EXPLOSIVE COMPOSITION CONTAINING BIOPOLYMERIC MATERIAL, METHOD OF PREPARING AND USING

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ABSTRACT

In a slurry explosive composition of matter comprising at least one oxygen releasing salt; water; and at least one fuel, the combination with said composition of at least one uncrosslinked biopolymeric material.

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EXPLOSIVE COMPOSITION CONTAINING BIOPOLYMERIC MATERIAL, METHOD OF PREPARING AND USING

This is a continuation of application Ser. No. 214,414 filed Dec. 30, 1971, now abandoned. This invention relates to new compositions of matter and in particular particular relates to new explosive compositions of matter.

Explosive compositions in the form of slurries and comprising oxidizing salts, fuel, sensitizers, and water, optionally together with conventional additives are known. Whilst such compositions have in the main been satisfactory for use as explosives it has been found that they suffer from the disadvantage that their sensitivity to detonation tends to be variable from batch to batch of production; in particular the sensitivity to detonation of such compositions tends to diminish from the original value during mixing, prolonged storage or after pumping into boreholes.

Amongst the materials which have been proposed in the prior art for use in slurry explosives are metals, particularly finely divided metals, to contribute energy to the explosive. The prior art has proposed the use of various metals of high thermal energy including aluminium, silicon, ferrosilicon, ferrophosphorus, magnesium, titanium, boron and mixtures thereof for example mixtures of aluminium with ferrosilicon. These metals have been suggested for use both as fuels and as sensitzers. In general, these materials have been employed predominantly as fuels. When however these metals are in a very finely divided form, for example in the form of a powder passing a 300 mesh sieve or prepared so as to have a high surface area per unit weight such as up to 2.5 and as much as 10 or more square metres per gram, certain of such metals act in the explosive composition as sensitizers to detonation as well as behaving as fuel materials. As a typical example of these metals in finely divided form there may be mentioned the so-called paint fine aluminium which is a fine aluminium powder conventionally used for the purposes of pigmentation. Whilst these finely divided metals are eminently suitable as sensitizers it is known from the prior art that their effectiveness as sensitizers in certain aqueous explosive slurries is progressively reduced with time either whilst the composition is standing or whilst it is being mixed or pumped or otherwise sheared. It is also known that such slurry explosives tend to become less sensitive to detonation when exposed to water in a wet bore hole. It has been suggested that such aqueous compositions containing very finely divided metal lose their sensitivity with time because more and more of the metal surface becomes wet. So as to reduce the wetting effect it has been suggested that the finely divided metals be treated with various coating or surface active materials which will render them hydrophobic. Such materials were for example paraffin, stearic acid, calcium stearate or a tallow amine. Whilst these materials were effective for a short period of time, they were ineffective over prolonged periods. In particular we have also observed that such hydrophobically treated metals incorporated in slurry explosive compositions become wetted when a conventional additive such as a guar gum is present.

It is an object of the present invention to improve the sensitivity to detonation of slurry explosive compositions, and in particular to reduce the rate at which such compositions become desensitized on storage or after having been mixed or pumped. It is a further object of the present invention to provide slurry explosive compositions which have an enhanced water resistance over compositions of the prior art. It is a still further object of the present invention to provide thickened slurry explosive compositions wherein the thickening system does not comprise a conventional crosslinking agent.

We have now discovered that the addition of non-crosslinked biopolymeric material to a slurry explosive composition reduces the rate of desensitization to detonation of said composition to a rate lower than has hitherto been possible. Under certain circumstances the loss of sensitivity to detonation of the explosive composition is reduced considerably or may even be eliminated entirely. We have also discovered that the addition of such material provides thickened slurry explosive compositions which have improved water resistance when compared with slurry explosive compositions of the prior art.

The nature of the slurry explosive composition to which the biopolymer is added is not critical. Such slurry explosives are well known and may comprise at least one oxygen releasing salt; water; and at least one fuel. Optionally such slurry explosives may also comprise sensitizing additives such as for example finely divided metals or gases or other conventional additives such as for example crosslinking retardants, anti-foaming agents or surfactants.

Accordingly we provide in a slurry explosive composition of matter comprising at least one oxygen releasing salt; water; and at least one fuel, the combination with said composition of at least one non-crosslinked biopolymeric material.

By biopolymeric material we mean polymeric material which is produced by a process comprising the microbial transformation of carbohydrate material. Such material may be prepared for example by reacting a carbohydrate with a microorganism to obtain a polymeric material which differs fundamentally from the parent polymeric material in respect of composition, properties and structure. Suitable carbohydrates include sugars such as pentoses or hexoses, for example glucose, sucrose, fructose, maltose, lactose, galactose, and starches, for example soluble starch, corn starch and the like. Since such carbohydrates need not be in a refined state, many crude products having a high carbohydrate concentration may be utilized. Amongst suitable materials there may be mentioned raw sugar, crude molasses and the like. Microorganisms suitable for effecting the microbial transformation of carbohydrates may be for example plant pathogenic bacteria such as plant pathogens which produce exudates at the site of lesions on infected plants. Typical of such microorganisms are the species of the genus Xanthomonas. Thus for example a heteropolysaccharide may be prepared from glucose by the plant pathogen Xanthomo nas campestris to give a product comprising D-mannose, D-glucose and D-glucuronic acid as the potassium or sodium salt. Similarly extracellular polysaccharides of a similar structure to the above may be prepared from glucose or sucrose by the plant pathogenic microorganism Xanthomonas oryzae or Xanthomonas phaseoli. It is of interest to note that the polysaccharide from X. oryzae resembles that from X. campestris since both contain combined pyruvic acid. Although the
structural significance of the pyruvic acid in these polysaccharides is obscure, it appears to present as a ketal group, as in the case of red seaweed polysaccharides. Amongst other species of organisms of the genus *Xanthomonas* from which suitable biopolymers may be prepared there may be mentioned *X. malvacearum*; *X. translucens* f. sp. *hordetavenaeae*; *X. translucens* f. sp. *undulosa*; *X. carolae*; *X. hederae*; *X. papavericola*; *X. incanae*; *X. vescatoria*; *X. begoniae* and *X. vasculorum*. Biopolymers may also be produced from organisms other than those of the genus *Xanthomonas*. Thus there may be mentioned amongst the bacterial polysaccharides the dextran produced by *Leuconostoc mesenteroides* and related species, and the glucosan produced by *Agrobacterium tumefaciens*. A biopolymer typical of those suitable for use in our invention is the material "Biopolymer" XB-23 (Registered Trade Mark) available commercially from General Mills Inc. of Minneapolis, Minn., U.S.A. This material comprises a biopolymeric material derived from a polymer which has been reacted with *X. campestris*. Another suitable material is the water soluble polymer known as XC polymer available commercially from Esso Production Research Co. of Houston, Tex., U.S.A. This polymer is produced by the action of bacteria of the genus *Xanthomonas* on carbohydrates to give a biopolymer of a very complex chemical structure.

Accordingly we provide explosive compositions of matter as described above wherein the biopolymeric material comprises matter prepared from a carbohydrate which has been reacted with a microorganism of the genus *Xanthomonas*.

We also provide explosive compositions of matter as described above wherein the biopolymeric material comprises matter prepared from a carbohydrate which has been reacted with a microorganism of the species *Xanthomonas campestris*.

The amount of biopolymer which may be incorporated in our compositions depends on the nature of the biopolymer and the composition of the explosive composition to which it has been added. Sufficient biopolymer should be present to ensure that all the insoluble materials are suitably dispersed and retained throughout the slurry. On the other hand the quantity of biopolymer in the composition should not be so great as to increase the viscosity of the composition beyond the point where the composition cannot be poured, pumped or mixed without excessive shearing at the temperature of preparation of transfer of the composition. Biopolymers which have been deliberately cross-linked in the preparation of the composition tend to form compositions which are firm gels and which on standing become increasingly firm. The use of such cross-linked biopolymers is not desired in the compositions according to our invention. The desired amount of biopolymer to be used in our compositions may be determined by simple experiment and in general we have found that amounts from as little as 0.1% w/w to as much as 5% w/w of the total weight of the composition are useful and amounts from 0.5% to 3% w/w of the total weight of the composition are satisfactory for most purposes.

The oxygen releasing salts suitable for use in our compositions are of the conventional types used in slurry explosive compositions. Thus they may be, for example, inorganic nitrates, chlorates and perchlorates and mixtures thereof. We prefer that the oxygen releasing salt material be chosen from the nitrates of the alkali and alkaline earth metals or metals and of these we prefer sodium nitrate and ammonium nitrate. The amount of oxygen releasing salt in our compositions is not narrowly critical; we have found that compositions containing amounts of oxygen releasing salts from 50% w/w to 90% w/w of the total composition are satisfactory and amounts from 65% w/w to 85% w/w are preferred. The particle size and shape of the oxygen releasing salt is not critical and is well known from the art of ammonium manufacture; powders and drilled particles are satisfactory.

The proportion of water in our compositions should be sufficient to dissolve at least part of the oxygen releasing inorganic salt and at least part of any water soluble fuel which may be present, and also be sufficient to hydrate at least part, preferably all, of the biopolymeric material. Suitably the amount of water present may constitute from 5% w/w to 25% w/w of the total composition, but the amount present should not be in excess of the explosive limit of the composition. We prefer that the water be in the range from 5% w/w to 25% w/w of the total composition and more preferably be in the range from 12% w/w to 17% w/w of the total composition.

When referring to fuels or fuel materials throughout this specification we mean substances which are stable in our explosive compositions, that is prior to detonation, during preparation and storage the substance is chemically inert to the system. The said substances must be combustible and their physical nature should be such that they may be incorporated in our compositions in a manner so as to be uniformly distributed throughout the compositions. Such fuels are well known in the art and they may be organic or inorganic and may also be derived from animals and plants.

The fuels employed in the compositions of this invention can be, for example, self-explosive fuels, non-explosive carbonaceous, non-metallic and metallic fuels or mixtures of the aforementioned types of fuels. They can be varied widely. Examples of self-explosive fuels include one or more organic nitrates, nitrocompounds and nitramines such as trinitrotoluene, cyclotrim (or tetra) methylenetri (or tetra) nitrate, tetryl, pentraerythritol tetranitrate, explosive grade nitrocellulose and nitrostarch.

The self-explosive fuel can be for example in any of the well known flake, crystalline or pelleted forms. In general up to 35% and preferably from 10 to 30% by weight based on the weight of composition of self-explosive fuel may be used.

Suitable water soluble fuels are organic water soluble substances for example urea, carbohydrates such as sugars or molasses, water soluble alcohols or glycols, glues or mixtures of these. Suitably the proportion of water soluble fuel in our compositions is in the range from 0.8% w/w to 8% w/w of the total composition. Amounts from 4% w/w to 7% w/w of the total composition are preferred.

Suitable water insoluble or sparingly water soluble fuels may be chosen from inorganic materials for example sulphur, aluminium, silicon, ferrosilicon, ferrophosphorus, magnesium, titanium, boron, mixtures thereof for example mixtures of aluminium with ferrosilicon, or organic materials for example finely divided charcoal, anthracite, gilsonite asphalt, cellulose materials such as sawdust, or cereal products for example flours, dex-
trins or starches. When the inorganic fuel is a metal it is preferably in granulated or powdered form ranging in particle size from coarse, for example retained on a 30 mesh sieve, to very fine for example passing a 325 mesh sieve. Such granulated or powered metal may be in the form of discrete regular shaped particles, but metal powders wherein the metal is in the form of irregular shaped particles, or in flakes or in the form of aggregates of particles or flakes are also satisfactory. Preferred fuels are the metallic powders. The most preferred metallic fuel is aluminium. The proportion of water insoluble or sparingly water soluble non-metallic fuels in our compositions may suitably be in the range from 1% w/w to 10% w/w of the total composition and amounts from 4% w/w to 7% w/w of the total composition are preferred. The proportion of metallic water insoluble fuels when present in our compositions may be as high as 25% w/w and amounts in the range from 0.5% w/w to 20% w/w of the total compositions are preferred.

As mentioned here before certain of the metallic materials referred to above as fuel materials also act in our compositions as sensitizers to detonation when the said materials are in finely divided form by which we mean a metal or metals passing a 300 mesh, and preferably a 325 mesh, sieve. In general such finely divided materials when used as sensitizing materials are usually present in slurry explosive compositions in a relatively small amount. Thus amounts in the range from 0.2% to 5% of the weight of the total composition are useful and amounts in the range from 1 to 3% of the weight of the composition are commonly used. Finely divided aluminium, especially finely divided aluminium coated with a hydrophobic material, is particularly useful in our compositions as a sensitizing additive.

Accordingly in a further embodiment of our invention we provide slurry explosive compositions as herebefore described characterized further in that said compositions comprise at least one metallic material in finely divided form.

Where desirable, it is convenient to add to the compositions according to our invention, in amounts expressed as parts by weight per 100 parts by weight of the final mixture, other additives such as for example conventional cross-linking retardants, for example tarteric acid, in amounts ranging e.g., from 0 to 0.1 part, conventional anti-foaming agents, for example ethyl hexanol, in amounts ranging e.g., from 0 to 0.1 parts, or conventional sensitizing surfactants, for example non-ionic surfactants such as alkylene oxide condensates of phenols or amides, from 0 to 5 parts. When desired, sensitizers in the form of gas or a mixture of gases such as air may be added to our compositions. Thus it may be added in the form of injected or stirred in air or gas or it may be added as air or gas encapsulated in or attached to the surface of particulate material. Alternatively a gas, such as nitrogen or carbon dioxide, may if desired be generated in the composition by known means.

We also provide a process for preparing slurry explosive compositions according to our invention which process comprises firstly preparing a mixture (I) comprising all of the water in the composition and a part of oxygen releasing salt or salts; secondly, adding to said biopolymeric material to hydrate at least in part to form solution (II); thirdly, mixing said solution (II) with a blend comprising the residual part of the oxygen re-leasing salt or salts and the fuel material to form mixture (III); and, optionally, fourthly adding to said mixture (III) finely divided metallic material and dispersing it through the composition.

The compositions according to this invention are pourable or pumpable slurries or dispersions. They are advantageous in that they have more constant sensitivity over similar explosive compositions not containing our biopolymeric materials. Our compositions permit blasting in smaller holes down to a diameter of 1 inch or less, maintain sensitivity more nearly constant than is possible with prior art compositions, extend the useful period of storage, and increase the degree of shearing to which slurry explosive compositions may be subjected during processing without undue loss of sensitivity to detonation. The enhanced retention of sensitivity of our compositions during mixing or pumping operations or whilst being stored is a major advance in slurry explosive technology. Thus our compositions may be pumped to desired site prior to detonation with a loss of sensitivity less than has hitherto been possible. Such retention of sensitivity by our compositions permits savings resulting from the smaller boosters required to initiate detonation and also improves the safety aspect of the use of slurry explosive since the possibility of non-detonation and the subsequent hazards in rectifying such non-detonation situations is thereby reduced.

Our compositions are also advantageous in that they have enhanced water resistance over compositions of the prior art. Thus they may be used at wet blasting sites, for example in boreholes which are wet or even under water, and we have found that detonation of our compositions is achieved even after prolonged storage under wet conditions in boreholes. It is known that slurry explosive compositions comprising conventional cross-linked materials, for example cross-linked guar gum, may be prepared and that such compositions have some water resistance. However such compositions often have such a high viscosity that they are difficult to pump into boreholes of small diameter. Attempts to use non-cross-linked guar gums and thus reduce the viscosity of the compositions have proved to be unsatisfactory when such compositions have been located in wet boreholes since the degree of water resistance has been so slight that the compositions have disintegrated in the water in the boreholes and thus it was impossible to detonate them. We have found that compositions according to our invention having suitable viscosity and water resistance characteristics may be prepared when there is additionally incorporated in such compositions non-cross-linked materials, the said materials being those which in a cross-linked form act as thickeners or water resisting agents. Thus for example non-cross-linked guar gum may be incorporated in our compositions as a thickening agent provided that there is sufficient biopolymeric material present to provide adequate water resistance to the compositions.

Our invention is now illustrated but by no means limited to the following examples wherein parts and percentages are expressed on a weight basis unless otherwise stated. Examples 1, 4 and 13 are not according to our invention and are included for the purposes of comparison.

EXAMPLE 1

For the purposes of comparison a small amount of finely divided aluminium particles which passed
through a 300 mesh sieve and which had been treated with a hydrophobic agent was spread as evenly as possible on the surface of each of 50 ml. of 0.5% w/v solutions in water of gluten, starch and "Guartec" F contained in 100 ml. beakers. ("Guartec" F is a registered trade mark for a commercially available guar gum). Aluminium particles sank to the bottom of the beaker after 20 minutes where the gluten solution was used; after 8 hours in the case of starch and after 7 hours in the case of "Guartec" F. This example demonstrates that prior art materials whilst affording some protection against the wetting of finely divided aluminium are only effective over relatively short periods of time.

**EXAMPLE 2**

The general procedure of Example 1 was repeated but the aqueous media therein were replaced by a 0.2% w/v solution of "Biopolymer" XB 23 in water. The contents of the beaker were observed for 5 days, during which time the aluminium particles remained substantially on the surface of the solution. This example demonstrates the efficacy of biopolymeric materials in preventing the wetting of finely divided metals in the presence of water and also demonstrates the superiority in this aspect of biopolymeric materials over prior art materials.

In the Examples 3 and 5 to 12 inclusive the general procedure as set out below was adopted to prepare the slurry explosive compositions described therein. Approximately half of the amount of oxygen releasing salt or salts was added to the water. The resultant mixture was stirred, the biopolymeric material was added and allowed to hydrate for 20 minutes. This mixture was then added to a dry blend consisting of the residual amount of oxygen releasing salt or salts, and the fuel material. After stirring to ensure homogeneity, usually for a period of 3 to 5 minutes, the finely divided metallic material was added and dispersed through the composition by stirring for a short period which was of the order of 2 minutes.

In Example 14 no finely divided metallic material was added to the composition.

**EXAMPLE 3**

An explosive composition consisting of 72 parts of ammonium nitrate, 5 parts of sugar, 3 parts of sulphur, 5 parts of atomized aluminium, 2 parts of paint fine aluminium, 12.5 parts of water and 0.5 part of "Biopolymer" XB 23 was prepared in a conventional mixing device for the preparation of explosive slurries. Portion of the composition was cardriged in 1 inch diameter cardboard cylinders. The minimum amount of pentolite to detonate a cartridge so prepared was 5 g.

Another portion of this composition was pumped through a "Mono" pump prior to cardriging in cardboard cylinders. ("Mono" is a registered trade mark — this pump is of the positive displacement type fitted with a screw feed). After this treatment the pumped composition was detonated in cylinders of 1 inch diameter by the use of 8 g. pentolite. Yet a further portion was allowed to stand for 14 days, remixed to ensure homogeneity and cardriged in cylinders of 1 inch diameter. The amount of pentolite to detonate the treated cardriged composition 10 g. This example demonstrates that the incorporation of biopolymeric material in explosive compositions of the slurry type comprising finely divided metal enables the sensitivity to detonation of such compositions to remain substantially constant after such compositions have been pumped or have been stored over prolonged periods.

**EXAMPLE 4**

A composition similar to that of Example 3 was prepared but the biopolymeric material was replaced by an equal amount of guar gum. The general procedure of Example 3 was repeated. The minimum amount of pentolite to detonate the freshly prepared cartridge was 10 g. However the pumped and stored compositions could be detonated only by the use of 60 g. and 100 g. of pentolite respectively. This example demonstrates that in the absence of a biopolymeric material in explosive compositions of the slurry type comprising finely divided metal the sensitivity to detonation of such compositions is reduced after pumping, mixing or storage operations have been performed. On said slurry.

**EXAMPLE 5**

Using *Xanthomonas malvaeforum* a biopolymeric material was prepared in the conventional manner by whole culture fermentation of a medium containing glucose, distillers' dry solubles, dipotassium hydrogen phosphate and magnesium sulphate. The biopolymeric material so prepared was recovered by precipitation in methanol of the clarified mixture from the fermentation. The general procedure of Example 3 was repeated but the 0.5 part of "Biopolymer" XB 23 used in that Example was replaced by 1 part of the biopolymeric material prepared above and the amount of ammonium nitrate was reduced to 71.5 parts. The minimum amount of pentolite required to detonate a freshly prepared cartridge was 10 g. whilst the pumped and stored compositions were detonated by 35 g. and 50 g. of pentolite respectively.

**EXAMPLE 6**

200 lb. of a slurry explosive composition consisting of 55.4 parts of ammonium nitrate, 13 parts of sodium nitrate, 13 parts of water, 4 parts of sugar, 13 parts of atomized aluminium powder available commercially from Alcoa of Australia Ltd. under the designation "Aluminium powder 125", 1 part of aluminium powder No. 408 (a paint fine aluminium powder substantially passing a 325 mesh sieve and available from Alcoa of Australia Ltd.) and 0.6 part of "Biopolymer" XB 23 was prepared in a conventional mixing device for the preparation of explosive slurries. The composition was transferred through 30 feet of a % inch internal diameter hose using a pneumatic loader into horizontal boreholes 12 feet long and 1 inches in diameter in a rockface under water. The composition was allowed to remain in the boreholes for 3 hours after which time the individual charges were successfully detonated at 89°F using a No. 8 aluminium plain detonator. This example demonstrates that explosive compositions comprising biopolymeric materials may be detonated under wet conditions.

**EXAMPLE 7**

An explosive composition similar to that of Example 6 was prepared except that the proportion of "Biopolymer" XB 23 was increased to 1 part and the proportion of ammonium nitrate was reduced to 55 parts. A portion of this composition was transferred through 30 feet of a % inch internal diameter hose using a pneu-
matic loader into steel pipes 6 feet long and 1½ inches internal diameter and which were inclined at an angle of +30° to the horizontal. The composition in the pipes was maintained at a temperature of 95°F for 3 days during which time the composition was self-supporting in the pipes. The composition in each pipe was then detonated successfully by means of one No. 8 aluminium plain detonator. Similar results were obtained with a further portion of the composition which was pumped through a "Mono" pump for 15 minutes prior to transferring it into the steel pipes. This example demonstrates that slurry explosive compositions not containing a cross-linking agent can be used in cavities inclined at an angle above the horizontal, i.e., they may be used in the so-called upholes. It also demonstrates that such compositions are not desensitized by pumping prior to use.

EXAMPLE 8

150 lb. of a slurry explosive composition consisting of 60.7 parts of ammonium nitrate, 12 parts of sodium nitrate, 12 parts of water, 5 parts of sugar, 5 parts of "Aluminium powder 125", 2 parts of "Aluminium powder No. 408", 2 parts of sulphur, 1 part of gilsonite and 0.3 part of "Biopolymer" XB 23 was prepared in a mixing device conventionally used for the preparation of explosive slurries. A first portion of this freshly prepared composition was cardraged in cardboard cylinders of 1 inch diameter to provide cartridges (A). A second portion of the composition was pumped from and recirculated to a container at a temperature of 75° to 80°F at a rate of 50 lb/minute for 15 minutes through a "Mono" pump using a hose which was 100 feet in length and of 1 inch internal diameter. The so-treated composition was then stored for 24 hours and cardraged in cardboard cylinders of 1 inch diameter to provide cartridges (B). A third portion of the composition was stored at a temperature of 95°F for 4 months and after this period the so treated composition was cardraged in cardboard cylinders of 1 inch diameter to provide cartridges (C). The cartridges so prepared from each portion were detonated within two hours of their preparation. From the cartridges designated above as (A) it was found that detonation of an individual cartridge could be achieved by using one No. 6 copper detonator. It was also found that individual cartridges designated (B) and (C) above could also be detonated by one No. 6 copper detonator. This example demonstrates the constancy of sensitivity to detonation of our compositions after pumping and prolonged storage.

EXAMPLE 9

The procedure of Example 6 was repeated except that the proportion of ammonium nitrate in the composition was increased to 55.5 parts, the proportion of "Biopolymer" XB 23 was reduced to 0.2 part, and uncrosslinked guar gum was added to the composition to the extent of 0.3 part. The composition was detonated by using one No. 8 aluminium plain detonator.

EXAMPLE 10

A slurry explosive composition consisting of 83.7 parts of ammonium nitrate, 6 parts of diethylene glycol, 2 parts of "Aluminium powder 408," 8 parts of water and 0.3 part of "Biopolymer" XB 23 was prepared in a conventional mixing device for the preparation of explosive slurries. The composition was cardraged in cardboard cylinders of 4 inches diameter. Individual cartridges so prepared were detonated using 120 g. of pentolite. The composition was stored at ambient temperature for four months; similar cartridges were prepared from the stored composition and detonated. It was found that the sensitivity of the composition to detonation was not significantly reduced after this period of storage.

EXAMPLE 11

A slurry explosive composition consisting of 55 parts of ammonium nitrate, 4 parts of sugar, 2 parts of "Aluminium powder 408," 35 parts of water and 4 parts of "Biopolymer" XB 23 was prepared in a conventional mixing device used for the preparation of explosive slurries. A portion of the composition was cardraged in cardboard cylinders of 4 inches diameter. Individual cartridges so prepared were detonated using 150 g. of pentolite. A further portion of the composition was pumped from and recirculated to a container at a rate of 50 lb/minute for 15 minutes through a "Mono" pump using a hose which was 50 feet in length and of 2 inches internal diameter. The so treated composition was then stored for 24 hours and cardraged in cardboard cylinders of 4 inches diameter. Individual cartridges so prepared were detonated using 175 g. of pentolite. This example demonstrates that the sensitivity to detonation of our compositions which comprise a relatively large proportion of water is not unduly impaired after having been subjected to a pumping operation.

EXAMPLE 12

A slurry explosive composition consisting of 69 parts of ammonium nitrate, 4 parts of silicon powder of which 95% passed a 30 mesh sieve, 90% passed a 100 mesh sieve and only 2% passed a 200 mesh sieve, 4 parts of sugar, 3 parts of "Aluminium powder 408," 17 parts of water and 3 parts of "Biopolymer" XB 23 was prepared in a conventional mixing device used for the preparation of explosive slurries. A portion of the composition was cardraged in cardboard cylinders of 3 inches diameter. Individual cartridges so prepared were detonated using 125 g. of pentolite. The composition was stored for one month, cardraged as above and detonated. No significant change in the amount of pentolite required to detonate the composition was observed.

EXAMPLE 13

For the purposes of comparison a composition was prepared on a laboratory scale using the proportions of ingredients as used in preparing the composition of EXAMPLE 6 except that the 0.6 part of "Biopolymer" XB 23 of that composition was replaced by 0.6 part of guar gum. 10 parts of the composition so prepared were suspended in a wire cage in 200 parts of water at 100°F for 75 minutes during which time 90% of the oxygen releasing salts originally present in the composition was leached by the water from the composition. By contrast when a composition according to Example 6 was treated in a similar manner the proportion of oxygen releasing salts leached from the composition was only 40%.

EXAMPLE 14

An explosive composition consisting of 69 parts of prilled ammonium nitrate, 2.5 parts of sodium nitrate,
9 parts of aluminium powder, 1 part of silicon powder, 5 parts of sugar, 13 parts of water, 0.01 part of tartaric acid and 0.5 part of "Biopolymer" XB 23 was prepared in a conventional mixing device for the preparation of explosive slurries. Portion of this composition was cartridge in 4 inch diameter cardboard cylinders. Individual cartridges so prepared were detonated by means of 200 g. of pentolite. Another portion of the composition was pumped through a "Mono" pump prior to cartridgeing in similar cylinders. Individual cartridges so prepared were detonated. No significant change in the amount of pentolite required to detonate the pumped composition was observed.

We claim:

1. An aqueous, pumpable water-resistant slurry explosive composition suitable for use in wet boreholes, said composition consisting essentially of at least one oxygen releasing salt; water; at least one fuel; finely divided aluminium passing a 300 mesh sieve as sensitizing additive and biopolymeric material prepared from a carbohydrate which has been reacted with a microorganism of the genus Xanthomonas, the composition being free of any material capable of crosslinking the biopolymeric material.

2. A composition of matter according to claim 1 wherein the biopolymeric material comprises matter prepared from a carbohydrate which has been reacted with a microorganism of the species Xanthomonas campesiris.

3. A composition of matter according to claim 1 wherein the biopolymeric material constitutes from 0.1% w/w to 5% w/w of the total composition.

4. A slurry explosive composition according to claim 1 wherein the oxygen releasing salt is selected from the group consisting of ammonium nitrate, chlorate and perchlorate, alkali metal nitrates, chlorates and perchlorates, and alkaline earth metal nitrates, chlorates and perchlorates present in an amount from 50 to 90 parts; water is present in an amount from 5 to 35 parts; the fuel material is selected from the group consisting of water soluble fuel present in an amount from 0.8 to 8 parts, non-metallic sparingly water soluble fuel and non-metallic water insoluble fuel present in an amount from 1 to 10 parts and metallic water insoluble fuel present in an amount from 0.5 to 20 parts; and the biopolymeric material is present in an amount from 0.1 to 5 parts all amounts being in parts by weight per 100 parts by weight of the composition.

5. A composition of matter according to claim 4 wherein the oxygen releasing salt is selected from the group consisting of the nitrates of the alkali metals and ammonium.

6. A composition of matter according to claim 4 wherein the oxygen releasing salt constitutes from 65% w/w to 85% w/w of the total composition.

7. A composition of matter according to claim 4 wherein water constitutes from 12% w/w to 17% w/w of the total composition.

8. A composition of matter according to claim 4 wherein the biopolymeric material constitutes from 0.5% w/w to 3% w/w of the total composition.

9. A composition of matter according to claim 1 wherein the aluminum constitutes from 0.2% w/w to 5% w/w of the total composition.

10. A composition of matter according to claim 1 wherein the aluminum constitutes from 1% w/w to 3% w/w of the total composition.

11. A composition of matter according to claim 4 wherein the biopolymeric material comprises matter prepared from a carbohydrate which has been reacted with a microorganism of the species Xanthomonas campesiris.

12. A process for preparing a slurry explosive composition of claim 1 which process comprises firstly, preparing a mixture (I) comprising all of the water in the composition and a part of the oxygen releasing salt or salts; secondly, adding to said mixture (I) the biopolymeric material and allowing said biopolymeric material to hydrate at least in part to form a solution (II); thirdly, mixing said solution (II) with a blend comprising the residual part of the oxygen releasing salt or salts and the fuel material to form mixture (III); and, finally adding to said mixture (III) finely divided aluminum and dispersing it through the composition.

13. In a process of blasting which process comprises detonating an explosive composition at a wet blasting site the improvement that the explosive composition is a composition of claim 1.

14. A method of filling a wet borehole which comprises loading a borehole with an aqueous slurred explosive composition of the type comprising at least one oxygen releasing salt, water, fuel, and biopolymeric material prepared from a carbohydrate which has been reacted with a microorganism of the genus Xanthomonas, the composition being free of any material capable of crosslinking the biopolymeric material.

15. A method according to claim 14 wherein the biopolymeric material comprises matter prepared from a carbohydrate which has been reacted with a microorganism of the species Xanthomonas campesiris.

16. A method according to claim 14 wherein the biopolymeric material constitutes from 0.1% w/w to 5% w/w of the total composition.

17. A method according to claim 14 wherein the slurred explosive composition comprises additionally a sensitizing additive, and wherein the sensitizing additive is a finely divided metallic material passing a 300 mesh sieve.

18. A method according to claim 17 wherein the metallic material is aluminum.

19. A method according to claim 14 wherein the oxygen releasing salt is ammonium nitrate.

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