(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: 0 459 959 A2

(12) EUROPEAN PATENT APPLICATION

(21) Application number: 91850118.0

(51) Int. Cl.[5]: C06B 21/00

(22) Date of filing: 10.05.91

(30) Priority. 29.05.90 SE 9001913

(43) Date of publication of application: 04.12.91 Bulletin 91/49

(84) Designated Contracting States: AT BE CH DE DK ES FR GB GR IT LI NL SE

(71) Applicant: Nobel Kemi AB
Box 800
691 85 Karlskoga (SE)

(72) Inventor: Schmid, Hermann
Västra Rävasgatan 2
S-691 35 Karlskoga (SE)

(74) Representative: Falk, Bengt et al
Nobel Corporate Services Patents and Trademarks
S-691 84 Karlskoga (SE)

(54) A method of producing polymerbonded explosive bodies.

(57) The disclosure relates to a method of producing polymer-bonded explosive bodies including crystalline explosives ground to a narrow particle distribution. According to the invention, the crystalline explosive is ground suspended in a flegmatization and grinding liquid in which at least parts of the polymer binder are included.

EP 0 459 959 A2

TECHNICAL FIELD

The present invention relates to a method of producing explosive bodies of crystalline, polymer-bonded explosives, with a predetermined particle size of the crystalline components achieved by grinding a coarser crystalline explosive fraction.

BACKGROUND ART

Modern high-energy explosives such as pentyl, octogene and hexogene, and others, are often of crystalline structure. However, it has proved difficult in both the manufacturing process and the recrystallization to control the crystal formation so as always to obtain products of sufficiently fine and uniform crystal size. For many applications, it has therefore been necessary to grind the originally obtained explosives crystals to the desired particle size before these become usable for their contemplated purpose. For reasons of safety, this operation has always taken place with the explosive suspended or slurried in water. This is a tricky enough process despite the presence of considerable quantities of water, a process which is no less tricky because of the fact that the explosive must, after completion of the grinding, be completely dried before it can be admixed with any binder and can be given desired finished form by granulation and/or compaction.

As examples of a few products for which particularly fine and uniform particulate crystalline explosives are needed, mention may be made of detonating fuzes of different types, which normally contain pentyl, and so-called hollow charges which normally contain polymer-bonded octogene or hexogene.

SUMMARY OF THE INVENTION

The present invention now relates to a novel method of producing explosive bodies, primarily hollow charges but also other charges being applicable hereto, comprising one or more crystalline explosives combined with a polymer binder and in which the crystalline explosive component has a particle size which has been achieved by grinding of an at least partly coarser crystalline starting material.

According to the present invention, the desired explosive bodies are thus produced in that crystalline explosives included therein are ground prior to final forming to the desired particle size, suspended in a flegmatization or grinding liquid which thereafter is at least partly included in the polymer binder.

This implies that the water previously employed as flegmatization and grinding liquid in the grinding operation is entirely or partly replaced by one or more of the polymer components included in the final product, possibly dissolved in a fugitive solvent, or alternatively in water, and the explosive is thus fed to the grinding apparatus suspended in this flegmatization or grinding liquid, which may be a dispersion or an emulsion and of which at least parts thereof are also subsequently employed in the process in their capacity as a binder or a component included therein. Such a procedure dispenses with the previously necessary drying operation when all flegmatization agent, i.e. the water, must be driven off. An explosive is, after all, at its most dangerous when completely dry. While solvent and/or water may, as has already been intimated, be included in the process according to the present invention and thus must be driven off or dried off, the polymer component included in the flegmatization and grinding liquid always remains as a flegmatization agent. Moreover, the advantage will be afforded that, by selection of a suitable polymer component as flegmatization and grinding liquid, a better lubrication effect will be achieved during the grinding stage than is attained using water alone.

When water is included as a component in the flegmatization or grinding liquid according to the invention, the polymer component included therein may consist, for instance, of a water-soluble polymer, for example a water-soluble polyurethane, or of a polymer soluble in a solvent, in which the solution thereof is in turn emulsified in water, or vice versa. One representative example would then be polyvinyl acetate dissolved in ethyl acetate and emulsified in water. Polyvinyl acetate dissolved in ethyl acetate may also be directly employed as grinding liquid, on condition that the concentrations are suitably adapted.

With or without an addition of water, the flegmatization and grinding liquid according to the present invention may further alternatively consist of one or more of a plurality of components included in a multi-component polymer system or alternatively the complete polymer system which may be in the prepolymerized or polymerized state and, in such an event (at least in the latter alternative) dissolved in a fugitive solvent which is driven off in connection with the final forming operation, in which event additional polymer components or alternatively some other polymerization initiator such as heat may also be supplied.

The present invention further encompasses the concept that the polymer components included in the flegmatization or grinding liquid may consist of individual components or mixtures which are not reactive with one another or with the explosive, or which alternatively consist of monomers, prepolymerized, or polymers of single- or multi-component type which are reactive with one another and/or may chemically be embodied in the explosive.

Hence, the basic inventive concept as herein disclosed encompasses a very large number of variations, depending upon which polymer system is selected as binder in the finished product.

The grinding proper in the method according to the present invention takes place in a grinding apparatus of per se known type which preferably consists of an appropriately loaded ball mill of one type or another and which thus may be of the vibrating or rotary type without moving agitators, or of the agitator type.

We have found that use may advantageously be made according to the present invention of vibrating ball mills loaded with cylindrical grinding balls with gently rounded ends. The grinding operation is preferably run continually and ideally in combination with filtering and circulation pumping of a coarse fraction as the desired fine fraction departs from the mill. However, its is probably technically more simple but more expensive in the long term to operate the grinding batchwise.

The quantity of grinding liquid may, in the method according to the present invention, vary between 80 and 30 per cent by weight, i.e. 20-70 per cent by weight crystalline charge, depending upon the selected polymer system and explosives, as well as the desired degree of grinding and the performance of the grinding apparatus.

The above-intimated alternative in which solvent and/or water is included must, as a rule, be employed when the final product must have a low binder content, and when the flegmatization and grinding liquid is of excessively high viscosity, i.e. in most cases when this consists of a prepolymer or a finished polymer. It is also conceivable to grind the explosive in a substantially greater amount of polymer component than is to be included in the finished product and remove, by suction or sedimentation, the surplus after the end of the grinding and subsequently add possibly additional polymer component adapted to the remaining quantity of the component in which the grinding was carried out, or alternatively drive off the solvent from the latter.

A very large number of different alternatives is thus conceivable within the inventive concept forming the basis of the present invention. The number of feasible polymer systems and components included therein, and solvents which could be employed in connection with the method according to the present invention is in actual fact even larger, for which reason we can only mention a limited number of conceivable examples.

The grinding could, for example, take place in an isocyanate, in a polyol, or in a polyol mixture.

Good binders in this context which also function satisfactorily as flegmatization and grinding liquids are monomer or prepolymerized acrylate (di-, tri- or tetra-acrylate), since the acrylates in their monomeric form have low viscosity and consequently a possible surplus may readily be removed by suction whereafter the product may be cured by an addition of peroxide and possibly heat. However, as a result of other considerations, other types of polymer binders falling within the scope of the inventive concept as herein disclosed may come into question.

As an example of the particle sizes which may come into question in connection with the method according to the present invention, mention may be made of final products with a substantially uniform particle size of between 2 and 5 μm. The uniform particle size is of crucial importance, since it is most preferable to avoid the necessity of sieving dry or semi-dry crystalline explosives. A circulation pumping of coarse particle fractions in maximum quantity of grinding liquid in connection with the removal of the goods from the grinding apparatus is, however, something completely different.

The method according to the present invention has been defined in the appended claims, while the accompanying drawing schematically illustrates an apparatus which could be applicable for carrying the method according to the present invention into effect. A number of representative examples are also discussed after the description of the accompanying drawing. The apparatus comprises a mixing tank 1 in which the crystalline explosive fed via the inlet 2 is dispersed in the polymer binder component fed via the inlet 3. From the tank 1, the dispersion is pumped by the pump 4 further towards a valve 5. The system also includes a return conduit 6 via which the dispersion which the valve 5 cannot accept is returned to the tank 1. From the valve 5, an adapted quantity of dispersion is fed to the ball mill 7 which, in this particular case, is conceived as being of the vibrating type and filled to a considerable extent with grinding bodies of aluminium silicate, each one in the form of a cylinder with slightly cupped ends. From the mill 7, the goods dispersed in the polymer component passes via the conduit 8 towards a separation device 9 which returns all coarse fraction together with a portion of the polymer component via the return conduit 10, while the fine fraction is fed via the conduit 11 to a sedimentation vessel 12 where a considerable proportion of the polymer component is removed and returned to the tank 1 via the return conduit 13. The goods, at desired total solids, is supplied from the vessel 12 to an additional vessel 14 in which other polymer components, are fed via the conduit 13, whereafter the thus obtained matrix is, possibly after granulation, finally formed into the desired explosive bodies and the binder is cured.

EXAMPLE

The apparatus employed consisted of a vibrating ball mill of a product volume of 9.8 litres and filled with cylindrical grinding bodies of aluminium oxide with rounded ends. Two sizes of grinding bodies were employed, of the dimensions 1/2" x 1/2" and 1/4" x

1/4". The inside of the grinding apparatus was polymer coated, and it has not been possible for us to ascertain any immediate difference between the grinding apparatus which had an inner teflon surface and that which was interiorly coated with a polyurethane layer. The electric drive motor of the grinding apparatus was of 5 hp, 50 Hz and operated at a speed of 1,350 rpm.

As flegmatization and grinding liquid, use was made in the following experiments of polyvinyl acetate dissolved in ethyl acetate emulsified in water in which the explosive crystals were suspended in an amount corresponding to a total solids content of approx. 60 per cent. After completion of the grinding operation, the ethyl acetate and water were driven off so that a total solids of approx. 80 per cent was obtained, whereafter the product was granulated and compacted into cohesive explosive bodies.

EXPERIMENT 1

Grinding of RDX (hexogene), mean particle size of starting material 1,000 µm. Grinding body 1/2" x 1/2". The completed grinding operation resulted in a product with particles of 10-15 µm.

EXPERIMENT 2

Grinding of HMX (octogene). Mean particle size of starting material 1,000 µm. Grinding bodies 1/4" x 1/4". The completed grinding operation resulted in a product with narrow particles distribution, with particles of approx. 2 µm.

The particle size of the finished product appears mostly to be a result of the size of the grinding bodies, even though a longer grinding time must be expected in order to achieve the smaller particle size. Since, in the experiments described above, we investigated those particle sizes we could achieve and therefore continued the grinding until no actual further particle change could be ascertained, our grinding times are not representative and are therefore not presented here.

Claims

1. A method of producing explosive bodies comprising one or more fine-grained crystalline explosives bonded together by a polymer binder, **characterized in that** crystalline explosives included therein are ground, prior to final forming of the explosive bodies, to the desired particle size suspended in a flegmatization or grinding liquid which thereafter at least partly is included in the polymer binder.

2. The method as claimed in Claim 1, **characterized in that** the crystalline explosive components are ground, prior to final forming of the explosive bodies, to the desired particle size suspended in at least one of the components in a multicomponent polymer system; **and that** the remaining polymer components are supplied after completion of the grinding operation, in conjunction with the final forming of the desired explosive bodies and polymerization of the binder.

3. The method as claimed in Claim 1, **characterized in that** the crystalline explosive components are, prior to final formation of the explosive bodies, ground to the desired particle size suspended in a flegmatization and grinding liquid which includes one or more polymer components which may be polymerized or prepolymerized and, in addition, includes water and/or an organic solvent for said polymer components, the water and/or solvent being driven off after completion of the grinding operation in conjunction with the final forming of the product.

4. The method as claimed in Claim 3, **characterized in that** the pertinent polymer components included in the flegmatization or grinding liquid are dissolved in a solvent ; and that this solution is emulsified in water, or vice versa, whereafter the charge is suspended in the thus obtained flegmatization or grinding liquid and the grinding operation is carried out to the desired particle size, whereafter the solvent and water are driven off and the product is given the desired final form.

5. The method as claimed in any one or more of Claims 1-4, **characterized in that** additional polymer components included in the binder are supplied after the end of the grinding operation and after any solvent and water have been driven off but before the final forming of the product.

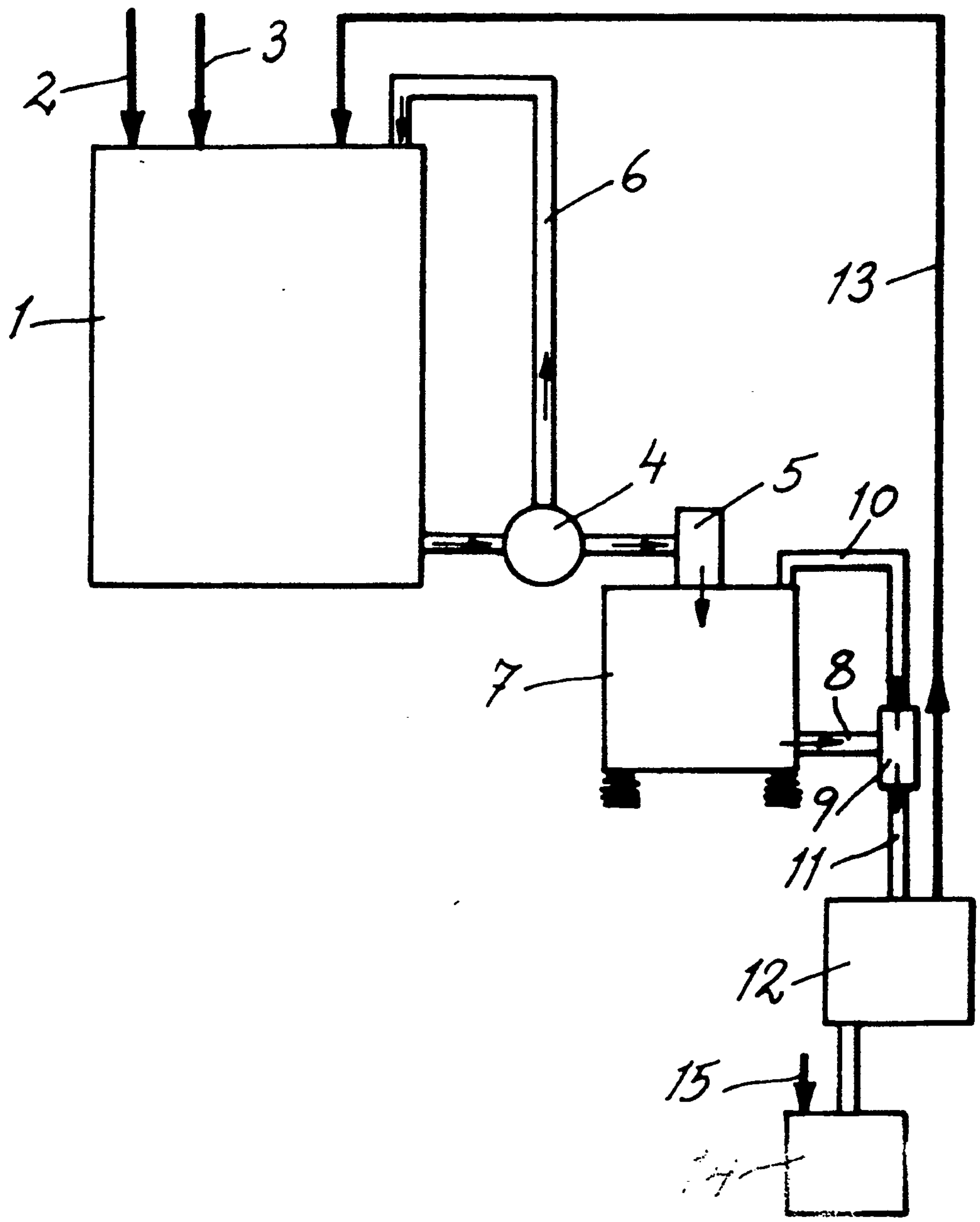
6. The method as claimed in any one or more of claims 1-5, **characterized in that** the ground product is granulated prior to final forming but after driving-off of any possible solvent, and after the addition of any further polymer components.

7. The method as claimed in Claim 1, **characterized in that** the grinding is carried out in a grinding liquid which contains more polymer binder or alternatively polymer component included therein that is intended to be included in the finished explosive body; **and that** this surplus is removed by suction and/or separated by sedimentation and recycled in the process before final forming of the finished product.

8. The method as claimed in any one or more of

Claims 1-7, **characterized in that** the grinding operation is carried out in a ball mill with or without moving parts.

9. A product produced in accordance with the method as claimed in any one of claims 1-7.


1
2
3
4
5
6
7
8
9
10
11
12
13
15