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AQUEOUS EXPLOSIVE COMPOSITIONS CONTAINING A PARTIALLY NITRATED AROMATIC HYDROCARBON DISPERSED BY A MONOAMIDE

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ABSTRACT OF THE DISCLOSURE

Aqueous explosive compositions comprising water, an inorganic oxidizing salt, thickener, and a partially nitrated aromatic hydrocarbon sensitizer dispersed in the explosive composition by a lower aliphatic monamide having 1 to 4 carbon atoms, and preferably, a nonexplosive carbonaceous fuel. The ingredients of the explosive composition can be combined in any manner, provided that the lower aliphatic monamide dispersing agent is added no later than about the time the partially nitrated aromatic hydrocarbon sensitizer is added.

BACKGROUND OF INVENTION

Aqueous explosive compositions, particularly of the "slurry" or "water gel" type, have recently come into wide use in commercial blasting operations. These aqueous explosive compositions generally comprise an inorganic oxidizing salt, a fuel, water and a gelling or thickening agent in combination with suitable cross-linking agents. Although blasting agents have been proposed which comprise only an inorganic oxidizing salt, a carbonaceous fuel, water and a thickener, generally a high explosive organic or meallic sensitizer, e.g., TNT, aluminum, ferrosilicon or smokeless powder, is present to guarantee reliable detonation. The use of a self-explosive type or metallic sensitizer is found to be particularly important when such blasting agents are used at low temperatures, e.g., 32 to 40° F. (0° to 50° C.). Furthermore, these blasting agents must be sufficiently sensitive to propagate detonation in a continuous unconfined column 6 to 10 inches in diameter. Accordingly, to insure reliable detonation, especially at low temperatures, it is necessary to include a relatively high proportion of a self-explosive, e.g., TNT, PETN (pentaerythritol tetranitrate), smokeless powder and/or a metal, e.g., aluminum, ferrosilicon, or ferrophosphorus in the formulation. The explosive slurries of U.S. 2,930,685 are representative of such prior art explosive compositions.

In the development of commercially acceptable aqueous explosive compositions, considerable emphasis is placed on factors such as cost and availability of the explosive ingredients, safety and handling characteristics in both manufacture and use, and resultant product properties, e.g., storability, reliability and sensitivity. While the thickened ammonium nitrate-TNT-H_2O slurries have enjoyed a measure of commercial success, consideration of the aforementioned factors points up a definite need for an aqueous explosive composition free of self-explosive organic sensitizers and/or metallic fuels and which possesses a combination of highly desirable physical and explosive properties, i.e., an economical, easily handled, stable, non-separating aqueous blasting agent, preferably oxygen balanced, which can be reliably detonated, especially at low temperatures, e.g., 0° to 5° C.

The use of a self-explosive such as TNT can present a definite safety hazard in the handling and storage of aqueous explosive compositions since those compositions which contain self-explosives are more sensitive than those compositions which are free of high explosive materials. Further, the use of self-explosives and/or metals substantially increases the cost of the blasting agent. Attempts to eliminate the use of self-explosives in aqueous explosive compositions have, in the past, met with little successe. It has been suggested to prepare water-bearing explosive compositions containing mono- or di-nitro aromatic hydrocarbons, e.g., the mono- and di-nitrobenzenes and the mono- and di-nitrotoluenes, as described in, for example, U.S. 3,161,551, 3,201,291 and Canadian 712,981. While the use of a non-high explosive sensitizer, particularly dinitrotoluene (DNT), offers definite advantages in blasting agents, e.g., safety in handling and storage and reduced product cost, it would appear obvious that AN-DNT-H_2O gels would possess certain drawbacks common to ammonium nitrate blasting agents containing organic nitro sensitizers and/or fuels, i.e., the tendency of such gels to separate on standing into layers, each layer containing different proportions of the explosive components. As is well known, such separation and the resulting inhomogeneity cause difficulties in handling and adversely affect the explosive characteristics, particularly at the low, even freezing, temperatures often encountered in use. Under such low temperature conditions, the compositions tend to solidify or harden as well as to separate so that blasting efficiency is further imapired. The separation problem is somewhat counteracted by the addition of various gelling agents or thickeners either alone or in combination with crosslinking agents which serve to increase the viscosity of the explosive compositions and reduce the tendency for the less soluble components to settle or separate. It has been found, however, that even with the use of such gelling and crosslinking agents, the physical properties of aqueous explosive compositions are not entirely satisfactory, particularly at low temperatures. The problem becomes paritcularly acute when the preparation and storage of explosive compositions containing liquid nitro aromatic hydrocarbons is attempted. Although nitro aromatic hydrocarbons are well known as valuable sensitizers in so-called "dry" explosive compositions, i.e., those containing no water, and have been introduced as solid materials, e.g., particulate TNT, in many water-bearing explosive compositions the low solubility of certain nitro aromatic hydrocarbons and mixtures thereof, e.g., dinitrotoluene oil often referred to as "drip oil," makes incorporation and retention of such insoluble organic materials in a water gel matrix a definite problem. While mixing and agitation procedures may serve to disperse materials such as DNT initially, upon standing, even for periods of time as short as one hour, separation of the components results. In packaged products of aqueous explosives, especially during extended storage periods, the gels containing liquid nitro aromatic hydrocarbon sensitizers tend to separate and settle into layers so that handling and subsequent loading at a borehole site becomes difficult. Even in those blasting compositions prepared at the blasting site and delivery directly into the borehole, e.g., compositions prepared on a pump or slurry truck, similar problems due to separation of the gels may occur when an appreciable amount of time elapses before the blasting agent is detonated. In most cases, sensitivity of the explosive compositions is affected and the gels fail to detonate.

Accordingly, there is a definite need in the industry for an aqueous explosive composition which comprises a stable, substantially homogeneous system at low temperatures which can be reliably detonated, for example, in 6-inch-diameter boreholes, even at low temperatures without the necessity of the presence of self-explosives and/or metallic fuels and which is applicable to simple, low-cost preparation at either plant or blasting site.

SUMMARY OF THE INVENTION

It has now been discovered that aqueous explosive compositions comprising water, an inorganic oxidizing salt at least partially dissolved in the water, and a thickener together with the presence of a partially nitrated aromatic hydrocarbon sensitizer dispersed in the explosive composition by a lower aliphatic monamide having 1 to 4 carbon atoms results in an aqueous explosive composition wherein the nitrated aromatic sensitizer does not separate or settle into layers but rather the composition remains substantially homogeneous during extended periods of storage and will reliably detonate even when used at low temperatures. Although the partially nitrated aromatic hydrocarbon sensitizer functions as a fuel, it is preferable that the composition also contain a nonexplosive carbonaceous fuel. In the preparation of the aqueous explosive blasting agent, water, inorganic oxidizing salt, thickener, dispersing agent, sensitizer and preferably, nonexplosive carbonaceous fuel are mixed. The order of addition of the above ingredients that constitute the explosive composition is discretionary, provided that the lower aliphatic monamide dispersing agent is added no later than about the time the partially nitrated aromatic hydrocarbon sensitizer is added. If the monamide dispersing agent is not added before or at about the same time as the partially nitrated aromatic hydrocarbon sensitizer, the sensitizer will not be adequately dispersed throughout the aqueous explosive composition and separation of the sensitizer will occur. The aqueous explosive compositions of the present invention remain stable and substantially homogeneous for extended periods of time, e.g., several months, are free of high explosive organic sensitizer and/or metallic fuels and are reliably detonated even at low temperatures.

PREFERRED EMBODIMENTS OF THE INVENTION

Preferably, the aqueous explosive compositions of this invention are prepared by mixing the dispersing agent, sensitizer, thickening agent, and preferably, a nonexplosive carbonaceous fuel, in a hot aqueous solution of the inorganic oxidizing salt. The dispersing agent is added no later than about the time the sensitizer is added. The resulting product is cooled to form a gelled product in which, at ambient temperatures, about 10 to 20% of the salt component is crystallized out of solution whereas all of the hydrocarbon sensitizer is dispersed in virtually colloidal dimensions throughout the gel by virtue of the lower aliphatic monamide dispersing agent. The resulting aqueous explosive composition can be stored for extended periods of time, e.g., several months, and the partially nitrated aromatic sensitizer does not separate or settle into layers. Consequently, the aqueous explosive composition containing the monamide dispersing agent and the dispersed partially nitrated aromatic hydrocarbon sensitizer can be reliably detonated. Generally, the compositions of the present invention have a density of about 1.0 to 1.5, and preferably about 1.1 to 1.4, g./cc.

Optionally, but preferably, the inclusion of at least about 0.01% of a soluble, proteinaceous material, for example, egg albumin, as described in copending application Ser. No. 609,329, filed Jan. 16, 1967 gives particularly outstanding physical properties to the aforementioned gel compositions in that such compositions remain soft and pliable at low temperatures, e.g., 30 to 40° F. (−7 to 5° C.), and can be foamed, in addition to the fact that the partially nitrated aromatic hydrocarbon sensitizer is dispersed throughout the composition by the monamide dispersing agent.

The sensitizers used in the present invention that are dispersed by lower aliphatic monamides are partially nitrated aromatic hydrocarbons. By partially nitrated is meant the mono and dinitrated derivatives. The amount of hydrocarbon sensitizer used is generally from about 2 to 40%, and usually 5 to 20%, by weight of the total weight of the explosive composition. When the nitro aromatic hydrocarbon sensitizer is used as the sole fuel, i.e., other nonexplosive carbonaceous fuels are not present in the composition, at least about 10% by weight of the nitro aromatic hydrocarbon sensitizer is employed. The partially nitrated aromatic hydrocarbon sensitizers include both single and fused ring hydrocarbons and especially the partially nitrated derivatives of single ring aromatic compounds such as benzene, toluene and xylene, for example, mono- and dinitroxylene, mono- and dinitrobenzene, and mono- and dinitrotoluene can be used as well as blends thereof. Particularly preferred aromatic nitro compounds are various grades of dinitrotoluene, for example, Dinitrotoluene Oil 26° Technical, min. F.P. 26.0±3.0° C., Dinitrotoluene Oil Technical, F.P. 30±5° C., Dinitrotoluene Mixture Technical, min. F.P. 56° C., available from E. I. du Pont de Nemours and Co., or mixtures of any of the dinitrotoluene isomers. It should be noted that while some of the partially nitrated aromatic hydrocarbons are normally solid at ambient temperature, the majority of blends that are most commercially attractive, are liquid at the temperature at which they are added to the inorganic oxidizing salt liquor in the manufacturing process.

The dispersing agents of the present invention that effect the distribution and promote the retention of discrete, extremely fine droplets, usually of colloidal dimensions of a nitro aromatic hydrocarbon, as herein described, throughout the matrix of a water-bearing gel are lower aliphatic monamides having 1 to 4 carbon atoms, or mixtures thereof. Generally, the amount of dispersing agent used is from about 1 to 30% by weight, and usually 2 to 10% is adequate under most conditions. Representative monamide dispersing agents that act to distribute a liquid nitro aromatic hydrocarbon throughout a water-bearing gel are, for example, formamide, N,N-dimethylformamide, acetamide, acrylamide and propionamide. These dispersing agents not only serve to distribute the nitro aromatic hydrocarbon throughout the aqueous explosive gel but also, by reason of their effect on nitrate ion solubility serve to enhance the overall gel properties and prevent subsequent separation of the nitro aromatic hydrocarbon sensitizer upon standing. For example, water gels containing dinitrotoluene dispersed by formamide will remain homogeneous for periods of at least 3 months. As a result of the use of these dispersing agents, the gelled explosive composition may be likened to a colloidal suspension in which the inorganic oxidizing salts are dissolved and the liquid nitro aromatic hydrocarbon is so finely dispersed as to be invisible to the naked eye. The size and stability of these finely dispersed droplets will vary somewhat depending on the dispersing agent used, but will generally be less than 10 microns in diameter. While it is not intended that this invention be limited by theory, it is believed that gel stability is largely enhanced by the fineness (in size) of the dispersed liquid nitro aromatic hydrocarbon. Consequently, formamide which acts to produce an ultrafine dispersion is especially preferred. Only very small amounts of the dispersing agent are necessary to produce excellent gels, e.g., as little as 2% by weight formamide will disperse up to about 20% by weight of dinitrotoluene. However, larger amounts of formamide or other lower aliphatic monamides, for example, up to about 20% by weight, can be used because these materials also provide the composition with a carbonaceous fuel.

The inorganic oxidizing salts employed in this invention can be any of the soluble salts conventionally used in aqueous explosive compositions including alkali metal, alkaline earth metal and ammonium nitrates and perchlorates as well as mixtures of two or more such salts. Examples of inorganic oxidizing salts which comprise from about 40 to 75% by weight of total composition include ammonium nitrate, sodium nitrate, calcium nitrate, barium nitrate, magnesium nitrate, ammonium perchlorate, so-

dium perchlorate, potassium perchlorate, and magnesium perchlorate. For reasons of economy as well as its known explosive properties, preferably at least 40% and up to 70% by weight of the total composition is ammonium nitrate. Sodium nitrate is a preferred auxiliary salt with ammonium nitrate in amounts of from about 5% up to about 25% of the total composition.

In a preferred embodiment of this invention, the novel explosive composition is prepared by incorporating the inorganic oxidizing salt as a hot "neutral liquir," e.g., the equeous ammonium nitrate solution obtained from the manufacture of ammonium nitrate prior to the graining or prilling operation. The inorganic oxidizing salts are chosen to be soluble in the hot liquor so that substantially all oxidizing agent is in solution at the time of manufacture. With the provision and use of heated storage tanks on the pump or slurry trucks for blasting operations, the inorganic oxidizing salts can be handled as a liquid. Such a procedure offers the advantages of ease of preparation and handling at the blasting site by minimizing the handling of solids. If desired, about 20 to 40% of the ammonium nitrate liquid can be substituted by ammonium nitrate prills.

The compositions of this invention generally contain 5 to 30%, preferably about 10 to 20% water, and are thickened by any of the thickeners conventionally used in water-bearing explosive compositions. "Thickened" as used herein refers to compositions in which the viscosity of the aqueous phase has been materially increased, e.g., to 20,000 cps. or more, as well as to gelled products including those gels which are crosslinked. The compositions can vary in consistency from pourable, pumpable semifluid solutions, slurries, and dispersions to moldable, tough, plastic masses. Such thickeners are used in amounts ranging from, by weight of the composition, 0.1 to 10%, and preferably from about 0.2 to 5%. Suitable examples of thickeners include three exudates such as gum arabic, ghatti, karaya, and tragacanth, seaweed colloids such as agar-agar, Irish moss, carrageenin, and the alginates; seed extracts such as locust bean, locust kernel, guar and quince seed gums; starches and modified starches such as dextrins, hydroxyethyl starch and British gums; water-dispersible derivatives of cellulose such as methylcellulose, sodium carboxymethylcellulose and sodium sulfoethylcellulose; gelatin; casein; polyvinyl alcohol; high molecular weight polyethylene oxides; exocellular heteropoly saccharides made by fermenting starch-derived sugars, silica gels as well as mixtures of two or more of the above thickening agents. Of these, galactomannans such as guar and locust bean gum, and particularly guar gum, are preferred. When a galactomannan, particularly guar gum, is used as the gelling agent, about from 0.25 to 2% of the galactomannan is usually employed. The galactomannan can be a self-complexing guar gum, e.g., EX–FC–50 and EX–FC–DP supplied by Stein-Hall Co. or a non-complexing guar gum such as Stein-Hall's Juguar 100 or Jaguar 10 in which no crosslinking agent is incorporated. When a non-complexing guar gum is used, small amounts, i.e., about 0.001 to 1% by weight of the total composition, of crosslinking agents, e.g., borax, sodium or potassium dichromate, for the gelling agent can be employed. Other suitable crosslinking agents are soluble antimony and bismuth compounds at a pH of 6 to 13 as described in U.S. Patent 3,202,556 and transition metal compounds as in application S.N. 343,140, filed Feb. 6, 1964, now U.S. Patent 3,301,723, the teachings of which are incorporated herein by reference.

Still further suitable gelling systems are those described in copending U.S. application Ser. No. 579,852, filed Sept. 16, 1966, which are formed by polymerizing in situ a moneithylenically unsaturated monomer, e.g., acrylamide, with a polyethylenically unsaturated monomer, e.g., methylenebisacrylamide.

Although the partially nitrated aromatic hydrocarbon sensitizer also functions as a fuel, it is preferable to add and incorporate therein a nonexplosive carbonaceous fuel. Representative carbonoceous nonexplosive fuels include, for example, coal and other forms of finely divided carbon; solid carbonaceous vegetable products such as sugar, cornstarch, wood and paper pulps, various meals such as ivory nut meal, solid and liquid organic hydrocarbons such as powdered paraffn waxes and fuel oils; as well as cellular carbonaceous materials such as piths, particularly bagasse piths, expanded cereal products, e.g., puffed wheats and rice, which can serve to lower the composition density, as well as mixtures of two or more of these fuels. The compositions can also contain expanded, cellular mineral or silaceous materials such as pumice, perlite, and vermiculite. Generally, up to about 50%, preferably about 20 to 50%, of the nitro aromatic hydrocarbon sensitizer may be replaced by one or more of the aforementioned carbonaceous fuels. The explosive composition will therefore contain up to about 20%, and preferably about 2 to 10% by weight, of the total composition of such carbonaceous fuels. Preferably, the amount of fuel is adjusted so that the total composition has an oxygen balance of about from −30 to +10% and preferably about −15 to 0%.

Preferably, the explosive compositions of this invention can be prepared by adding the sensitizer, dispersing agent and other optional nonexplosive carbonaceous fuels to a hot (150–170° F.) concentrated solution containing the major proportion of inorganic oxidizing salt, then adding sodium nitrate and galactomannan, premixed if desired, along with suitable crosslinking agents. To achieve the desired dispersion of the partially nitrated aromatic hydrocarbon sensitizer in the explosive composition, it is necessary that the monamide dispersing agent be added no later than about the time the sensitizer is added. Addition of the monamide dispersing agent after the addition of aromatic nitro compound results in poor distribution of relatively large drops of said aromatic nitro compound which separate from the gel on standing. If it is desired to incorporate a soluble, proteinaceous material, particularly egg albumin, in the composition, it is advisable to first add to the hot liquir one or more of the other ingredients, e.g., formamide and DNT, sugar, coal, etc., which act to cool the liquor as they are added, to about 140° F. or less. Since it is known that heat (ca. 140° F.) coagulates egg albumin, such cooling insures a smooth and discrete incorporation of said egg albumin. After the addition of the proteinaceous material, it is preferable to agitate the mix for about 0.1 to 5 minutes so as to foam the composition. The foaming ability of egg albumin and certain other proteinaceous materials acts to incorporate small gas-filled cavities by the entrainment of air in the gel matrix which serves to sensitize the explosive composition.

The following examples illustrates specific embodiments of the invention, but are not to be construted as limiting its scope.

In the following examples, parts, unless otherwise indicated, are by weight. In the Tables 1 and 2, "PAT" refers to potassium antimony tartrate.

Examples 1–5

Water-bearing explosive compositions are prepared in a turbine-type slurry mixer from the materials shown in Table 1 by the following sequence of steps:

(1) Ammonium nitrate "neutral liquor" (78–80% ammonium nitrate) at 150–170° F. is placed in the mixer and the pH of the liquir adjusted to 4.5–5.0 by addition of nitric acid.

(2) Potassium antimoy tartrate crosslinking agent is added and agitation is begun.

(3) A soluble carbonaceous fuel (if specified) is added with mixing and the temperature drops to below about 140° F.

(4) A proteinaceous material (egg albumin) (if specified) is added and mixed for about 1 minute.

(5) The dispersing agent (formamide) is added, followed by the addition of the nitro aromatic hydrocarbon (dinitrotoluene) and mixed for about 2 minutes.

(6) A premixed composition of sodium nitrate and guar gum is added and mixed for about 4 to 5 minutes, or until thickening is observed.

(7) Ammonium nitrate prills and/or solid carbonaceous fuels (if specified) are added and mixed in.

(8) Crosslinking agent (sodium dichromate) is added while the composition is pumped from the slurry truck.

The compositions formed (except that of Examples 1 and 5) are loaded into 6-inch-diameter, 32 feet deep boreholes filled with 10 to 18 feet of water. Stemming consists of about 20 feet of sand. The compositions of Examples 2 and 3 remain loaded for a period of 5 days before shooting; the composition of Example 4 for 4 days before shooting. The compositions of Examples 1 and 5 are packed in 5-inch, 40-lb. polyethylene bags and shot unconfined in air. No separation is observed of DNT oil in any of the compositions. The compositions were initiated at the temperatures designated with 2 1-lb. (454 g.) cast TNT primers. The detonation velocity measurements are given in meters/second.

TABLE 1

Example	1	2	3	4	5
78% AN liquor	48.4	48.4	47.8	61.2	48.4
(Ammonium Nitrate)	(37.8)	(37.8)	(37.5)	(47.8)	(37.8)
(Water)	(10.6)	(10.6)	(10.3)	[1] (16.1)	[2] (13.0)
Ammonium nitrate prills	19.8	18.9	19.7		17.8
Sodium Nitrate	13.9	13.9	13.8	18.1	12.9
DNT (26°)[3]	7.9	[4] 10.9	[4] 7.9	11.0	10.0
Formamide	4.9	1.9	4.9	1.8	1.9
Sugar (granulated)	4.9	4.9	4.9	5.0	
Coal (fine)					3.8
Bagasse Pith			0.8		2.8
Egg albumen	0.2	0.2	0.2	0.2	
The compositions also contain per hundredweight:					
Guar gum, lbs	1.0	1.0	1.0	1.0	1.0
5% $Na_2Cr_2O_7$, cc	300	300	300	400	300
PAT, g	1.25	1.25	1.25	1.25	1.25
Velocity, m./sec.:					
76° F	4,150				[5] 4200
56° F		5,100	4,920	5,100	[6] 3850
40° F	2,915				
Density, g./cc	1.32	1.29	1.22	1.22	1.32

[1] 2.7 lbs. of H_2O added to AN liquor.
[2] 2.4 lbs. of H_2O added to AN liquor.
[3] Dinitrotoluene oil 26° technical.
[4] Dinitrotoluene oil technical, 30±5° C.
[5] Teestd at 70° F.
[6] Tested at 50° F.

The compositions of Examples 2 and 3 are also loaded in dry boreholes and after 4 days standing, are detonated at 4920 m./sec. and 4620 m./sec. respectively. Similarly, the compositions of Examples 2 and 3 are packed in polyethylene bags as described for the compositions of Examples 1 and 5; no separation is observed in any of these compositions even after 3 months' storage, the maximum period of observation. The compositions of Examples 2 and 3 are detonated in air unconfined in 6" diameter with 2 1-lb. cast TNT primers at 76° F. at velocities at 4500 m./sec. and 4150 m./sec., respectively and at 40° F. at velocities of 4000 m./sec. and 3915 m./sec., respectively. The composition of Example 2 when formulated at a density of 1.41 g./cc. detonated in air unconfined in 6 inch diameter at 76° F. at a velocity of 3400 m./sec. and at 40° F. at 3915 m./sec.

The composition of Example 3 is also evaluated as a seismic blasting agent by packaging in 4½-inch-diameter, 20 lb. metal cans and shooting underwater at a depth of 6 feet and a temperature of about 70° F. Five shots recorded velocities of 4000–4400 m./sec. when primed with an 18.5 g. charge of RDX.

When 56° C. DNT is substituted for 26° C. DNT in the composition of Example 2, the composition had a density of 1.29 and detonates in a wet 6-inch-diameter, 32 feet-deep borehole under conditions previously described for the compositions of Examples 2 and 3 at 5100 m./sec. at 56° F. It is also observed that the 56° C. DNT remains evenly dispersed, as did the 26° DNT, by the addition of formamide to the explosive composition. Similar results are obtained when a 3/1 mixture of DNT and nitrotoluene is used in place of 26° DNT in the composition of Example 2. When the compositions of Examples 1–5 are prepared without formamide, the gels are separated after standing for 1 day or less and fail to detonate at both 56° and 40° F.

Examples 6 to 9

Water-bearing explosive compositions of the formulations given in Table 2 are prepared in a rotary mixer by the following procedure:

(1) Ammonium nitrate liquor (78–80% ammonium nitrate) at 150–170° F. is placed in the mixer and agitation is begun.

(2) A soluble carbonaceous fuel (if specified) a dispersing agent and dinitrotoluene as indicated in Table 2, proteinaceous material, premixed soda and guar gum, ammonium nitrate prills and/or solid carbonaceous fuels (if specified) are added with agitation as described in the procedure for the preparation of the compositions of Examples 1–5. In all of the compositions, the dispersing agent is added no later than about the time the sensitizer is added.

(3) Crosslinking agents (sodium dichromate and potassium antimony tartrate) are added; the compositions are mixed for several minutes and discharged into 6 inch, 50 lb. polyethylene bags. The products are detonated in air, unconfined with 2 1-lb. cast TNT primers.

TABLE 2

Example	6	7	8	9
78–80% AN liquor	61.0	60.0	61.0	61.0
(Ammonium Nitrate)	48.0	47.4	48.7	48.7
(Water)	[1] 16.0	[1] 15.6	[2] 14.3	[2] 14.3
Sodium nitrate	18.0	17.4	18.4	18.4
DNT (26°)	8.0	7.7	15.3	13.3
Formamide	4.9	4.9	3.1	5.1
Sugar (granulated)	4.9	4.9		
Bagasse Pith		1.9		
Egg albumin	0.2	0.2	0.2	0.2
The compositions also contain per hundred weight:				
Guar gum, lbs	1.0	1.0	1.0	1.0
5% solution, $Na_2Cr_2O_7$, cc	400	400	400	400
5% PAT, cc	200	200	200	200
Velocity, m./sec.:				
76° F	[3] 4,000	[3] 3,950	4,150	3,950
40° F	4,500	3,600	3,900	3,600
Density, g./cc	1.33	1.12	1.32	1.30

[1] 3 lbs. of H_2O added to AN liquor.
[2] 1 lb. of H_2O added to AN liquor.
[3] Tested at 100° F.

Similar results are observed when the procedure of Example 7 is repeated except that acetamide is substituted for formamide as the dispersing agent.

The compositions of Examples 6 to 9 remain homogeneous even after prolonged storage; the compositions of Examples 6 and 7 are subjected to 10 weeks hot (ca. 100° F.) and cold (ca. 20° F.) storage with no evidence of separation of the DNT at the end of that time.

I claim:

1. In an aqueous explosive composition comprising water, an inorganic oxidizing salt, and thickener, the improvement comprising having a mononitrated or dinitrated aromatic hydrocarbon sensitizer dispersed therein by a lower aliphatic monamide having 1 to 4 carbon atoms.

2. The composition of claim 1 wherein the monamide is formaide.

3. The composition of claim 1 containing a nonexplosive carbonaceous fuel.

4. The composition of claim 3 wherein the monamide is formamide.

5. The composition of claim 3 wherein said sensitizer is a nitrated single ring aromatic hydrocarbon.

6. The composition of claim 4 wherein the hydrocarbon sensitizer is dinitrotoluene.

7. The composition of claim 6 wherein the inorganic oxidizing salt is ammonium nitrate.

8. In an aqueous explosive composition comprising from about 5 to 30% water, from about 40 to 70% ammonium nitrate, from about 5 to 25% sodium nitrate, from about 2 to 20% nonexplosive carbonaceous fuel and from about 0.2 to 5% thickener, the improvement comprising having from about 2 to 40% of a mono-nitrated or dinitrated aromatic hydrocarbon sensitizer dispersed therein from about 1 to 30% of a lower aliphatic monamide having 1 to 4 carbon atoms.

9. The composition of claim 8 wherein the monamide is formamide.

10. The composition of claim 9 wherein the hydrocarbon sensitizer is dinitrotoluene.

11. In a process for making aqueous explosive compositions which comprises mixing water, an inorganic oxidizing salt, thickener, dispersing agent and sensitizer, the improvement which comprises adding as the dispersing agent a lower aliphatic monamide having 1 to 4 carbon atoms no later than about the time a mono-nitrated or dinitrated aromatic hydrocarbon sensitizer is added so as to disperse said sensitizer in the aqueous explosive composition.

12. A process of claim 11 wherein the monamide is formamide.

13. A process of claim 11 wherein a nonexplosive carbonaceous fuel is added.

14. A process of claim 13 wherein the monamide is formamide.

15. A process of claim 13 wherein said sensitizer is a nitrated single ring liquid aromatic hydrocarbon.

16. A process of claim 14 wherein the sensitizer is dinitrotoluene.

17. A process of claim 16 wherein the inorganic oxidizing salt is ammonium nitrate.

18. In a process for making aqueous explosive compositions which comprises mixing from about 5 to 30% water, from about 40 to 70% inorganic oxidizing salt, from about 2 to 20% nonexplosive carbonaceous fuel, from about 0.2 to 5% thickener, dispersing agent and sensitizer, the improvement which comprises adding from about 1 to 30% of a lower aliphatic monamide dispersing agent having 1 to 4 carbon atoms no later than about the time that from about 2 to 20% of a mono-nitrated or dinitrated aromatic hydrocarbon sensitizer is added so as to disperse said sensitizer in the explosive composition.

19. A process of claim 18 wherein the dispersing agent is formamide.

20. A process of claim 19 wherein the sensitizer is dinitrotoluene.

21. A process of claim 20 wherein the inorganic oxidizing salt is from about 40 to 70% ammonium nitrate and from about 5 to 25% sodium nitrate.

References Cited

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,406,051 October 15, 1968

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It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

Column 9, line 14, "formaide" should read -- formamide --; li 32, "therein from" should read -- therein by from --. Column 10, line 18, "70%" should read -- 75% --; line 24, "20%" should read -- 40% --.

Signed and sealed this 10th day of March 1970.

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents