ENERGY REUSE OF OBSOLETE PROPELLANT

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Abstract: Obsolete Propellant is also high macromolecule material with high volume energy density. To reuse the energy, converting obsolete propellant to civilian explosive was studied in this paper,and a kind of perfusion gel explosive was got. In the explosive, obsolete propellant, unnecessary to be crashed, served as reducing agent, ammonium nitrate and sodium nitrate served as oxidant, polyacry lamide served as gelatinizer, little amount of chromium nitrate served as cross linker. In the process, the oxidant water solution, gelatinizer, cross linker were mixed at a certain temperature, then poured into the obsolete propellant to form perfusion gel explosive after gelling, and there are no second pollution. The perfusion gel explosive was tested for its power, brisance, thermal consistency, vibration consistency.

Keywords: obsolete propellant; perfusion explosive

After World War II, because of political and military need, the countries all over the world had stored a large number of weapons and ammunitions. The ammunitions stored would be turned into obsolete after certain storage period. The explosives filled in projectile are the mixture of TNT and RDX or TNT and HMX or explosives and non-explosives. The disposal of this part of explosives at present is that TNT would be reclaimed and the other explosive would be demolished directly. The quantity of the propellant out of date is much more than that of explosives. The propellant, a kind of energy material, contain a large amount of chemical groups as C-NO_2,N-NO_2,O-NO_2, whose fracture energy are more than 240kJ/mol, so the reuse of obsolete propellant is very important under current situation lack of energy.

1. Introduction

There are three kinds of traditional methods to dispose obsolete propellant in big batch:①dumping in international waters;②burying in deep land;③burning in open area. Burning in open area would produce a large amount of high density polluted gas and ignition residue, which can flow with air, rainwater, etc, encroaching on mankind and ecological environment. Developed countries began to ban burning in open area gradually from the middle of the seventies [1]. Some developed countries began to adopt burning in destructor,

that is, burning under the terms of adjusting and controlling, making obsolete propellant fully decomposed and then oxidized fully again. But this approach need a lot of maintenance charge, and will consume certain fuel and electricity energy. In order to make the best use of obsolete propellant without polluting environment, some countries have begun to study on recycling discarded material containing energy, and research on obsolete propellant is the most active. The nitrocellulose retrieved from single-based propellant can serve as raw material of nitro-cotton coatings; the overdue propellant can be used to make high hydroscopicity resin, or serve as assisting fuel of boiler. Regarding the characteristic of burning or exploding rapidly of propellant, it can be turned to special energy sources, of which industry explosive is the best. In China, research of obsolete propellant reused as explosive began in 1986, and had already made great progress now, and make the leading position in the world. Some technique has realized industrialization production.

Militarily propellant has certain shape and size, such as single-hole or porous or floriated granular propellant, single-hole or porous tubular propellant with different length, cricoid propellant and other special shape propellant. Under normal conditions, propellant only can burn, not explode, but, can explode under strong constraint condition (powder grain filled in steel tube) or detonated with strong strength (such as detonated by RDX). So the obsolete propellant can't be used as explosive alone directly. When made to industry explosive, such as water-glue and emulsification-explosive,powdered industry explosive,pappy industry explosive [2,3], propellant is mainly used as sensitizer. In the above technique process, comminuting propellant into powder of certain granularity is very dangerous, and the storage, transportation of the explosive powder is very dangerous, too. In September of 2005, an accident of deflagrating happened when ex-service gunpowder was made to emulsification explosive in the Northeast, causing 3 deaths. The Nanjing university research institute of charge technology has explored a method, perfusion technique, without comminution, of making obsolete propellant into civil explosive, but it is still at experiment explore stage. In this paper, the research of making obsolete 14/7 and 22/1 single-based propellant into perfusion explosive were carried out.

2. Experiment

2.1 Material

14/7, 22/1 single-based propellant; UPVC tube, Inner diameter: 30mm, 50mm, 75mm, length:13cm; nitrate ammonia and cubic niter, weigh ratio of NH_4NO_3:$NaNO_3$:H_2O is 4:1:1 (according to the ternary phase diagrams of NH_4NO_3-$NaNO_3$-H_2O); polyacrylamide macromolecule, serve as absorbent material; cross linker.

Fig. 1 shows the experiment process of making perfusion explosive from single-based propellant:

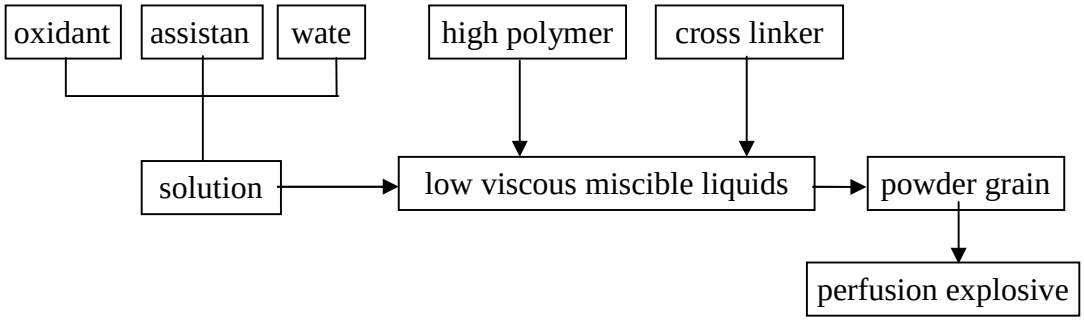

Fig. 1 flowchart of making perfusion explosive

At room temperature, the bottom of UPVC tube was sealed with PVC board. The propellant was filled in UPVC tube in natural state, and the effective porosity of the volume of the UPVC tube is measured with method of filling water. A certain amount of high polymer polyacrylamide and firming agent were added to water solution of solid oxida including ammonia nitrate and cubic niter. Then, mixed high polymer-saline solution was poured slowly into UPVC tube filled with propellant, and the space for detonating charge shoud be left with emplacing a mould at one end of the tube. about an hour later, the mould for detonating charge can be removed, the UPVC tube with perfusion gel explosive can be sealed with PVC board for use.

3. Results and discussion

The compositions of single-based propellant are basically same except for the shape and the size,such as 7/7,9/7,11/7,12/7,13/7,14/7,16/7 and 8/4 single-based propellant, whose main ingredient, about $94\times10^{-2}\sim98\times10^{-2}$, is the same batch of nitrocellulose with nitrogen content between 12.75%～12.97%. As can be seen, single-based propellant has high content of nitrocellulose with high content of nitrogen and comparatively single composition. So, 14/7 and 22/1 single-based propellant were chosen to be made into perfusion civil explosive firstly.

3.1 Test for power and brizance

Making 14/7 and 22/1 single-based propellant into perfusion explosive according to Fig. 1 .The ready-made perfusion gel explosive was detonated with 1# and 2# detonating charge made with a certain of pressure in laboratory, while the detonating ability of 2# is greater than that of 1 #. The explosion ability was tested by lead plate . Tab.1 and Tab.2 show the explosion ability of the perfusion explosive made from 14/7 and 22/1 single-based propellant.

Tab. 1 explosion ability of perfusion explosive from 14/7 single-based propellant

Serial number	UPVC tube inradius/ mm	Porosity/ %	Solidifying time/h	Detonating charge	Detonating ability	Exploding speed/ ($m \cdot s^{-1}$)
1	30	35	48	1#	penetrated	5210
2	30	33	48	1#	penetrated	5137
3	30	34	48	2#	penetrated	5312
4	30	33	48	2#	penetrated	5426
5	50	28	48	1#	deep dint	
6	50	28	48	1#	deep dint	
7	50	26	48	2#	penetrated	5408
8	50	26	48	2#	penetrated	5411
9	75	23	48	1#	undetonated	
10	75	24	48	1#	undetonated	
11	75	24	48	2#	penetrated	5189
12	75	23	48	2#	penetrated	5213

Tab. 2 explosion ability of perfusion explosive from 22/1 single-based propellant

Serial number	UPVC tube inradius/mm	porosity/ %	time of solidifying/ h	detonating charge	Detonating ability	Exploding speed ($/m \cdot s^{-1}$)
1	30	38	48	1#	undetonated	
2	30	37	48	1#	undetonated	
3	30	38	48	2#	penetrated	5245
4	30	38	48	2#	penetrated	5107
5	50	35	48	1#	undetonated	
6	50	34	48	1#	undetonated	
7	50	33	48	2#	deep dint	
8	50	34	48	2#	deep dint	
9	75	32	48	1#	undetonated	
10	75	31	48	1#	undetonated	
11	75	31	48	2#	deep dint	
12	75	30	48	2#	deep dint	

Through the test data in Tab.1 and Tab.2, it can be seen , the perfusion gel explosive made from 14/7 single-based propellant can explode steadily when detonted by 2# detonating charge, and the explosion speed tested is relatively identical, from the date of Tab.1, the charge critical diameter should be smaller than 30mm and its terminal diameter should be greater than 75mm. 1# detonating charge can only detonate perfusion explosive with a diameter smaller than 30mm completely. The detonating ability of 1# detonating charge suppressed in laboratory is greater than that of the detonator, it can be seen that the perfusion explosive made from 14/7 single-based propellant is not sensitive to detonator and it is comparatively safe. The nature of the perfusion explosive made from 22/1 single-based propellant is similar to that made from 14/7 single-based propellant. However, it can be seen from the data in Tab.1 and Tab.2 that the perfusion gel explosive made from 22/1 single-based propellant is less sensitive, because 2# detonating charge can only detonate the perfusion explosive completely with a diameter smaller than 30mm. When the diameter is 50mm or 75mm, 2 # detonating charge can not detonate perfusion explosive. So the perfusion explosive made from 22/1 single-based propellant is safer, and even more difficult to be detonated.

3.2 Test for thermal consistency and vibration consistency

There are much of water astricted by polyacry lamide in the perfusion gel explosive made from obsolete propellant. So the thermal consistency and vibration consistency were tested.

When the perfusion gel explosive were put in 80℃, there are no water lost, when put in 100℃,there are some little lost. As can be guessed that under nomal environment temperature, also the perfusion explosive storage temperature, the thermal consistency is good.

When the perfusion gel explosive were put in tractor traveling about 100km, there are no water lost. And the state of the perfusion explosive is good.

When perfusion explosive explodes, chemical reaction in detonating wave is very fast. The explosion mechanism can be explained by mix reaction mechanism because of complicated components . The perfusion explosive is composed of oxidant, incendiary agent and non- explosive composition, the detonating reaction is not carrying on in the whole chemical reaction area but in some boundaries. While exploding, the gas produced by oxidant decompound permeates or spreads to the surface of other particles to react at first, and the producer of different components react with each other once again. The explosion process of the perfusion explosive researched in this paper is great impacted by the granularity. The littler the granularity is, the more easily the reaction is; while the larger the granularity is, the more unfavorable the reaction is, and the exploding speed may drop even .

4. Conclusions

The perfusion explosive composed of oxidant including ammonium nitrate and cubic niter, polyacrylamideit and obsolete 14/7, 22/1 single-based propellant without comminuting is not sensitive to detonator, but can be detonated by detonate charge of certain ignition ability, and the exploding speed is more than 5000m/s. That means it is possible to use obsolete single-based and double-based propellant to make perfusion explosive without any dangerous and any pollution. The work in this paper is only preliminary experiments. The experiments on others have not been carried out, and stability, compatibility and long storing performance of theperfusion explosive made from14/7, 22/1 single-based propellant need further discussion and research.

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