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EXPLOSIVE COMPOSITION CONTAINING AN ADDITIONAL PRODUCT OF UREA AND NITRIC ACID AND METHOD OF PREPARING SAME

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ABSTRACT OF THE DISCLOSURE

A slurry blasting composition thickened sufficiently to suspend fine solid particles, which can be pumped or poured into a borehole is made up of proportions of 12 to 55 or even 70% by weight of nitric acid containing at least a little water, 15 to 40% of urea or a urea equivalent, 0 to 55%, preferably at least 10% of inorganic nitrate and a supplemental fuel, where needed for oxygen balance. The slurry should either be self-thickening or should include an added thickener. Proportions of urea preferably do not exceed 30%; the inorganic nitrate preferably is ammonium nitrate because of its negative heat of solution or a mixture of ammonium and sodium nitrates, added to the nitric acid as a coolant. The supplemental fuels used in proportions up to 20% should not be substantially reactive with the nitric acid under ambient conditions and should be reasonably miscible with the other ingredients. Within these limitations, one may combine light or heavy mineral oils, tall oils, pulverized or ground coal, gilsonite, asphalt, charcoal if not too finely divided, graphite, especially some of the expanded graphites, and/or particulate metals such as aluminum, magnesium, and alloys thereof. Any one or more of these and analogous fuels may be used.

PRIOR ART

The strong oxidative properties of nitric acid are well known. Many suggestions have been made in the past for preparation of explosives based on physical mixtures of nitric acid with fuel materials readily oxidizable thereby. A recent example is U.S. Patent 3,282,754 which describes a mixture of nitric acid with various oils, waxes and related organic fuels. Inclusion of ammonium nitrate or alkali metal nitrates also is suggested. Other examples are given in U.S. Patents 3,164,503, 3,242,019, and 3,296,044.

For many years the so-called Sprengel explosives have been known. These are liquid solutions, based on use of nitric acid containing dissolved nitrobenzene and the like. See British Patents 921 and 2642 of 1871. Liquid and slurry explosives often have certain advantages over solid materials. Nitric acid is relatively inexpensive and widely available and would seem to be useful in explosives. However, the difficulty of handling the concentrated acid, which is highly corrosive and hazardous, as well as its strong chemical reactivity with many inorganic as well as organic compounds, has prevented its wide use in explosive compositions. The present invention is based on the discovery that a reasonably self-thickening fluid or quasi-fluid composition of high blasting power can be made basically of nitric acid and urea, with or without supplemental fuels, thickeners, etc., provided that the conditions for combining these ingredients are kept under proper control. The stabilization of explosives containing nitric acid and fuels presents problems which the present invention also deals with.

The art has taught the advantages of using particulate fuels suspended in liquid media, e.g. for pumping into

boreholes directly after mixing. In order to achieve stable suspension, it is usually desirable or necessary to increase the viscosity of the liquid phase by use of a thickener or gelling agent. Many and probably most conventional thickeners cannot be used in strong nitric acid mixtures because of reaction with or destruction by the acid. One phase of the present invention has to do with effective and stable thickening of such compositions for the purposes just mentioned. An elevated viscosity in such compositions is needed for two reasons: (1) to keep solid particles present in suspension and (2) to resist water intrusion in the boreholes.

Since commercial concentrated nitric acid is commonly about 70% by weight of acid in water, an acid-fuel mixture of reasonable oxygen balance may be expected to contain about 20 to 22% or a little more of water. Explosive compositions of such water content are quite insensitive to detonation unless effective means are provided to improve sensitivity. To provide such is another purpose of the invention.

The prior art has suggested use of various organic materials as fuels for nitric acid-based explosives. Some of these are too reactive—others are often not reactive enough. To achieve stability of the compositions while retaining suitable sensitivity for useful applications is often difficult, aside from the problems of controlling viscosity and stabilizing the suspending power of the liquid phase as already mentioned. An important aspect of the present invention is the discovery that urea may be employed usefully, both as a fuel and as thickener. However, special care must be taken to limit the reaction between urea and nitric acid to an addition reaction rather than a nitration reaction.

According to this invention, by constant and careful control of the temperature of the reaction, as urea and nitric acid are combined, addition products of urea-nitric acid are formed rather than nitro compounds. The nitric acid adds on to at least one of the amine groups. These addition products, moreover, are self-thickening; that is, they form gels, viscous sols, or thickened liquids of suitable body for suspending appreciable quantities of granular or particulate materials such as aluminum, TNT particles, coal, etc., and retaining such in suspension for long time periods without gravitational segregation. Temperature control can be maintained in various ways, of course, as by suitable refrigeration and by carefully controlled rates of combining and mixing of the acid and urea. It is highly advantageous, however, to add solid ammonium nitrate or a similar energy-contributing and endothermic dissolving salt to the nitric acid and urea simultaneously as the latter are being mixed together. By a judicious control of rates of addition and mixing, the several ingredients may be combined in such a way that the tendency to heat up due to any exothermic reaction of the nitric acid and urea, is offset by the strong cooling effect of the ammonium nitrate as it dissolves in the water which is present. The result is that the reaction is limited essentially to addition. Hence, there is no danger of the temperature running away. Moreover, the ammonium nitrate so added adds energy to the mixture, provided the whole mixture is in reasonable oxygen balance. Particulate solid fuels such as mentioned above may be added and liquid organic fuels may be included if desired. While proportions of the acid and urea may be varied rather widely, the overall oxygen balance of the final composition should be kept within the range of about 10% positive to 15% negative.

Sodium nitrate may be used to replace part or even all of the ammonium nitrate in some cases. The latter has superior cooling effects while being dissolved, however, and preferably is used at least as part of the nitrate salt content.

While the above system has been mentioned as being somewhat self-thickening because the addition product of urea and nitric acid in small amounts of water at ordinary temperatures form a slurry, it is ordinarily desirable to include a supplemental thickener also, to provide a gel-type matrix. Care must be taken to choose a thickener which is not destroyed by the acid before the explosive composition can be used.

Inorganic materials such as gelled or amorphous silica, e.g. "Cabosil," have been used as a supplemental thickener in rocket propellants. However, they contribute no energy to the composition and may promotee degradation reactions in some cases. It is preferable to use thickeners which contribute some fuel value. Unless the explosive is to be used immediately the thickener must not be broken down or otherwise affected greatly by the nitric acid. Some conventional gelling agents, such as natural gums and thickeners often used in neutral or basic aqueous solutions, for example, either are not effective thickeners or they deteriorate rapidly in the presence of strong acid such as concentrated HNO_3. Under some conditions, however, guar gum, starch and related materials may be used effectively. A rather satisfactory thickener for the purpose is a polyacrylamide resin obtainable from several sources which causes aqueous solutions to gel, even when their acid content is very high. This may be used with starch, guar gum, and other conventional thickeners also. It serves to cross-link them and make them more resistant to the acid.

The fuel or mixture of fuels, whether solid or liquid, selected should be reasonably miscible with the nitric acid-urea mixture and not too readily or vigorously attacked thereby. The fuel should impart energy to the mix by being readily oxidizable. It should be used in proportions appropriate for the desired control of oxygen balance. Liquid fuels such as mineral oils, tall oil, etc., may be used in some cases; if so they may require some emulsification for composition stability. In such cases the emulsifier selected should be one which will resist substantial reaction with or destruction by the strong nitric acid. Surface active agents such as certain sulfates and sulfonates, which are resistant to strong acids, may be used. Most soaps, however, are quickly destroyed by the acid. Hence they are not useful, at least not when extended storage times are contemplated for the explosive composition. Solid particulate fuels such as ground bituminous coal, graphite, carbon black, charcoal, acid sludges from petroleum refining operations, etc., may be used; most of these do not react substantially or too energetically with the nitric acid. Particulate metals such as aluminum may be used, when available, in a form which does not react unduly with the acid. For example, granular or powdered aluminum may be used, provided it is first coated or passivated with wax, graphite, etc., substances which per se are not too much affected by nitric acid. The self oxidized coatings on some forms of aluminum, magnesium, etc., are often sufficiently resistant to the acid. Sulfur, in proper form, i.e. finely divided and stably mixed in, also may be used as a fuel ingredient.

Aromatic fuels, such as benzene, styrene, etc., have been used with nitric acid; they can be used in the present invention under some circumstances along with urea and particular thickener compositions described below.

DESCRIPTION OF PREFERRED EMBODIMENT

In general terms, the invention contemplates use of aqueous nitric acid of commercial grade, along with compatible fuels and thickeners, usually including urea and at least one other fuel. The latter may be water soluble, such as sugar or other carbohydrates, ethylene glycol or diethylene glycol, other water-compatible alcohols, benzene and cellulosic materials which do not react too readily with nitric acid under storage conditions. Use of polyacrylamide, with or without cross-linker materials, such as hexamethylene tetramine (HMT) is particularly

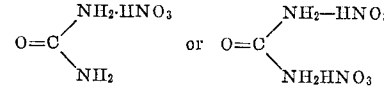
desirable but is not always necessary, especially where a stable gel is produced by use of urea reacting by addition with the nitric acid.

In its broader aspects the invention contemplates blasting compositions made up of 17 to 55% by weight of nitric acid (commercial or 70% grade), up to 55% of an inorganic nitrate selected from the group which consists of ammonium nitrate, the alkali metal nitrates and the alkaline earth metal nitrates, and enough urea or urea equivalent, preferably with another solid or liquid fuel, to provide reasonable oxygen balance and to form a thickener. Preferably the nitrate is ammonium nitrate, used in proportions of at least 10% and added with the urea to maintain good temperature control over the reaction of acid and urea, in order to produce an addition product such as indicated below. However, other nitrates may be used in lieu of or along with the AN. The urea may be replaced, at least in part, by guanidine or close homologues such as substituted carbamates; thus urea may be used, or semicarbazides, methylated carbazides or semicarbazides, etc. In general, urea and its closely related analogs and homologues can be used as long as they have an active nitrogen or NH_2 group to which HNO_3 can be attached to form a salt without large loss of energy. The supplemental solid fuels may be ground coal, gilsonite, charcoals, acid sludges from petroleum, aluminum and the like.

The invention will be understood better by reference to specific examples below. The weight of acid shown is the nominal acid, usually containing 30% water since most examples used 70% HNO_3. One ml. of 70% HNO_3 contains approximately 1 gm. of HNO_3 and approximately 0.4 gm. H_2O. Therefore the weight of acid thus is essentially the same as its volume, measured in ml. Water is present in all examples in the above ratio except as otherwise noted.

Example 1

A composition was made up of 17.1 ml. of concentrated nitric acid (70% in water), 55 g. of granular ammonium nitrate finely ground, and 27.6 g. of granular urea. The concentrated nitric acid contained about 6.7 grams of water. The ingredients were stirred together as they were added, the urea and ammonium nitrate being premixed before stirring them into the nitric acid. There was no noticeable increase in temperature and the mixture became rather viscous. Apparently the nitric acid added directly onto the urea to form a composition of general structure:



This material was readily detonable and showed good blasting power.

Example 2

A composition was made up of 39 parts 70% nitric acid, 26 parts ammonium nitrate, 13 parts urea, 6.5 parts ground gilsonite, 15.5 parts water (contained in the nitric acid) and about 0.05 part of guar gum. All parts were by weight. This composition was strongly acid but it thickened reasonably well and was detonated to show good blasting power.

Example 3

A composition was made up of 32 parts by weight of nitric acid, 23 parts ammonium nitrate, 31 parts urea, 14 parts water (contained in the nitric acid), and 0.05 part guar gum. There was no heating, or substantially none, as the ingredients were blended and mixed together. The composition thickened, however, almost as rapidly as it was mixed. It was readily detonable with a small booster.

Example 4

The following materials were combined in parts by weight as indicated:

	HNO_3 (70% aqueous)	AN	Urea	Gilsonite
(A)	4.0	2.88	1.5	0.0615
(B)	4.0	2.88	2.12	0.45
(C)	4.0	2.88	2.82	0.28

In each of the above examples a mixture of the first three ingredients was selected for good consistency and thereafter the gilsonite was added in appropriate proportions to give good oxygen balance. In general, oxygen balance is preferred within the +10 to −15% range. The three samples made up first without the gilsonite were set aside and observed for changes in consistency. Composition A, after 15 seconds, was cold. After 80 seconds it warmed somewhat, forming a thin paste. After 5 minutes it had cooled down to normal temperature and was still a thin paste. Composition B behaved quite similarly. It was cold for 15 seconds, warmed and formed a paste at 80 seconds, and was still warm and pasty at 2 minutes. After 14 minutes there was no noticeable change in consistency. Composition C remained cool for about 35 seconds, then heated up and became pasty in the next 10 seconds. After 15 minutes this mixture had cooled, leaving a paste of about the same consistency as before cooling. Gilsonite was added after cooling, in each case. The fuel, especially when in particle form, such as ground gilsonite, preferably is added to the dry ammonium nitrate and the urea before mixing all of them together into the acid. Nitric acid tends to react somewhat with gilsonite per se, or at least with some gilsonites. The reaction is indicated by evolution of gas slowly. The paste sets up more quickly when gilsonite is added. For this reason, the time of addition of gilsonite may depend on whether a thin mix is desired for pumping, to set up more thickly later, or whether a viscous mix is desired at the outset.

Example 5

Two additional compositions were made as follows: Proportions shown are parts by weight.

	HNO_3 (70% aqueous)	AN	Urea	Gilsonite	Guar gum
(A)	4.5 g	3.0	1.5	0.75	0.06
(B)	4 g	2.88	3.88		0.06

The first composition was mushy thick within one minute after mixing. It showed no change after two hours but began to break up a little after three hours, becoming eventually of thick syrup consistency. After standing a week it was still a syrup but somewhat thinner. In this case the dry ingredients were all mixed together and then added to the liquid acid while stirring. The ammonium nitrate substantially prevented a temperature rise.

Sample B became almost too thick to stir in less than a minute after the solid ingredients were mixed into the acid. This mix became quite hot. After three hours it was a hard paste.

Example 6

A group of compositions were made in the same general manner as described above, using concentrated nitric acid (70%, aqueous) and adding various fuels as indicated. Parts shown are by weight.

Mix A became very thick and sticky immediately and it was not possible to stir in all of the urea and AN prills fully until about four hours later. By this time the mixture had become a thin paste in consistency. After six hours, and after addition of the remaining prills, it was still a thin paste.

	HNO_3 (70% aqueous)	AN	Urea	Fuel	Guar gum
(A)	4.5	3.0	1.5	Starch, 1.97	0.06
(B)	4.5	3.0	1.5	Graphite, 0.83	0.06
(C)	4.5	3.0	1.5	Tall oil, 0.80	0.06
(D)	4.5	3.0	1.5	Bituminous coal dust, 1.00	0.06
(E)	4.5	3.0	1.5	Activated carbon, 0.80	0.06

Mix B was quite watery for about three minutes before a paste began to form. The paste later developed into a homogeneous product but after six hours the mixture thinned out and became somewhat watery.

Mixture C showed a mild exothermic reaction at first as the solids were added to the acid but the materials mixed together well. It began to thicken in about one minute but started to break down in consistency after six hours.

Mixture D turned brown as it was mixed together, due apparently to action of the acid on the coal.

Mixture E reacted immediately and then puffed up, showing evolution of gas.

Example 7

Another group of compositions were made substantially like Example 6, using similar proportions of acid, AN and urea, with different fuels as listed below. To the first, A, was added 0.8 gm. of high melting gilsonite in finely divided form. To the second, B, 0.8 gm. of No. 30 motor lubrication oil was added, and to Mixture C, 0.8 gm. of No. 4 fuel oil. Likewise, Mixtures D and E contained 0.8 gm. respectively of "Vaseline" and No. 2 fuel oil. It was found to be desirable to wet the urea with the oils, when oils were used, before adding the gilsonite to the other ingredients. Mix A was a fluffy product which remained viscous and stable, without noticeable segregation of solids, over a weekend (Friday evening to Monday morning). Mix B became a thin yellow paste in about 30 seconds. However, no noticeable segregation occurred over the weekend of storage. The same was true of Mixture E. There were apparently some mild reactions which took place over the weekend in compositions B and E of this example.

Explosives described above were prepared with reagent grade nitric acid (varying from 69 to 71% acid concentration), the remainder being water. Commercial acids of this or closely similar composition are readily available at low cost. Preferably, nitric acid should not exceed 55%, and more desirably not over 50% of the mixture. The reaction with urea should be kept under control by careful temperature control. The latter is preferably accomplished by adding an energy absorbing quantity of ammonium nitrate to keep the mixture cooled, along with other solids which may be stirred into the acid along with the AN. Suitable precautions, of course, always must be taken during the mixing. It is important that urea nitrate (the addition product) be formed in preference to nitrourea. It is a more effective thickener and has substantially higher blasting energy. Moreover, the reaction temperature may rise and the mix may become oversensitive and hazardous if steps are not taken to keep the temperature under good control. Where the resulting product is to be pumped into a borehole or into a package, the slurry consistency should not be too stiff or too viscous. If necessary, fuel may be added to control consistency as well as oxygen balance. Carboacid fuels which will not react with nitric acid are often preferred. Some forms of gilsonite are somewhat reactive with nitric acid. Those of higher car-

bon content usually are preferable because they are less reactive.

Example 8

A composition was made up of 54.5% by weight of nitric acid (on a pure acid basis), 23.3% of water, 4.9% urea, 4.9% AN, 10.6% of benzene, and 1% each of polyacrylamide, from General Mills, and hexamethylene tetramine (HMT). The urea and AN were added first to the aqueous acid, producing a stringy gel or syrup. Benzene was then mixed in with some difficulty, along with the polymer and HMT. This composition had a density of 1.36 grams per cc. It was placed in a 4" tube and set off with a detonator. It failed to detonate completely, due to its high density but its behavior indicated that it would have detonated well had it been aerated or mixed with a bulky diluent to reduce its density. See Cook, "The Science of High Explosives," Chapters 3 and 5 for discussion of the theory.

A similar composition was made up using sodium dichromate instead of HMT as a cross-linking agent to determine whether this would improve viscosity. It thickened a little more rapidly.

Example 9

A series of tests were performed, without urea, to determined whether starches, flours, etc., could be used as thickeners in strong nitric acid compositions. Each contained 1% of polyacrylamide (PA). Results are tabulated:

PA	70% Nitric acid, percent by wt.	Starch, percent	Organic	Results
PA, percent:				
1	73	Corn starch 13	Ethylene glycol 13	Thickened in 20 sec. and still thick and strong after 1 hr. Good consistency, still cross-linked after 4 days.
1	73	do	Diethylene glycol 13	Thickened in 20 sec. Thinned a little after 2 hrs., but not water.
1	73	Tapioca flour 13	Ethylene glycol 13	Thickened in 20 sec., cross-link broke up after 1 hr. Thin in 2 hrs. After 4 hrs. foamed over the top of the vessel.
1	73	do	Diethylene glycol 13	Same as above. Became quite thin after 1 hr. and foamed up in 4 hrs.

These results show that corn starch is a good thickener but that tapioca flour is marginal for short time thickening and unsatisfactory for longer times. Since urea-containing mixtures are less acid, these materials should perform somewhat better in urea-nitric acid explosives than in the more acid compositions.

The blasting agents of this invention are highly desirable because all products of detonation are gaseous, moreover, as already noted the 70% grade of nitric acid is readily available and relatively inexpensive. Water present in such acid is effectively thickened by addition of guar gum when the thickening conditions are suitable. As noted above, some types of guar gum may not thicken in the presence of strong nitric acid or they may be attacked chemically to such an extent that their thickening properties do not endure very long. For slurries which are to be used immediately, the durability of thickening is much less important than for those which are to set in a borehole, or in a package for many hours, or for days or weeks.

The viscosity of the liquid or gel menstruum should be sufficient to support the suspended particulate matter against gravitational segregation on standing. At the same time, particularly if the slurry is to be pumped through a pipe or hose to a borehole, or to a package loading station, it must not be so viscous as to require excessively high pumping pressure or excessive shear. The composition preferably will flow like heavy oil or molasses, at ordinary temperatures.

While the nitric acid content may be as low as 17% by weight, based on the total composition, or may go as high as 70% in exceptional cases, the preferred range is between about 20% and 50%, or in some cases up to 55% of the total. While ammonium nitrate is a preferred ingredient, other oxidizer salts named below may be used with it or in lieu of it, preferably in total proportions between 10 and 40%. These may be omitted altogether if other and adequate means, e.g., refrigeration and stirring, are used to control the temperature quite uniformly throughout the mixture so that the nitric acid and the urea react to make an addition product, as described above, thus minimizing or excluding to a substantial degree the production of nitro-urea, as well as preventing hazardous or runaway temperature rise. Proportions of 15 to 30% of ammonium nitrate are particularly preferred. Other salts or mixtures having negative heat of solution may replace part or all of the ammonium nitrate.

While the nitric acid-urea addition product has higher viscosity than concentrated HNO_3 or nitric acid and water, or i.e., it has a substantial fluid thickening effect, it is often necessary and usually desirable to add a small amount of colloidal thickener which is effective in the water. Since water is usually present, at least in small proportions, in commercial grades of nitric acid, a thickener for the water which is not destroyed or inactivated by the acid, should be used. Proportions of 0.01 to 5 percent by weight, based on the total composition, or a colloidal thickener may be used; i.e., 0.01 to 2% of guar gum may be used, or starches in larger proportions, 0.1 to 5%, or silica gel, "Cabosil," carboxy methyl cellulose in proportions of 0.05 to 2%, or other commercial thickeners of similar or analogous types. Sugar solutions, molasses, etc., may be added and mixtures of these various thickeners may be used, so long as they are compatible with the acid to increase the viscosity and suspending power of the liquid or gel menstruum.

As indicated above, particulate matter, including ammonium nitrate, sodium nitrate, other alkali metal or alkaline earth metal nitrates may be used. Other oxidizer salts, such as the alkali and/or ammonium chlorates and perchlorates may be added to the nitric acid-urea addition product. In addition, a supplementary fuel usually should be added, preferably in finely divided particulate form. Finely divided carbon, such as carbon black, ground coal, gilsonite, charcoal, etc., or metallic fuel such as finely divided aluminum, magnesium, iron, etc., may be used, inactivated or passivated by coating, etc., as already noted. Proportions of fuel, as noted above, should be adjusted to bring the total composition into reasonable oxygen balance, i.e., between −15 and 10%, preferably between −5% and 0%. Proportions of fuel generally will run between about 0.1 to 30%, preferably 0.5 to 10% by weight of the total.

Other fuels, e.g., liquids, and other sensitizers such as sulfur, etc., may be added, as is well known in the slurry explosive art. These include liquid fuels such as formamide, dimethyl formamide, glycerol, glycol, monohydric alcohols, hydrocarbon oils, waxes, mixtures such as tall oil, and the like. Also particulate self-explosives such as TNT, nitrocellulose, smokeless powders of single, double and triple base, RDX, may be used in proportions up to about 25% of the total, depending upon the sensitivity

requirements, the proportions of water present, and the like.

Since the commercial nitric acids usually include water, the separate addition of water often will not be necessary but enough may be added to bring the total water content up to as much as 15%, or even 20%, by weight of the total. It is preferred that at least 5% of water be present in all cases.

It will be understood that various other modifications may be made within the spirit of the invention, and it is desired to include them within the scope of the claims as far as the prior art properly permits.

What is claimed is:

1. A water-containing gel or slurry explosive composition which comprises an addition product of 13–40 percent by weight urea and 12–70 percent by weight nitric acid in viscous liquid form, and particulate matter comprising undissolved fuel suspended in said viscous liquid, the viscosity of said slurry being sufficient to prevent substantial gravitational segregation of the particulate fuel from the viscous liquid.

2. A slurry or gel explosive composition according to claim **1** which is pumpable through a slender conduit such as a hose or pipe without excessive shear or pressure.

3. A slurry or gel explosive composition according to claim **1** which comprises up to 55% of at least one inorganic oxidizer salt selected from the group which consists of ammonium nitrate, the alkali and alkaline earth metal nitrates, ammonium chlorate and perchlorate and the alkali metal chlorates and perchlorates, including mixtures of any two or more.

4. Composition according to claim **1** which includes 1 to 30% of fuel.

5. Composition according to claim **1** which includes 0.1 to 5% of a colloidal thickener and 5 to 20% of water.

6. Composition according to claim **1** which includes 10 to 40% of ammonium nitrate.

7. Composition according to claim **1** which includes 12 to 70 percent by weight of nitric acid, 14 to 40% of urea, 10 to 40% of ammonium nitrate, 5 to 20% of water, at least 1% of suspended particulate fuel, and 0.01 to 5% of a colloidal thickener for said water which is not destroyed or inactivated by the nitric acid.

8. The process of preparing a flowable gel or slurry explosive composition of high blasting power, which comprises adding particulate 13–40 percent by weight urea to a 12–70 percent by weight concentrated nitric acid and simultaneously keeping the temperature under control throughout the mixture to prevent substantial temperature rise, whereby an addition product of said nitric acid and said urea is obtained, with substantial exclusion of nitro-urea formation or urea degradation and thereafter adding a suspendable particulate fuel to said addition product.

9. The process of preparing a flowable gel or slurry according to claim **8** which comprises adding simultaneously to an aqueous concentrated nitric acid 14 to 40% by weight, based on the final composition, of urea, and 10 to 40% of ammonium nitrate, and controlling the rate of addition of each so that the negative heat of solution of the ammonium nitrate prevents substantial temperature rise due to the combining of the nitric acid and urea.

10. Process according to claim **9** wherein the temperature is controlled at least in part by adding ammonium nitrate.

11. Process according to claim **8** which comprises adding a colloidal thickener to increase the viscosity and suspending power of the liquid or menstruum, thereby to prevent gravitational segregation of suspended particles in the slurry.

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