said guar gum in substantially hydrated form in amount to impart sufficient consistency to said slurry to preclude settling of ingredients therefrom, adding a crosslinkable guar gum to the said slurry under crosslinking conditions therefor in an amount to impart additional consistency to said slurry upon being crosslinked, to retain an air ingredient described hereinafter in dispersion in said slurry, injecting air into said slurry in an amount to cause

a pre-determined lowering of the said slurry to regulate its explosive strength, and then storing the resulting aerated slurry under crosslinking conditions.

11. A blasting composition of claim 10, wherein the aerated slurry product is formed from an admixture of from 20 to 75 percent of said oxidizer salt, from 4 to 60 percent of said sensitizer, from 4 to 35 percent of said water, from 0.2 to 2 percent of said guar gum, and up to 10 percent of said surfactant.

12. A blasting composition of claim 11 wherein said surfactant is cationic.

13. A blasting composition of claim 12 wherein said surfactant is bis(2-hydroxyethyl) cocoamine oxide.

14. A blasting composition of claim 11 wherein said oxidizer salt is from 40 to 60 percent ammonium nitrate and up to 30 percent sodium nitrate.

15. A blasting composition of claim 11 wherein said surfactant is selected from the group consisting of bis

(2-hydroxyethyl) cocoamine oxide, an ethylene oxide adduct of a straight chain fatty alcohol, and sodium lauryl sulfate.

16. A blasting composition of claim 9 wherein guar gum is the said thickener.

References Cited by the Examiner

UNITED STATES PATENTS

2,768,072	10/1956	Stark	-----	149—2
3,049,454	8/1962	Stark	-----	149—2
3,127,835	4/1964	Alexander	-----	86—20.3 X

FOREIGN PATENTS

665,742	6/1963	Canada.
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BENJAMIN R. PADGETT, *Primary Examiner*.

S. J. LECHERT, JR., *Assistant Examiner*.