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**THICKENED AQUEOUS INORGANIC NITRATE
SALT-NITROPARAFFIN EXPLOSIVE COMPO-
SITION SENSITIZED WITH AN AIR ENTRAP-
PING MATERIAL****Joseph J. Minnick, Marion, Ill., assignor to Commercial
Solvents Corporation, New York, N.Y., a corporation
of Maryland****No Drawing. Filed May 3, 1967, Ser. No. 635,681****17 Claims. (Cl. 149—2)****ABSTRACT OF THE DISCLOSURE**

A thickened slurry explosive which contains an inorganic nitrate oxidizing salt, a nitroparaffin, e.g., nitromethane, nitroethane, 1-nitropropane, 2-nitropropane, and 2,2-dinitropropane, water, a sensitizer, e.g., a non-explosive, finely divided air-entrapping material, and a thickening agent. Said explosive composition is useful in small bore hole blasting operations.

BRIEF SUMMARY OF THE INVENTION

This invention relates to thickened slurry explosive compositions comprising an inorganic nitrate oxidizing salt, a nitroparaffin selected from the group consisting of nitromethane, nitroethane, 1-nitropropane, 2,2-dinitropropane and 2-nitropropane, water, as sensitizer a non-explosive, finely divided air-entrapping material and thickening agent. In a particular aspect, this invention relates to thickened slurry explosive compositions having high rates of detonation and suitable for use in small bore hole blasting operations, said compositions containing an inorganic nitrate oxidizing salt, a nitroparaffin selected from the group consisting of nitromethane, nitroethane, 1-nitropropane, 2,2-dinitropropane and 2-nitropropane, water, thickening agent, and as sensitizer a non-explosive, finely divided air-entrapping material.

The use in explosive compositions of inorganic nitrate salts such as the alkali metal nitrates, the alkaline earth metal nitrates and, in particular ammonium nitrate has become widespread in the mining and quarrying arts. For example, thickened aqueous slurries containing ammonium nitrate have found extensive use in many blasting operations. Explosive compositions containing ammonium nitrate and a nitroparaffin are also known to the art and have a wide variety of applications.

Even though explosive compositions such as those described above have proven effective for numerous uses, such explosives are generally not suitable for use in small bore hole explosive applications unless sensitized by a sensitizer which is itself a high explosive, such as for example, trinitrotoluene (TNT). The principal reason for this is that without the employment of a high explosive sensitizer the detonation velocities of such compositions are not sufficiently high to give the desired results. For reasons of economy and more importantly, for reasons of safety, it is desirable to avoid the use of high explosive sensitizers in ammonium nitrate containing explosive compositions.

It is an object of the present invention to provide thickened explosive compositions containing an inorganic nitrate oxidizing salt, water, a nitroparaffin selected from the group consisting of nitromethane, nitroethane, 1-nitropropane, 2,2-dinitropropane and 2-nitropropane, a thickening agent, and a non-explosive sensitizer.

It is a further object of the present invention to provide thickened slurry explosive compositions containing an inorganic nitrate oxidizing salt, water, a nitroparaffin selected from the group consisting of nitromethane, nitroethane, 1-nitropropane, 2,2-dinitropropane and 2-nitro-

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propane, a thickening agent and a non-explosive sensitizer which have high rates of detonation and are suitable for use in small bore hole blasting operations.

Other objects and advantages of the present invention will be apparent from the specification and appended claims.

The present invention resides in the discovery that explosive compositions having high rates of detonation and suitable for use in small bore hole blasting operations are prepared by forming an admixture of from about 10 to about 90 percent by weight of an inorganic nitrate oxidizing salt, from about 5 to about 50 percent by weight of water, from about 5 to about 50 percent by weight of a nitroparaffin selected from the group consisting of nitromethane, nitroethane, 1-nitropropane, 2,2-dinitropropane, 2-nitropropane and mixtures thereof, a thickening agent and a sensitizing amount of a non-explosive, finely divided air-entrapping material, the said weights being based on the total of the weights of the nitrate salt, the water and the nitroparaffin.

The "detonation rate" of an explosive composition is the rate at which the detonation front passes through the explosive material. Detonation rate is typically expressed in feet per second. For the purpose of the present invention, high detonation rates are generally considered to be in excess of 14,000 feet per second. The compositions of the present invention have detonation rates in excess of 14,000 feet per second, with detonation rates in excess of 16,000 feet per second being reasonably common.

DETAILED DESCRIPTION

Nitroparaffins selected from the group consisting of nitromethane, nitroethane, 1-nitropropane, 2-nitropropane and 2,2-dinitropropane are employed in the compositions of the present invention in an amount in the range of from about 5 to about 50% with an amount in the range of from about 5 to about 30% being preferred.

The said nitroparaffins are essentially insoluble in water. In order to provide stable compositions, it is therefore necessary to provide the nitroparaffin in a form which is dispersible in the compositions of the present invention. This is readily accomplished by gelling the nitroparaffin with a suitable gelling agent, preferably nitrocellulose, before it is mixed with the other ingredients. Other suitable gelling agents for nitroparaffins are disclosed in application Ser. No. 446,732, filed Apr. 8, 1965, for L. R. Jones, and in U.S. Patent 2,954,350, issued Sept. 27, 1960, to R. F. Purcell. Dispersion of nitroparaffins may also be accomplished by the employment of solubilizing or emulsifying agents for the nitroparaffin. Suitable solubilizing agents in which the nitroparaffins are soluble and which in turn are soluble in water are known to the art and include the lower aliphatic alcohols, such as for example, methanol, ethanol, propanol and n-butanol. Such alcohols also serve to depress the freeze point of the explosive composition. Suitable emulsifying agents are also known to the art and include such commercially available emulsifiers as the "Spans" and "Tweens" of Atlas Powder Company which are derived from polyhydric alcohols and the "Plurionics" of Wyandotte Chemical Company.

Any suitable inorganic nitrate oxidizing salt or mixture of two or more such salts may be employed in the compositions of the present invention with ammonium nitrate being preferred. The form and particle size of ammonium nitrate (or other salt) are not critical features of the present invention. For example, low density and high density ammonium nitrate prills as well as ground or granular ammonium nitrate may be employed. Preferably, the particle size of the nitrate salt is sufficiently small to pass a 20 mesh screen.

As previously indicated, the inorganic nitrate oxidiz-

ing salt is employed in an amount in the range of from about 10 to about 90% with an amount in excess of 40% being preferred.

The water content of the compositions of the present invention is such as to dissolve all or a portion of the inorganic nitrate salt. Water is employed in the compositions in an amount in the range of from about 5 to about 50 percent with an amount in the range of from about 5 to about 30 percent being preferred.

The sensitizers employed in the compositions of the present invention are non-explosive, finely divided air-entrapping materials. Examples of such sensitizers include resin balloons, bagasse, wood flour, cork, balsa and the like. Resin balloons of use as sensitizers in the compositions of the present invention are water insoluble, thin-walled, hollow, spherical balloons of a polymerized

thermosetting resin selected from the group consisting of urea formaldehyde and phenol formaldehyde. Such resin balloons are commercially available and are more fully described in U.S. Patent 3,101,288 to Coursen et al., issued Aug. 20, 1963.

The amount of non-explosive sensitizer required to sensitize the compositions of the present invention will vary and will depend, among other things, upon the particular sensitizer employed and the degree of sensitization desired. Generally, an amount in the range of from about 0.1 to about 6.0 percent by weight is suitably employed, with amounts in the range from about 0.4 to about 3.0 percent being preferred, the weights based on the total weight of the composition.

The class of materials used as thickeners for aqueous inorganic nitrate oxidizing salt explosive compositions is known and is illustrated by such materials as guar gum, gum arabic, pregelatinized starch, and carboxymethyl cellulose, with guar gum being preferred. The amount of thickening agent employed in the composition of the present invention will, of course, depend upon the particular thickening agent and the viscosity desired for the particular composition. An amount of thickening agent in the range of from 0.5 to about 5.0 percent by weight based on the weight of the composition is typically employed.

The compositions of the present invention may optionally contain a metal powder, such as aluminum, to enhance their power.

The compositions of the present invention are prepared by known mixing procedures. The composition may be safety manufactured, stored and shipped, and hence may be prepared in a processing plant and transported to the blasting site. If desired, the compositions may also be prepared at the site.

The compositions of the present invention are resistant to water, making them useful in wet as well as dry holes. The compositions require no container, even in wet holes. They displace water and maintain their integrity without dilution for extended periods of time before detonation. The compositions have a density in excess of 1.0 and because of this high density possess high bulk strength.

The compositions of the present invention are detonated in the known manner by conventional booster systems, such as for example, Pentolite, Composition B,

RDX and the like. The amount of booster is determined in accordance with known practice in the use of the particular booster chosen.

The invention will be understood more fully by reference to the following specific examples. It is understood that the examples are presented for the purpose of illustration only, and are not intended as a limitation of the invention.

Example 1

A series of runs was conducted in which the detonation velocities of thickened slurry explosive compositions having ingredients in the parts by weight indicated in Table 1 were determined. In the runs, ground ammonium nitrate of particle size sufficiently small to pass a 20 mesh screen was employed. Detonation was accomplished with ½ pound Composition B boosters.

TABLE 1

Composition.....	A	B	C	D	E	F
Ammonium nitrate.....	80.0	60.0	80.0	8.0	60.0	60.4
Water.....	9.7	19.4	9.7	9.7	19.4	20.0
Resin balloons (urea-formaldehyde).....	1.0	2.0	1.0	1.0	2.0	2.0
Guar gum.....	0.3	0.6	0.3	0.3	0.6	0.6
Nitrocellulose.....	0.5	1.0	0.3	0.5	0.4	1.0
Nitromethane.....	8.5	17.0				
Nitroethane.....			8.7			
2-nitropropane.....				8.5		
55% nitromethane-45% 2-nitropropane mixture.....					17.6	
1-nitropropane.....						17.0
Detonation velocity, feet/second.....	16,900	19,650	16,400	16,400	19,650	17,700

The above formulations were prepared as follows: The nitroparaffin and nitrocellulose were placed in a mixing machine and the mixer was operated until a gelled nitroparaffin composition was formed. The ammonium nitrate, resin balloons, water and guar gum were then individually added to the gelled composition under mixing. Mixing was then continued until a composition of substantially uniform viscosity was obtained. The mixing procedure was carried out at room temperature.

Example 2

Explosive compositions similar to those of Example 1 are shown in Table 2. In the preparation of these formulations a solution of the nitroparaffin in methanol is first formed and this solution is then mixed with the other ingredients following the general procedure of Example 1.

TABLE 2

Composition.....	G	H
Ammonium nitrate.....	62.4	62.4
Water.....	10.0	10.0
Cork (ground).....	2.0	
Balsa (ground).....		2.0
Guar gum.....	0.6	0.6
Methanol.....	10.0	10.0
2,2-dinitropropane.....	25.0	
2-nitropropane.....		25.0

Since many embodiments of this invention may be made and since many changes may be made in the embodiments described, the foregoing is to be interpreted as illustrative only and the invention is defined by the claims appended hereto.

I claim:

1. A thickened slurry explosive composition comprising
 - (a) from about 10 to about 90 percent by weight of an inorganic nitrate oxidizing salt,
 - (b) from about 5 to about 50 percent by weight of a nitroparaffin selected from the group consisting of nitromethane, nitroethane, 1-nitropropane, 2-nitropropane, 2,2-dinitropropane and mixtures thereof,
 - (c) from about 5 to about 50 percent by weight of water,
 - (d) a non-explosive, finely divided air-entrapping sensitizing material selected from the group consisting of thin-walled, hollow, spherical resin balloons,

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- bagasse, wood flour, cork and balsa in amounts sufficient to sensitize the composition,
- (e) a thickening agent in amounts sufficient to thicken the composition, said weights being based on the total of the weights of the nitrate salt, the nitroparaffin and the water.
2. The composition of claim 1 wherein the nitroparaffin is in dispersible form.
3. The composition of claim 2 wherein the inorganic salt is ammonium nitrate.
4. The composition of claim 3 wherein the ammonium nitrate is of particle size sufficiently small to substantially completely pass a 20 mesh screen.
5. The composition of claim 3 wherein the nitroparaffin is nitromethane.
6. The composition of claim 3 wherein the nitroparaffin is nitroethane.
7. The composition of claim 3 wherein the nitroparaffin is 1-nitropropane.
8. The composition of claim 3 wherein the nitroparaffin is 2-nitropropane.
9. The composition of claim 3 wherein the nitroparaffin is 2,2-dinitropropane.
10. The composition of claim 3 wherein the amount of water is in the range of from about 5 to about 30%.
11. The composition of claim 3 wherein the amount of nitroparaffin is in the range of from about 5 to about 30%.
12. The composition of claim 3 wherein the amount of ammonium nitrate is in the range of from about 40 to about 90%.

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13. The composition of claim 3 wherein the amount of sensitizing material is in the range of from about 0.1 to about 6.0% by weight based on the weight of the composition.
14. The composition of claim 3 wherein the sensitizing material is a polymerized thermosetting resin selected from the group consisting of phenol-formaldehyde and urea-formaldehyde resins in the form of thin-walled, hollow, spherical balloons.
15. The composition of claim 3 wherein the sensitizing material is cork.
16. The composition of claim 3 wherein the sensitizing material is balsa.
17. The composition of claim 3 wherein the thickening agent is guar gum.

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25 CARL D. QUARFORTH, *Primary Examiner*.S. J. LECHERT, JR., *Assistant Examiner*.

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