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# WATER-RESISTANT EXPLOSIVE COMPOSITIONS

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This invention relates to water-resistant, explosive compositions which preferably contain a major proportion of a water soluble nitrate salt.

Nitrate-based explosives containing ammonium, sodium, or other water soluble nitrates, are frequently used in blasting operations in which the explosives are loaded into bore holes drilled into the earth. Due to the fact that the bore holes often contain water, it is necessary to adopt some means of waterproofing the explosive since the presence of water desensitizes the explosive and renders it useless. The waterproofing requirement is of critical importance where, as is often the case, the bore hole is loaded with the explosive but detonation postponed anywhere from a few hours to several days. Many different means for waterproofing nitrate-based explosives have been proposed but, for one reason or another, these are not entirely satisfactory.

It has now been discovered that nitrate-based explosives can be safeguarded against desensitization or similar deterioration from exposure to water, even over relatively prolonged periods of time, by adding a small amount of bone meal to the explosive composition. This is completely surprising and unexpected since bone meal has no known capacity to waterproof water soluble materials, nor has its use in explosives in such a capacity ever been proposed in the art. Nevertheless, it has been proven by actual tests that bone meal can make nitrate-based explosive compositions water-resistant to such an extent that the compositions will detonate even after 144 hours of direct exposure to water.

The advantages offered by the present invention are many. First of all, bone meal is relatively inexpensive and does not appreciably increase the cost of the nitrate-based explosive composition. The bone meal need be used only in small quantities and it is simply admixed with the explosive composition without having to form coatings, pellets or other special physical forms, as is often necessary with conventional water proofing materials. The bone meal is substantially oxygen balanced so that it may be added in any desired proportion to the explosive composition without upsetting the oxygen balance thereof. Finally, the bone meal acts as an anticaking agent so that its presence in the explosive composition helps to maintain the composition in a free flowing condition.

The invention is applicable to explosive compositions containing ammonium nitrate alone or in admixture with other inorganic nitrate salts such as alkali metal and alkaline earth metal nitrates. At least 50% of the combined weight of all inorganic nitrate salts in the composition is ammonium nitrate and the total amount of nitrate salts should constitute the principal explosive component of the composition. This means that the combined weight of all nitrate salts certainly should be greater than the weight of all other explosive ingredients in the composition and, preferably, the combined weight of all nitrate salts should constitute at least 50% of the weight of the entire composition. Accordingly, as used in the specification and claims herein, the term nitrate-based explosive composition is defined to mean any composition which contains inorganic nitrate salts as the principal explosive component, with ammonium nitrate comprising at least 50% of the combined weight of all of the nitrate salts.



In accordance with the invention, a small amount of bone meal added to the nitrate-based explosive composition will be effective in preventing desensitization or like deterioration of the composition on exposure to water for substantial periods of time. This result can be achieved with from about 1% to about 7% of bone meal based on the weight of the total explosive composition. Actually even larger amounts of bone meal may be employed, but this gives no significant additional benefits and ordinarily is an economic waste. Use of less than about 1% bone meal will not give results of practical utility and therefore is not recommended. Generally speaking, the presence of from about 1% to about 5% of the bone meal gives results that will be satisfactory for almost all field applications and these amounts are preferred.

As is known, bone meal is the ground residue of slaughterhouse bones which have been stripped of extractable organic matter and then cooked in water or high pressure steam. It is composed principally of tricalcium phosphate and calcium and magnesium carbonates, along with minor amounts of organic matter, moisture and other alkaline salts. It is available commercially as a water-insoluble, particulate material having the appearance of a white powder and in several grades of particle size and purity. Generally speaking, any of the commercially available bone meals may be employed in the invention. It is preferred that the bone meal be in a relatively fine state of subdivision, for example, 50% or more by weight should pass No. 20 screen and be retained on No. 100 screen of the U.S. Standard series. However, this is not absolutely necessary and coarser particles of the bone meal will also give results. In all cases, the bone meal must be in particulate form, of any particle shape, for mixing with the nitrate-based explosive composition.

The nitrate-based explosive composition may contain additional conventional ingredients such as detonatable and non-detonatable sensitizers. Examples of the former are nitrostarch, nitroglycerin, trinitrotoluene and other nitrotoluenes, nitronaphthalenes, pentaerythritol tetranitrate, pentolites (mixtures of pentaerythritol tetranitrate and trinitrotoluene) and cyclotrinitrotrimethylenetetramine, and these will usually be used in amounts up to about 25% by weight of the composition. Non-detonatable sensitizers may be finely divided metals such as aluminum and magnesium and alloys thereof, and these will usually be used in amounts up to about 10% by weight of the composition.

Carbonaceous fuels may be included such as coal, charcial, carbon black, vegetable char, bagasse, nut and wood flours and starch. These will be used in amounts up to 7% by weight of the composition in order to bring the nitrate-based explosive composition into oxygen balance.

Fuels such as rosin and metallic resinates, hexamethylene tetramine, paraffin waxes and oils such as mineral oil also can be included in small amounts, usually up to about 0.5% by weight of the composition.

The composition may also contain stabilizers such as calcium carbonate, magnesium oxide, zinc oxide and like inorganic salts as is conventional in the art. These will be used in amounts up to about 0.5% by weight of the composition.

The water-resistant, nitrate-based explosive composition of the invention may be prepared as a dry, free-flow-

ing particulated product simply by mixing the dry ingredients together in conventional equipment. Aside from the desirability of forming a uniform admixture of the various ingredients, no special precautions are necessary in making the product which can be packaged in any convenient form of container for storage or shipment.

Further details of the invention will be illustrated in the following examples which constitute preferred embodiments thereof.

*Example 1*

A nitrate-based explosive composition with 2% by weight of bone meal was prepared as follows:

| | |
|---|---|
| Nitrostarch, dry | 25.0 |
| Grained ammonium nitrate | 51.6 |
| Grained sodium nitrate | 20.8 |
| Zinc oxide | 0.3 |
| Mineral oil | 0.3 |
| Bone meal | 2.0 |
| | 100.0 |

The bone meal used was a commercial fertilizer grade which had been extracted with carbon tetrachloride, acetone and water, and then ground to give a screen analysis, using U.S. Standard screens, as follows:

| | Percent |
|---|---|
| +20 | 0 |
| −20 +40 | 1 |
| −40 +60 | 3.5 |
| −60 +80 | 10.5 |
| −80 +100 | 39.0 |
| −100 +120 | 5.5 |
| −120 +230 | 24.0 |
| −230 | 16.5 |

The explosive composition was tested for water-resistance in an immersion test using cylindrical paper cartridges 1¼ inches in diameter and 8 inches long. The wall of each such cartridge was scored longitudinally with four lines spaced 90° apart from each other. Four pairs of ⅛ inch holes were punched into the wall along these lines at distances measuring 1, 3, 5 and 7 inches from one end of the cartridge, the holes of each pair being on diametrically opposite score lines and being rotated 90° in position with each increase in distance from one end of the cartridge.

The explosive composition was loaded into several of the cartridges which in turn were immersed in 24 inches of water and periodically removed for detonation testing.

After 48 hours of immersion, the above-described composition with 2% bone meal could still be detonated, but not after 72 hours of immersion.

A similar composition, but not including bone meal, was prepared and tested. After several hours of immersion, the composition could not be detonated and was useless.

Thus, the small amount of bone meal that was included was unexpectedly effective in a significant and substantial manner for imparting water resistance to the nitrate-based explosive composition.

*Example 2*

A composition similar to that of Example 1 was prepared with the exception that 50.6% of ammonium nitrate and 3.0% of bone meal were employed. In the water immersion test, the composition could still be detonated after 96 hours of immersion, but not after 120 hours.

*Example 3*

A composition similar to that of Example 1 was prepared except that 49.6% ammonium nitrate and 4% of bone meal were employed. After 120 hours in the water immersion test, this composition could still be detonated, but not after 144 hours.



*Example 4*

Examples 1 was repeated except that a commercially purified grade of bone meal was used, the screen analysis for this bone meal being as follows:

| | Percent |
|---|---|
| +20 | 0 |
| −20 +40 | 0.5 |
| −40 +60 | 0.5 |
| −60 +80 | 6.0 |
| −80 +100 | 66.0 |
| −100 +120 | 4.0 |
| −120 +230 | 15.5 |
| −230 | 7.5 |

In the water immersion test, this composition could still be detonated after 144 hours of immersion, but not after 168 hours.

From the foregoing, it will be evident that bone meal has been found to be an extremely effective adjuvant for nitrate-based explosive compositions, rendering such compositions highly water-resistant and capable of withstanding substantial periods of direct exposure to water without deleterious effects. Attempts have been made to duplicate the remarkable results achieved with bone meal using other forms of mineral matter such as chalk, zinc oxide, iron oxide, powdered gypsum and diatomaceous earth. These have not been successful and thus illustrate the unique and surprising effect of bone meal the reasons for which are not known at the present time.

It will be understood that it is intended to cover all changes and modifications of the preferred embodiments of the invention, herein chosen for the purpose of illustration, which do not depart from the spirit and scope of the invention.

What is claimed is:

1. An explosive composition resistant to deterioration from exposure to water which comprises at least one detonatable inorganic nitrate salt as the principal explosive component of which at least 50% by weight is comprised of ammonium nitrate, and from about 1% to about 7% of particulate bone meal based on the weight of the total composition.

2. An explosive composition resistant to deterioration from exposure to water which comprises at least one detonatable inorganic nitrate salt as the principal explosive component of which at least 50% by weight is comprised of ammonium nitrate, a sensitizer in an amount up to about 25% and from about 1% to 7% of particulate bone meal based on the weight of the total composition.

3. An explosive composition resistant to deterioration from exposure to water which comprises at least one detonatable inorganic nitrate salt as the principal explosive ingredient of which at least 50% by weight is comprised of ammonium nitrate, nitrostarch in an amount up to about 25% and from about 1% to about 7% bone meal based on the weight of the total composition.

4. An explosive composition resistant to deterioration from exposure to water which comprises at least one salt selected from the group consisting of ammonium nitrate, alkali metal nitrates and alkaline earth metal nitrates as the principal explosive component, at least 50% of the weight of said component being comprised of ammonium nitrate, and from about 1% to about 7% of bone meal based on the weight of the total composition.

5. A composition in accordance with claim 4 which includes a sufficient amount of carbonaceous fuel to bring the entire composition substantially into oxygen balance.

6. A composition in accordance with claim 4 which includes up to about 25% a sensitizer based on the total weight of the composition.

7. A composition in accordance with claim 4 in which the amount of bone meal is from about 1% to about 5% of the weight of the total composition.

8. A composition in accordance with claim 4 in which the particle size of the bone meal is such that at least about one-half the weight thereof passes No. 20 screen but is retained on No. 100 screen, U.S. Standard Series.

9. An explosive composition resistant to deterioration from exposure to water which comprises a mixture of ammonium nitrate and an alkali metal nitrate as the principal explosive component, at least 50% of the weight of said mixture being comprised of the ammonium nitrate, and from about 1% to about 7% of particulate bone meal based on the weight of the total composition.



10. A composition in accordance with claim 9 which includes up to about 25% of nitrostarch based on the total weight of the composition.

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