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3,522,117

AERATED WATER-BEARING INORGANIC OXIDIZ- ER SALT BLASTING AGENT CONTAINING DIS- SOLVED AND UNDISSOLVED CARBONACEOUS FUEL

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8 Claims

ABSTRACT OF THE DISCLOSURE

Water-bearing blasting agents based on inorganic oxidizing salt and non-explosive fuel containing as a fuel component, the combination of carbonaceous fuel soluble in the system and insoluble cellular carbonaceous fuel.

CROSS-REFERENCE TO PRIOR APPLICATIONS

This application is a continuouation-in-part of copending application Ser. No. 564,526, filed July 12, 1966, now U.S. Pat. 3,397,097.

DISCLOSURE

This invention relates to blasting agents and, more particularly to blasting agents having improved physical and explosive properties.

In recent years, blasting agents particularly those of the types known as water-gels or slurries have gained considerable commerical acceptance. These water gels generally comprise an inorganic oxidizing salt, predominately ammonium nitrate, a thickening or gelling agent for the liquid, and a fuel.

For large-scale blasting operations, e.g. for blasting taconite ore, blasting agents must be sensitive enough to propagate detonation throughout the mass in confined columns of usually about 6 to 9 inches diameter, during both hot and cold conditions. In general, the blasting agent should be sufficiently sensitive for propagation of detonation in a continuous unconfined column of about 6 to 10 inches in diameter, at the borehole temperature.

Although water-bearing compositions which comprise a carbonaceous material as the sole fuel have been proposed for such blasting compositions, their use in commercial blasting has been restricted since at lower temperatures detonation is not reliably propagated through the mass. When water-bearing blasting compositions are to be used at low temperatures, e.g., 32 to 40° F. (0 to 5° C.), it is usually necessary to incorporate a relatively high proportion of a self-explosive, e.g., TNT or smokeless powder, and/or a particulate metal, e.g., aluminum, in the formulation.

The use of either the self-explosive or the metal fuel in water-bearing blasting agents requires handling of solids, a feature which is undesirable particularly when the compositions are to be prepared at the site in pump or slurry trucks. Further, the need for self-explosive can present a hazard in storage and handling of the compositions since such compositions are more sensitive than compositions which do not contain such self-explosives or metals. Still further, both self-explosive and metal fuels materially add to the cost of the blasting agent.

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Accordingly, there is a distinct need for a water-bearing blasting composition which will detonate reliably at low temperatures without the presence of self-explosive and/or metallic fuels, and which can be easily compounded, at relatively low cost, either in a plant or at the blasting site.

In copending application Ser. No. 564,526, filed July 12, 1966, there is described an improvement in water-bearing blasting agents which permits formulation of compositions detonatable in columns as small as 6 inches or less at temperatures as low as 40° F. (ca. 5° C.) without high explosive or metallic sensitizers. Such improvement comprises providing throughout the blasting agents about from 5 to 60% by volume of small gas-filled cavities, a crystal habit modifier for the inorganic oxidizing salt therein, and a fuel component consisting essentially of at least 3% by weight, based on the total weight of composition, of dissolved carbonaceous fuel. The aforesaid application teaches that said cavities can be incorporated in the explosives either by dispersing gas therein or by the use of cellular materials.

SUMMARY OF INVENTION

This application is directed to compositions, preferably free of high-explosive or metallic sensitizers like those of the aforesaid parent case, containing a particular combination of fuels. It has also been discovered in accordance with the invention claimed herein that when such specific fuel combination is employed and when severe cold weather requirements need not be met, that the compositions of the invention claimed herein need not contain the aforesaid crystal-habit modifier. The compositions of this invention have the added advantage that they are particularly easy to formulate and extremely storage stable and the solid fuels used therein are adapted, and preferably added to the blasting agents at the time of formulation of the other ingredients.

More, specifically, this invention comprises an improvement in thickened water-bearing blasting agents consisting essentially of water, inorganic oxidizing salt at least partially dissolved in said water and non-explosive fuel, said improvement comprising providing as said non-explosive fuel component the combination of (a) at least 3% by weight, based on the total composition, of dissolved carbonaceous fuel and (b) solid undissolved cellular carbonaceous fuel having finely divided gas-filled cavities therein, said cavities comprising about from 10 to 40% by volume of said blasting agent, said solid undissolved fuel having a bulk density of less than about 0.6 g./cc.

The compositions of this invention are prepared by incorporating the aforesaid fuel component and other additives such as gelling and cross-linking agents in a hot solution of the inorganic oxidizing salt component. As prepared, the oxidizing salt is usually substantially all in solution in the hot product. When the product cools, part of the salt crystallizes therein so that at ambient temperature 10 to 20% of the salt component may be undissolved, while at 40° F., as much as 50% or more of the salt may be crystallized.

The inorganic oxidizing salts employed in this invention can be any of the soluble salts conventionally used in water-bearing explosives including alkali metal, alkaline earth metal and ammonium nitrates, perchlorates and dichromates. In general, for economic reasons, ease of handling and overall sensitivity and other explosive properties compositions containing a salt component consist-

ing essentially of at least 65% by weight of ammonium nitrate are preferred. Examples of other inorganic salts are sodium nitrate, calcium nitrate, potassium nitrate, magnesium nitrate, sodium perchlorate, potassium perchlorate, ammonium perchlorate and magnesium perchlorate. Of these, sodium nitrate is a preferred auxiliary salt, used in lesser proportions with ammonium nitrate, preferably in amounts up to 25% of the salt component.

In preparing the composition of this invention the inorganic oxidizing salt is preferably incorporated directly as hot "neutral liquor" or solution, preferably, e.g., one such as that obtained from the manufacturing of ammonium nitrate prior to graining or prilling. The inorganic salts are chosen to be soluble in the hot liquor so that substantially all oxidizing agent is in solution at the time of manufacture. This is a boon in the preparation of blasting compositions at the blasting site, since, with the provision and use of heated storage tanks, the inorganic oxidants can be handled as a liquid minimizing the need for handling solids.

As stated above, the solution of inorganic oxidant is preferably based on hot, concentrated aqueous solution of ammonium nitrate, which usually contains about from 70 to 85% ammonium nitrate by weight. Such a solution is obtained from the neutralization step in the preparation of ammonium nitrate by the reaction of ammonia and with 40-60% nitric acid in a continuous process. Crystallization of the ammonium nitrate is prevented by keeping the temperature above the "crystallization point" of the liquor. This does not present particular problems since, for example, storage of hot, neutralized liquid in 10,000 gallon tanks normally is possible for 2 to 3 days without crystallization taking place and without the need for large amounts of additional heat. The crystallizing temperature of 70% liquor is 84° F. (29° C.), 80% solution will not crystallize out above 136° F. (58° C.) and 85% solution will not crystallize out if maintained at temperatures above about 165° F. (74° C.). Since the liquor from commercial processes is well above 215° F. when it leaves the neutralizer, and in normal storage volumes it cools slowly, stored liquor of even 85% strength normally will not begin to crystallize out for several days. However, during cold winter months, it usually is necessary to insulate the tanks and frequently is desirable to apply heat occasionally to prevent crystallization from the solution of 70 to 85% concentration commonly employed. Means for supplying this heat are commonly provided on pump or slurry trucks. The neutral liquor desirably will maintain alkalinity of 0.01 to 0.05% NH_3 . It is desired that the liquor retain this alkalinity in handling and storage so as to preclude corrosion of equipment, and prevent the contamination of blasting agent particularly with regard to ions such as of iron, copper, zinc, and aluminum, which would inhibit or destroy a gelling system.

Although auxiliary oxidizing agents, in preferred systems salts other than ammonium nitrate, can be added as finely divided solids, preferably they are added in aqueous solution. When added in solution, the water content of the solution naturally will be included in determining the total water content of the composition. Usually, gelling or thickening agents as described in more detail hereinafter will be added with the preferred sodium nitrate auxiliary oxidizing agent to facilitate dispersion of ingredients.

The soluble fuel added to the hot inorganic oxidizing salt solution is an organic, i.e., carbonaceous, fuel soluble in the salt solution. "Soluble" as used herein means the fuel dissolves in the subject compositions to the extent of at least about 2 grams of fuel per 100 grams of product at ambient temperature. "Dissolved" and the like terms used herein with reference to the fuel means the fuel is dispersed in a colloidal or smaller, e.g., molecular, state. Examples of fuels used in this invention are carbohydrates such as disaccharides and starches, aliphatic mono- and polyhydric alcohols, aldehydes, ketones, ali-

phatic acids, nitriles, amides, lignin, sulfonates, and mixtures of these fuels. Specific examples of such soluble fuels include: monosaccharides such as d-xylose, d-glucose (dextrose), d-mannose, d-galactose, d-fructose, and d-sorbose; disaccharides such as maltose, lactose, and sucrose; aliphatic polyhydric alcohols such as ethylene glycol, propylene glycol, polypropylene glycol, and glycerine; aliphatic monohydric alcohols such as methanol, ethanol, isopropanol, propanol, and n-butanol; aldehydes such as formaldehyde, acetaldehyde, and propionaldehyde; ketones such as acetone; aliphatic carboxylic acids such as acetic acid, propionic acid, acrylic acid, and lactic acid; amides such as formamide, acetamide, acrylamide, and propionamide; and aliphatic nitriles such as acetonitrile.

Of these fuels, the mono- and disaccharide carbohydrates are preferred. Sucrose (common table sugar) and dextrose are particularly preferred from the viewpoint of availability at low cost. Some fuels such as the alcohols may act as solvents for cavity-contributing fuels, thus reducing cavity volume. Thus it is usually preferred to use such solvent-type fuels in small proportions or in combination with other fuels such as sucrose or dextrose. Particularly with fuels other than the soluble carbohydrates, solubility may vary with the composition; especially when large amounts of the fuel are to be used the particular soluble fuel should be added to a sample of the remainder of the composition to test for gross phase separation, which should be avoided. In addition to allowing fuel to become completely dispersed in the blasting agents, thus promoting homogeneity of the composition and leading to intimate contact of fuel with oxidizing agent, soluble fuels tend to increase the fluidity of the compositions particularly at low temperatures. Although at least 3%, based on the total composition, of fuel is of the aforementioned soluble type, the fuel component can total up to 25% of the product. Preferably, however, at least 50% of the fuel component is of the soluble type.

Gas-filled cavities or bubbles are necessary in providing compositions which are sensitive to initiation by a standard source and which propagate detonation in six-inch diameter charges. As used herein, the term "gas-filled cavities" refers to minute bubbles of a gas, e.g., mono- or diatomic molecules or a mixture thereof such as in air, uniformly and homogeneously dispersed through the composition of this invention. The gas-filled cavities are provided by the incorporation of a closed cell rigid foam or other cellular, low-density fuel in the composition as the second essential constituent of the fuel component in the compositions of this invention. As used herein "cellular" carbonaceous fuels refer to such fuels having one or a plurality of the aforesaid gas-filled cavities in each particle thereof. Such fuels can include unicavity materials such as phenol- and urea-formaldehyde "Microballoons" or spheres, but preferably contain a plurality of spherical columnar or irregularly shaped cavities as in synthetic polymer foam and naturally occurring carbonaceous materials. The dimensions of the gas-filled cavities within the composition will be small, i.e., their largest dimension will, in general, not exceed about $\frac{1}{16}$ inch, and, as indicated, the cavities and fuel are uniformly distributed throughout the composition, thereby precluding discontinuities in the composition such as would be provided by large cavities or agglomerates of cavities and would preclude detonation of the entire column of the composition. Preferably the average diameter size of the cavities is on the order of 500 microns or less. In general the cellular carbonaceous fuels used to incorporate gas cavities into the composition of the invention are those which, when added to the product of this invention in amounts of 1 to 20% by weight, lower the density thereof at least 5%, preferably 20 to 30%, corresponding to a bulk density preferably of 1.1 to about 1.3 g./cc. Typical cellular carbonaceous fuels include closed cell foams or other cellular particles of polymeric materials such as polystyrene, poly(vinyl chloride), poly(vinylidene chloride), phenol-

and urea-formaldehyde resins, polyethylene, polyurethane, poly(vinyl alcohol), and polypropylene; cellulose carbonaceous natural materials such as piths, particularly bagasse piths, ground cork, peanut hulls and expanded cereal products, e.g., Brewer's grit or puffed wheat or rice, and mixtures of such fuels. The membranes comprising the cell walls of cellular fuels preferably will be relatively rigid, water-impermeable, and insoluble in the solution or inorganic oxidant in order that the gas content thereof will be preserved during formulation and storage of the blasting compositions. Materials preferred from the viewpoint of availability at low cost and ease of incorporation include bagasse pith, expanded cereal products such as Brewer's grit and closed-cell rigid foams such as those of polystyrene, polyethylene, and polyurethane.

Preferably about 10 to 40%, by volume, of gas is provided in the composition. Although when minor amounts of heavy metallic fuels are added density may exceed 1.3 g./cc, e.g. be up to 1.4, the density of compositions exclusive of such high density materials as well as that of all preferred compositions is less than 1.3 g./cc., usually about from 1.0 to 1.3 g./cc., and preferably about from 1.1 to 1.3 g./cc. The solid, non-gaseous portion of these foams or cellular fuels naturally will be considered in calculating the oxygen balance of the blasting agent. In general, the porous or foamed fuel will constitute, on a weight basis, about from 1 to 10% and preferably about from 2 to 5% of the composition. In general the amount of cellular fuel decreases with the bulk density thereof. Since the density of the composition without any gas is about 1.47, in general the bulk density of the cellular fuels is about 0.03 to 0.6 g./cc. (final density 1.0 to 1.3 with 1 to 10% of fuel, respectively) and preferably 0.04 to 0.4 g./cc. (final density 1.1 to 1.3 with 2 to 5% of fuel, respectively). When the density of the composition is about 1.3 or above, corresponding to the incorporation of less than about 10% of gas by volume, the compositions without surfactant cannot reliably be initiated at diameters of 6 inches.

As stated, the crystal habit modifier can be employed in combination with the fuel component in the compositions of this invention, but is not required. Illustrative crystal-habit modifiers and amounts and means for incorporation thereof are disclosed in the aforesaid Ser. No. 564,526 and such modifier teachings are incorporated herein by reference. Preferred crystal habit modifiers are alkali metal salts of the higher (C_8 - C_{18}) sulfonic esters, e.g. sodium lauryl sulfate, and the alkyl aryl sulfonic acids, which acids have a total of 7 to 30 and preferably 10 to 20 carbon atoms per molecule, the aryl portion of the compound being either a benzene or naphthalene nucleus. The sodium salts of methylnaphthalene sulfonic acid ("Petro-AG Special") and of dimethylnaphthalene sulfonic acid, sodium dodecylbenzene sulfonate, sodium lauryl sulfate and mixtures thereof are particularly preferred crystal habit modifiers. Usually the amount of modifier falls within the range of about 0.1 to 3% or more. Generally at least about 0.5% or anionic surfactant is used to sensitize the compositions to detonation at 40° F.; the use of more than about 2% anionic surfactant increases the cost without materially increasing the sensitivity.

The compositions of this invention, which usually contain 5 to 30% and preferably about 10 to 20% of water, are thickened, "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 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. Examples of thickening agents are those conventionally used in water-bearing explosives and generally are used in amounts ranging from, by weight of the compositions, 0.1 to 10%, and preferably from 0.2 to 5%. Examples thereof

include tree 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 dextrans, hydroxyethyl starch and British gums; water-dispersable derivatives of cellulose such as methyl-cellulose; sodium carboxymethyl cellulose and sodium sulfoethylcellulose; gelatin; casein; polyvinyl alcohol; polyacrylamides and modified polyacrylamides; high molecular weight polyethylene oxides; exocellular heteropolysaccharides 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 the gelling agent is a galactomannan, particularly guar gum, 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 Jaguar 100 or Jaguar 10 in which no cross-linking agent is incorporated. When a non-complexing guar gum is used, small portions, e.g., about 0.001 to 1% by weight of the total composition, of cross-linking agents, e.g., borax or potassium dichromate, for the gelling agent can be employed. Other suitable cross-linking agents are those discussed more completely in U.S. 3,202,556 or copending, coassigned U.S. patent application Ser. No. 343,140, filed Feb. 6, 1964, the teachings of which are included herein by reference. Preferably, the product is gelled in situ by the crosslinking of gum such as guar gum which can be self complexing or can be crosslinked by the addition of a crosslinking agent. The crosslinking (complexing) of the gum markedly strengthens the gel. As with the crystal habit modifiers, carbonaceous thickening agents serve the dual functions of fuel and thickener, may comprise all or part of the soluble fuel and are included in the calculation of the requisite fuel values.

To impart fluidity to the water-bearing thickened or gelled explosive compositions, particularly at temperatures below -10° F., the composition can contain about from 0.25 to 10% and preferably about 1 to 5%, by weight, based on the total composition, of those materials which function as winter-fluidizing (antifreezing) agents as described in U.S. Pat. 3,190,777. Of the compositions enumerated in this patent, methanol, formamide, dimethyl sulfoxide and methyl cellosolve yield compositions with particularly desirable low-temperature properties. These fluidizing agents can be considered as a portion of the soluble fuel contained in the composition.

Preferably less than 50%, of the total fuel value, of solid fuels are included in the compositions of this invention. Aside from the cellular carbonaceous fuels which constitute the major proportion, at least 50% of the solid fuel, small proportions of other solid fuels can be used including, for example, finely divided coals, sulfur and sulfur-containing compounds such as iron pyrites, ferrophosphorus and ferrosilicon. In incorporating such fuels the total weight of fuel should be adjusted so that the oxygen-balance of the composition is within the range of -25 to +10%, preferably -15 to 0% and the density of the composition is less than about 1.4 g./cc.

In the following examples, parts and percentages are by weight unless indicated otherwise.

Examples 1-5

Blasting agents of the compositions shown in Table 1 below, are prepared in a rotary mixer in the following sequence of steps.

(1) Ammonium nitrate "neutral liquor" (nominally 80% ammonium nitrate) at >150° F. is placed in the mixer and agitation is begun.

(2) Crystal habit modifier (sodium methylnaphthalene sulfonate "Petro-AG," then soluble fuel (granulated

sugar), sodium nitrate and guar gum are dissolved in the hot neutral liquor.

(3) Other fuels (if specified) and cellular or foam fuel are added.

(4) Crosslinking agent for the guar gum is added; the blend is mixed for at least 3 minutes.

The compositions formed are loaded into 6-inch diameter containers and samples of each composition initiated at 40° and at 90° F. by conventional cast primers. In the table, F indicates that the composition fails to propagate a detonation, when the composition detonates measurements of detonation velocity are given in meters/second.

TABLE I

Example	1	2	3	4
80% AN liquor	70.0	71.0	72.0	73.0
(Ammonium Nitrate)	(56.0)	(57.0)	(57.6)	(58.4)
(Water)	(14.0)	(14.0)	(14.4)	(14.6)
Sodium Nitrate	15.0	15.0	15.0	15.0
Sugar (granulated)	8.0	8.0	8.0	8.0
Bagasse Pith (bulk density 0.1-0.3 g./cc.)	3.0		3.0	3.0
Expanded Corn Flakes (Brewer's grit) (Bulk density 0.1-0.3 g./cc.)		3.0		
Polyethylene foam ¹ (bulk density 0.01-0.04 g./cc.)			0.5	
"Petro-AG Special" ²	1.0	1.0	1.0	1.0
Stearic Acid	3.0	3.0		
Guar gum	1.0	1.0	1.0	1.0
Fine coal			4.0	2.0
Velocity, m./sec.:				
90° F.	4,500	4,250	2,900	4,500
40° F.	4,150	3,550	2,250	4,250
Density, g./cc.	1.2	1.2	1.08	1.2
Volume percent gas-filled cavities	20-30	20-30	30-40	20-30

¹ Scrap, closed cell foamed polyethylene pellets (0.2" diam. x 0.2" length) from Donray Products Co. as "Ethafoam."

² Sodium methylnaphthalene sulfonate.

³ Tested at 78° F.

All products are crosslinked with about 450 cc./cwt. of 5% aqueous potassium dichromate. All products have gas-filled cavities of less than about $\frac{1}{16}$ inch in major dimension and, at ambient temperature, about 10 to 20% of the inorganic oxidizing salt therein is crystallized out.

Similar results are obtained when about 2% of sodium lauryl sulfate is employed as the surfactant in place of "Petro-AG Special" in the above compositions.

For comparison, compositions are prepared as in Example 1 above except that insoluble fuels, sulfur and coal are substituted for the sugar in one composition (equal parts by weight of each of sugar and coal). This composition detonates at 2850 m./sec. at 90° F. but fails to detonate at 40° F. When a light-bodied paraffin oil ("Corvus" oil available from Texaco) is substituted for the sugar, the composition fails to detonate both at 90° F. and at 40° F.

Examples 6 to 8

The following compositions of this invention are prepared in a ribbon blender or turbine mixer in the following sequence of steps.

(1) A solution of ammonium nitrate and sodium nitrate in water at approximately 150° F. is placed in a mixer and agitation is begun.

(2) Granulated sugar and guar gum are added to the hot liquor and substantially dissolved therein.

(3) Bagasse pith or expanded corn flakes is then added.

(4) Cross-linking agent for the guar gum is added immediately before discharging the blend.

(5) The compositions are loaded into six-inch diameter containers and samples of each composition initiated at 40° F. and at 70° F. by conventional cast primers.

TABLE II

Example	6	7	8
AN/SN liquor	87.4	87.4	87.9
(Ammonium Nitrate)	(45.0)	(51.1)	(51.4)
(Sodium Nitrate)	(22.3)	(17.5)	(17.6)
(Water)	(20.1)	(13.3)	(18.9)
Sugar (granulated)	8.0	8.0	8.0
Bagasse Pith (bulk dens. 0.1-0.3 g./cc.)	4.0		
Expanded Corn Flakes (bulk dens. 0.2-0.3 g./cc.)		4.0	3.5
Guar gum	0.6	0.6	0.6
5% aq. K ₂ Cr ₂ O ₇ , cc./cwt.	450	450	450
Velocity, m./sec.:			
70° F. in air	4,500	5,100	4,500
55° F. in air	3,300		
40° F. in air	F	F	F
60° F. under pipe confinement	5,100	4,500	4,880
Density, g./cc.	1.15	1.24	1.15
Volume percent gas-filled cavities	25-35	20-30	25-35

¹ In 4 inch diameter.

The compositions in Examples 6 to 8 cannot be detonated in air at 40° F. but can be successfully detonated in boreholes which maintain approximately this temperature throughout most of the year.

Example 9

The following composition of this invention is prepared by the general procedures shown in the preceding examples by first adding the sodium methylnaphthalene sulfonate crystal habit modifier thereto, then the fuels, sodium nitrate, guar gum and finally crosslinking agent. Air-filled cavities less than about $\frac{1}{16}$ -inch in major dimension are incorporated in the product with the bagasse pith and also mechanically with a high-speed agitator.

TABLE III

Example	9
80% AN liquor	74
(Ammonium nitrate)	(59.2)
(Water)	(14.8)
Sodium nitrate	15.0
Stearic acid	3.0
Ethylene glycol	3.0
Bagasse Pith (bulk dens. 0.1-0.3 g./cc.)	4.0
Sodium methylnaphthalene sulfonate	1.0
Guar gum	1.0
5% Aq. K ₂ Cr ₂ O ₇ , cc./cwt.	450
Density, g./cc.	1.2
Percent gas-filled cavities, by volume	20-30

The product of Example 9 detonates at about 40° F. in $\frac{3}{16}$ -inch diameters.

Similar results are obtained if half of the sodium methylnaphthalene sulfonate is replaced by 0.5 part sodium lauryl sulfate.

We claim:

1. In thickened water-bearing blasting agents consisting essentially of water, inorganic oxidizing salt at least partially dissolved in said water and non-explosive fuel, the improvement which comprises using a non-explosive fuel component, dispersed throughout said blasting agent, comprising the combination of (a) at least about 3%, based on the total weight of the blasting agent, of dissolved carbonaceous fuel and (b) solid undissolved carbonaceous fuel having finely divided gas-filled cavities therein, said cavities comprising about from 10 to 40% by volume of said blasting agent, said solid undissolved fuel having a bulk density of less than about 0.6 g./cc.

2. A blasting agent of claim 1 having a density of at least about 1.0 but less than 1.3.

3. A blasting agent of claim 2 wherein said fuel component contains greater than about 50% by weight of said dissolved carbonaceous fuel.

4. A blasting agent of claim 3 wherein said inorganic oxidizing salt component consists essentially of ammonium nitrate or mixtures thereof with lesser proportions of sodium nitrate and said dissolved carbonaceous fuel is at least one of the group consisting of mono- and disaccharides.

5. A blasting agent of claim 4 wherein said undissolved

carbonaceous fuel has a bulk density of about from 0.04 to 0.4 g./cc.

6. A blasting agent of claim 5 wherein said undissolved carbonaceous fuel is at least one of piths and expanded cereal products.

7. A blasting agent of claim 6 containing about from 2 to 5% by weight of said undissolved carbonaceous fuel.

8. A blasting agent of claim 6 wherein said soluble fuel is sugar.

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