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MANUFACTURE OF EXPLOSIVE COMPOSITIONS OR BLASTING CHARGES

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The present invention relates to new or improved methods for the production of explosive compositions and blasting charges containing ammonium nitrate and carbonaceous ingredients, and to the improved explosive compositions and blasting charges produced by these methods.

As is well known, mixtures of ammonium nitrate and the vegetable cellular carbonaceous ingredients commonly used in explosives are generally more difficult to initiate than the so-called "permitted" explosives.

The sensitiveness to initiation of a mixture of a given carbonaceous ingredient with ammonium nitrate is relatively high when the composition of the mixture is highly oxygen-positive, and falls considerably as the proportion of the carbonaceous ingredient is increased up to and beyond the point at which the composition becomes oxygen-balanced. The presence of any of the flame-quenching ingredients used in permitted explosives also diminishes the sensitiveness. The ammonium nitrate explosives of commerce, which are preferably approximately oxygen-balanced and so modified as to be safe in gassy atmospheres, contain a proportion of a nitric ester as sensitising ingredient.

Within recent years the so-called low-density blasting explosives have found considerable application in the winning of coal, as when used in an appropriate manner they bring down a large proportion of the coal blasted in lump form. In addition to the other ingredients usually present i explosive compositions in which nitric esters are used as sensitising ingredients, these explosives contain vegetable cellular carbonaceous ingredients of unusually low bulk density, with or without minor proportions of the normal vegetable cellular carbonaceous ingredients. Ammonium nitrate is a common ingredient of such explosives.

Like other powder explosives, the low-density explosives are cartridged under a controlled pressure; so that, when the mixture is filled into the usual paper containers, the various ingredients do not segregate during transport nor suffer inconvenient deformation while being handled and loaded into the bore hole. Whereas ordinary powder explosives are cartridged under various pressures such that their bulk densities range from about 0.9 gram per c. c. upwards, the low-density explosives are cartridged only under a gentle pressure, and are characterised by bulk densities lower than about 0.75 gram per c. c.

An object of the present invention is the manufacture of low-density explosive compositions which contain no sensitising nitric esters nor aromatic nitrocompounds, but which are nevertheless sufficiently sensitive to the direct impulse of a detonator to be employed for commercial blasting when enclosed under moderate confinement. Sufficient confinement may be afforded by a substantially rigid casing, e. g. a thin tinplate container, or in some cases by even an ordinary waterproof paper container. By the words "sensitive to the direct impulse of a detonator" I imply that, when used under the specified conditions of confinement in boreholes not exceeding two inches in diameter, the compositions can be satisfactorily initiated by means of a No. 7 detonator without an additional primer. Efficient flame-quenching ingredients may be introduced into such compositions without rendering them too insensitive, and compositions may be thus provided which are adapted to meet modern requirements for safety in fiery and dusty atmospheres. As will be understood, the elimination in the manufacture or handling of the explosive of the highly inflammable or explosive nitric esters commonly employed as sensitisers is an obvious advantage, and the use of the compositions in question for blasting favors the production of lump coal.

The present invention is based in part on the observation that, in the absence of self-explosive sensitisers such as nitric esters, the bulk density of an ammonium nitrate mixture has a considerable effect on its sensitiveness, which increases as the bulk density is reduced. The sensitiveness of the mixture is dependent on the nature of the carbonaceous ingredients, as well as on their individual bulk density.

Although a simple mixture of ammonium nitrate and low-density carbonaceous ingredients may be sufficiently sensitive to be detonated by a commercial detonator, such compositions are unsatisfactory for use as commercial explosives on account of the persistent tendency to segregation of the ingredients and packing to a considerable bulk density during the transport and handling of the mixture.

According to the present invention, a low-density blasting explosive free from self-explosive sensitisers is manufactured by mixing ammonium nitrate in the presence of water with a carbonaceous material consisting of a low-density woodmeal or pithmeal having in the undisintegrated state a bulk density not exceeding 0.25 gram per c. c., so that the ammonium nitrate is at least partly impregnated into the low density woodmeal or pithmeal; and the mixture, after being

exposed to a raised temperature not exceeding 120° C. and evaporated till not more than about 2% moisture is present, is granulated so that the particles will pass through a sieve of about 6 mesh B. S.

In putting the invention into effect, I may incorporate the woodmeal or pithmeal with a hot solution of the ammonium nitrate in only a small amount of water. In presence of the low-density meal, the action of mixing at a high temperature greatly assists in the evaporation of the excess of water, and a special drying operation subsequent to the mixing is ofen unnecessary. In view of the tendency to spontaneous decomposition shown by mixtures of ammonium nitrate and carbonaceous materials at high temperatures, I prefer to carry out the incorporation and drying at a temperature not above 120° C.

In granulating the mixture I may conveniently pass it through the sieve while it has still a pasty consistency before it has cooled sufficiently for the mixture to form a hard cake. A large proportion of the material granulated in this manner has a grist corresponding to the sieve used. I may also allow the material to set, and then break up the cake mechanically, rejecting particles too large to pass through a 6 mesh B.S. sieve (apertures 0.11 inch square). If desired, however, a finer mesh sieve, e. g. a 12 mesh B.S., may be used with advantage. The letters B.S. denote an abbreviation for British Standard and apply to a standard basis for screens. These initials or letters are used in this sense throughout the present description.

For the purposes of the invention I may use, for instance, balsa wood, bongo wood, bagasse, megasse, or cornstalk pith. If desired, minor proportions of ingredients other than ammonium nitrate and low density woods or piths, e. g. other carbonaceous materials, cooling or flame-quenching ingredients, oxidants, and inorganic fuels, may be included in the granulated mixture, according to the type of low-density explosive required. Such materials may be introduced after the granulation; in which case care should be taken that their particle size and/or amount is such that the voids between the granules are not filled. Some ingredients, especially those insoluble in water may be incorporated during the impregnation of the low-density material with the ammonium nitrate liquor.

The granulated product produced according to my invention may have a lower bulk density than any of the ordinary low-density explosives, and owes its low density partly to the low density of the wood or pith, and partly to the operation of granulation. Unlike low-density mixtures produced by simple dry mixture of the same ingredients, it maintains its low density and sensitiveness well when subjected to a slight degree of pressure such as is usually employed in cartridging low-density explosives. It also maintains its sensitiveness on transport and storage. The ratio of ammonium nitrate to low-density ingredient in the impregnated meal may conveniently be from 4.5/1 to 8.5/1; and the explosive may be oxygen-balanced.

Example 1

96 parts of ammonium nitrate and 4 parts of water are brought to a temperature of 115° C. at which the mixture is almost completely liquid. 5 parts of this liquor are then added with stirring to 1 part of a 50:50 mixture of balsa meal and bagasse meal, previously brought to a temperature of 100° C. Stirring is continued until the liquid is distributed throughout the mass, and, after being cooled to about 60° C., the mass is lightly rubbed through a 6 mesh B.S. sieve, spread out, and allowed to cool to ordinary temperature. The product, of which 50% is held on a 16 B.S. sieve, and not over 5% passes a 50 B.S. sieve, is then loaded under a light pressure of about 20 lb. per sq. inch into paper shells so as to give cartridges having a density of 0.5 gm. per c. c. A 1¼" dia. x 3" cartridge of the above, when initiated by a No. 6 80:20 fulminate-chlorate detonator, transmits detonation to another similar cartridge at a separation not exceeding 1" (Ardeer double cartridge test). A file of 6 cartridges propagated throughout at a speed of 1700 metres per sec.

Example 2

80 parts of ammonium nitrate, pulverised so that 80% of it passes a 100 mesh B.S. sieve, 10 parts of balsa meal and 2 parts of water are incorporated together in a jacketed mixer maintained at 100° C. until the mixture has attained a temperature of about 60° C. The mixture is sieved while still hot through a 12 mesh B.S. sieve, spread out, and allowed to cool. 50% of this product is held on a 16 B.S. sieve, and not over 5% of it passes a 50 B.S. sieve. When cold, the mass is loaded at a light pressure of 20 lb. per square inch into paper shells to give cartridges at a bulk density of 0.55 gram per c. c. A 1¼" dia. x 3" cartridge, when initiated by a No. 6 80:20 fulminate-chlorate detonator, detonates and transmits detonation to a similar cartridge at a separation not exceeding 1".

Example 3

6.4 parts of an ammonium nitrate liquor, containing 96 parts ammonium nitrate and 4 parts water, are added at about 115° C. to 1 part of a mixture of equal parts of balsa meal and megasse dust. The fibre is heated to 90° C. in a steam-jacketed incorporator before the ammonium nitrate liquid is added, and the hot-mixing is continued until not more than 2% moisture remains in the mass. The mixture is then rubbed through a 6 B.S. sieve, dried completely, and again sieved through a 6 B.S. sieve.

The composition, when cartridged under a pressure of 20 lb. per sq. inch, has a bulk density of 0.45 gram per c. c.; and when initiated by a No. 6 detonator as used in the previous examples, has a power equivalent to 75% of blasting gelatine, and a sensitiveness of ½–¾ inch. The velocity of detonation is 1780 metres/second.

I claim:

1. A method for producing a low density blasting explosive free from self-explosive sensitizers, which comprises incorporating ammonium nitrate in the presence of water with a low density carbonaceous material having in the undisintegrated state a bulk density not exceeding 0.25 grams/cc., drying the resultant mixture to a moisture content not exceeding 2%, and granulating to such fineness that all the particles pass through a 6-mesh screen and at least 50% are held on a 16-mesh screen.

2. A method of producing a low density blasting explosive free from self-explosive sensitizers, which comprises intermingling ammonium nitrate in the presence of water with a low density carbonaceous material having in the undisintegrated state a bulk density not exceeding 0.25 gram/cc., said intermingling being effected at an

elevated temperature not exceeding 120° C., drying the resultant mixture to a moisture content not exceeding 2%, and granulating to such fineness that all the particles pass through a 6-mesh screen and at least 50% are held on a 16-mesh screen.

3. A method of producing a low density blasting explosive free from self-explosive sensitizers, which comprises intermingling carbonaceous material having in the undisintegrated state a bulk density not exceeding 0.25 gram/cc. with a mixture of ammonium nitrate and water, said intermingling being effected at a temperature not exceeding 120° C., cooling the resultant mixture, then granulating to such fineness that all the particles pass through a 6-mesh screen and at least 50% are held on a 16-mesh screen, and drying these particles to a moisture content not exceeding 2%.

4. A blasting explosive composition capable of maintaining after packaging a bulk density below 0.75 gram/cc. and sensitive to initiation by a commercial detonator, said composition comprising granules consisting of low density carbonaceous material having in the undisintegrated state a bulk density not exceeding 0.25 gram/cc. impregnated with ammonium nitrate, said granules being of such size that all of them pass through a 6-mesh screen and at least 50% are held on a 16-mesh screen.

5. The blasting composition of claim 4, wherein the blasting composition includes particles of flame-quenching ingredients, the particles being of such size that the voids between the ammonium nitrate-carbonaceous material granules are not filled.

6. A blasting explosive composition capable of maintaining after packaging a bulk density below 0.75 gram/cc. and sensitive to initiation by a commercial detonator, said composition comprising granules consisting of low density carbonaceous material having in the undisintegrated state a bulk density not exceeding 0.25 gram/cc. impregnated with ammonium nitrate in amounts from 4.5 to 8.5 times the weight of the carbonaceous material, said granules being of such size that all of them pass through a 6-mesh screen and at least 50% are held on a 16-mesh screen.

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