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PROPELLANT POWDER

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This invention relates to an improved propellant smokeless powder and more particularly to a novel and improved method of producing a high gravimetric density, free flowing, non-clustering, progressive burning smokeless powder.

Heretofore the art has recognized and used surface coated propellant powder. The surface coated propellant powder which the art has produced by coating powder grains with a deterrent material has proved partially satisfactory but there are a number of disadvantages to the known processes of coating. The powder grains coated with deterrent materials by the accepted processes now known to the art are not entirely successful because in all instances there is a tendency for the individual grains to be coated with unequal amounts of deterrent. Unequal coating results in clustering, low gravimetric densities and non-uniform ballistics.

The methods of coating smokeless powder with deterrent materials now used comprises, in general, the tumbling or stirring of powder grains in the presence of a quantity of deterrent material. The tumbling or stirring process is normally carried out in a revolving drum or "sweetie barrel" and the coating processes now used are aided by the addition to the drum of solvents or non-solvents for the powder grains and coating materials.

However, in each of the above described methods of prior art in which the powder grains do not finally receive a substantially equal concentration of the deterrent material on all of the grain surfaces, because of this unequal distribution, high gravimetric densities are not obtained and uniform ballistics are difficult to maintain. The grains also tend to be more or less sticky and form clusters and thus do not load freely into the cartridges. This clustering is mainly due to the lack of a uniform coating on the grains.

It is the object of this invention to produce a propellant smokeless powder which has a substantially equal coating of deterrent deposited on all surfaces of the individual powder grains.

A further object of this invention is to provide an improved means of surface coating progressive-burning smokeless powder.

A further object of this invention is to produce a smokeless powder with an increased gravimetric density, better free flowing characteristics and more regular ballistics.

A still further object of this invention is to provide a propellant smokeless powder which will give standard ballistics with a lower weight of charge. Other objects will appear hereinafter.

By this invention, smokeless powder is coated with the same class of deterrent materials as used by the prior art, but in such a way as to obtain uniform distribution and ample penetration of the deterrent material in a reasonable time and without stickiness and with much less clustering. Further the process of this invention produces powder having a high gravimetric density and excellent ballistics. According to this invention, smokeless powder is wet with a volatile liquid which is a non-solvent or a poor solvent for the smokeless powder and is a poor solvent for the deterrent materials. To the powder so wet, is added a finely ground deterrent material, which is only weakly soluble in the volatile liquid, and the mass tumbled together at elevated temperatures. The temperatures may be below or above the melting point of the deterrent material, but it has been found advisable when nearing the end of the coating process to raise the temperature of the powder to a point above the melting point of the deterrent material for a short time.

The volatile vehicle is so selected that it is a weak solvent for the deterrent and thus serves as a transfer medium dissolving small quantities of the deterrent material and then giving it up to the powder. Because of the low solubility of the deterrent material in the volatile vehicle, the concentration being deposited on the grains is never high enough to cause stickiness and the deterrent material penetrates into the grain as fast as the volatile vehicle allows its disposition. The volatile vehicles which are suitable in accordance with this invention are ethyl alcohol, dioxane, acetone, petroleum naphtha, butyl acetate and the like either alone or in admixture with each other or water. The most suitable mixtures being ethyl alcohol-water, acetone water, dioxane-water and petroleum naphtha-butyl acetate. The composition of the mixture is determined by the solubility of the specific deterrent to be used. Deterrent may be for example, dimethyldiphenylurea, diethyldiphenylurea, dinitro-toluene, ethyl ortho benzoyl benzoate, triphenylphosphate, or similar substances or mixtures thereof.

The improved method of coating smokeless powder in accordance with this invention is more specifically indicated by the following examples which show the comparison between smokeless powder manufactured in accordance with the prior art methods and smokeless powder manufactured by this invention.

EXAMPLE 1

As a basis of comparison, 1812 parts by weight of uncoated double base tubular rifle powder containing 20% nitroglycerin was coated by a prior art method which comprises wetting the powder with a solution containing 100 parts by weight of Centralite (symmetrical diethyldiphenylurea) dissolved in 181 parts by weight of ethyl alcohol. The wetted powder was revolved in a sweetie barrel for one hour at a temperature of 85° C., after which, the powder grains were dried, glazed, screened and humidified. The powder so manufactured gave a 60% yield of unclustered grains which had a gravimetric density of .941 and which when tested in a .50 caliber rifle with a charge of 243 grains gave velocity of 2833 ft. per second with a pressure of 46,700 pounds per sq. inch.

EXAMPLE 2

To show the improvement obtained by using the process of this invention for coating, 1812 parts by weight of the uncoated double base tubular rifle powder grains such as was treated in Example 1 were placed in a sweetie barrel and wet with 182 parts by weight of a 2:1 alcohol water mixture, which mixture is a poor solvent for Centralite. To the wet powder in the sweetie barrel was added 100 parts by weight of Centralite and the barrel revolved for a period of one hour at a temperature of 85° C. The Centralite was gradually dissolved and deposited on the powder. After this treatment the powder was dried, glazed, screened, and humidified. Upon removing the powder from the barrel, a yield of 84% of unclustered grains was obtained which had a gravimetric density of .950 and which when tested in a .50 caliber rifle with a charge of 255 grains gave a velocity of 2830 ft. per second and a pressure of 46,300 pounds per sq. in. It will be noted that the yield of unclustered grains has been increased by ¼ and substantially the same ballistics were obtained.

EXAMPLE 3

A sample of uncoated powder grains was coated by a prior art method which comprises coating 50 parts by weight of tubular rifle powder with 4 parts by weight of water and 1.25 parts by weight of ethyl ortho benzoyl benzoate. The coating was applied by revolving the sweetie barrel for 45 minutes at a temperature of 65° C., after which, two parts by weight of additional water and .875 part by weight of additional ethyl ortho benzoyl benzoate were added. The drum was revolved an additional 50 minutes at 65° C. and then 2 parts of additional water and .265 part additional ethyl ortho benzoyl benzoate were added. The barrel was revolved an additional 30 minutes at 60° C. The powder was cooled, glazed, screened, humidified, and from this treatment a 99% yield of grains having gravimetric density of .900 were obtained. In a .50 caliber rifle a charge of 202 grains giving a velocity of 2670 ft. per second and a pressure of 41,000 pounds per sq. in.

EXAMPLE 4

To show the improvement afforded by this invention over the powder of Example 3, 1812 parts by weight of the same type powder grains were wet with 145 parts of 95% alcohol and 36 parts by weight of water, which mixture is a poor solvent for ethyl ortho benzoyl benzoate. The material was revolved in a barrel and 100 parts by weight of ethyl ortho benzoyl benzoate were added. The barrel was revolved for one hour at a temperature of 65° C. and the deterrent was gradually dissolved and deposited on the grains. The powder was dried, glazed, screened, and humidified. From this example, a yield of 98.5% unclustered grains having a gravimetric density of 1.007 was obtained. When tested in a .50 caliber rifle, a charge of 263 grains gave a velocity of 2792 ft. per second and a pressure of 40,600 pounds per sq. in.

It will be noted that the powders of Examples 3 and 4 which were coated with ethyl ortho benzoyl benzoate definitely prove that the method of coating in accordance with this invention gives a higher gravimetric density and allows higher velocities with reduced pressures to be obtained.

EXAMPLE 5

A sample of powder was coated by a prior art method by coating 1812 parts by weight of a tubular rifle powder, granulated .045–.015 x .048 and containing 20% nitroglycerin by adding thereto the deterrent material in a solution and tumbling the mass for one hour at 65° C. The solution consisted of 120 parts by weight of triphenyl phosphate in 181 parts by weight of water. The powder was removed from the barrel, dried, glazed, screened, humidified and tested. The gravimetric density of the powder was .848.

EXAMPLE 6

To show the improvement possible over the results given in Example 5, a powder was prepared in accordance with this invention by coating 1812 parts by weight of the uncoated powder grains of Example 5 by wetting the material with 181 parts by weight of an alcohol-water (125–56) mixture and 120 parts by weight of triphenyl phosphate added. The barrel was revolved for one hour at 65° C. and the powder finished as in Example 5. The alcohol-water mixture is a poor solvent for the triphenyl phosphate and allows a slow transfer to the powder grains. The gravimetric density of the powder was .898 or .050 point higher than the powder produced by Example 5.

The coating procedure of this invention in the preceding examples has been applied to double base smokeless powder; however, it is readily adaptable to the coating of single base powders and the following examples show the improvement obtainable.

EXAMPLE 7

A sample of single base tubular rifle powder granulated .045–.015 x .91 was coated by a prior art method in the following manner. To 100 parts by weight of the powder grains wet with water was added 1 part by weight of ethyl ortho benzoyl benzoate. The mass was tumbled for one hour at 75° C. and the powder finished as in the previous examples. The results are listed in the table.

EXAMPLE 8

To show the improvement possible over the results given in Example 7 a single base powder was prepared in accordance with this invention by coating 100 parts by weight of the powder described in Example 7 by wetting the mass with 10 parts by weight of a 4–1 alcohol-water mixture and adding thereto 1 part by weight of ethyl ortho benzoyl benzoate. The deterrent is only slightly soluble in liquid. The mass was tumbled

for one hour at 75° C. and finished as in previous examples. The results obtained are listed in the table.

Table

Examples	Gravimetric density	Per cent yield
Ex. 7	.892	99.0
Ex. 8	.921	99.0

From the above table it is apparent that the coating procedure of this invention provides an improvement over the prior art as there has been a substantial increase in the gravimetric density figure which is highly desirable.

The coating procedure of this invention provides a means whereby a high gravimetric density powder may be obtained and gives increased yield of usable powder. Further, clustering is materially reduced and a powder is produced which sas superior ballistics over prior art powders. The coating procedure is not time consuming and may be carried out in one step, thus, decreasing labor costs over some of the known methods.

It will be understood that the details and examples hereinbefore set forth are illustrative only, and that the invention as broadly described and claimed is in no way limited thereby.

What I claim and desire to protect by Letters Patent is:

1. In the process of making progressive burning smokeless powder by coating substantially completely colloided smokeless powder grains with a deterrent material, the improvement comprising wetting the smokeless powder grains with a volatile liquid which is a weak solvent for the deterrent material and substantially a non-solvent for the smokeless powder grains; adding the deterrent material to the wetted smokeless powder grains; and tumbling the mass thus formed and heating sufficiently to progressively and slowly dissolve small quantities of the deterrent material in the weak solvent, whereby said small quantities of dissolved deterrent penetrate into the smokeless powder grains to form a uniform deposition thereon which is progressively and uniformly increased as said deterrent material is progressively dissolved, to form a uniform coating of deterrent on the powder grains.

2. In the process of making progressive burning smokeless powder by coating substantially completely colloided smokeless powder grains with a deterrent material, the improvement comprising wetting the smokeless powder grains with an alcohol-water admixture which is a weak solvent for the deterrent material and substantially a non-solvent for the smokeless powder grains, the proportion of said alcohol-water admixture being in the order of 2:1; adding, as the deterrent material, symmetrical diethyldiphenolurea to the wetted smokeless powder grains; and tumbling the mass thus formed and heating sufficiently to progressively and slowly dissolve small quantities of the deterrent material in the weak solvent, whereby said small quantities of dissolved deterrent penetrate into the smokeless powder grains to form a uniform deposition thereon which is progressively and uniformly increased as said deterrent material is progressively dissolved, to form a uniform coating of deterrent on the powder grains.

3. In the process of making progressive burning smokeless powder by coating substantially completely colloided smokeless powder grains with a deterrent material, the improvement comprising wetting the smokeless powder grains with an alcohol-water admixture which is a weak solvent for the deterrent material and substantially a non-solvent for the smokeless powder grains, the proportion of said alcohol-water admixture being in the order of 4:1; adding, as the deterrent material, ethyl ortho benzoyl benzoate to the wetted smokeless powder grains; and tumbling the mass thus formed and heating sufficiently to progressively and slowly dissolve small quantities of the deterrent material in the weak solvent, whereby said small quantities of dissolved deterrent penetrate into the smokeless powder grains to form a uniform deposition thereon which is progressively and uniformly increased as said deterrent material is progressively dissolved, to form a uniform coating of deterrent on the powder grains.

4. In the process of making progressive burning smokeless powder by coating substantially completely colloided smokeless powder grains with a deterrent material, the improvement comprising wetting the smokeless powder grains with an alcohol-water admixture which is a weak solvent for the deterrent material and substantially a non-solvent for the smokeless powder grains, the proportion of said alcohol-water admixture being in the order of 2:1; adding, as the deterrent material, triphenyl phosphate to the wetted smokeless powder grains; and tumbling the mass thus formed and heating sufficiently to progressively and slowly dissolve small quantities of the deterrent material in the weak solvent, whereby said small quantities of dissolved deterrent penetrate into the smokeless powder grains to form a uniform deposition thereon which is progressively and uniformly increased as said deterrent material is progressively dissolved, to form a uniform coating of deterrent on the powder grains.

5. The process of claim 1, wherein the volatile liquid is an ethyl alcohol-water admixture.

6. The process of claim 1, wherein the volatile liquid is an acetone-water admixture.

7. The process of claim 1, wherein the volatile liquid is a dioxane-water admixture.

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