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THE STUDY OF COMBUSTION PROCESS OF CHEMICAL GAS-GENERATING CATRIDGE (CGC) IN THE COMPOSITION OF AMMONIUM NITRATE AND NANO ALUMINUM COMBUSTIBLE ADDITIVES

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Abstract
The regularities of combustion of pyrotechnic composition depending on the content of nanoaluminum have been studied. Chromatographic analysis for composition №2: AN-NA-DC-Mg was performed. Flash point of pyrotechnic component was determined.

Keywords: pyrotechnics, composites, burning, chromatography

Introduction

In the industry, gas generators are used to increase the yield of oil and gas in the wells, which provides thermal-gas-chemical processing of idled oil and gas wells. In this case, disclosure of fracturing and cleaning of perforated hole from sludge and paraffin in the pipe occur. There are known gas-generating chemical compositions: $NaClO_3$ – oxidizer, liquid hydrocarbons such as kerosene, diesel fuel, gas condensate, secondary industrial and vegetable oils are used as fuel; NH_4NO_3 – oxidizer, nanocarbon – fuel [1].

Lately when extraction of block stone people try to use substances, which create the pressure in the hole due to combustion reaction in deflagration mode, i.e. in the combustion mode or in the low speed detonation mode [2].

Carbon containing nanostructured materials based on mineral and vegetable raw materials are developed at Institute of Combustion Problems [3].

Experimental part

The mixtures were prepared with the different ratio of components: granulated ammonium nitrate (AN), nanoaluminum powder, depleted material (10% bitumen + 90% used oil), dispersed coal (DC), magnesium powder. The components were weighed on electronic balances and thoroughly mixed in a phosphorus mortar. The mixtures were loaded into thick-walled pipe with diameter 1,5 cm and height 22,7 cm. The burning process was initiated from top of pipe with initiator composition (50% Mg + 50% smokeless powder Burning time of mixtures was measured using stopwatch. The burning rate was measured by dividing height of pipe by the burning time.

Flash point of pyrotechnic component was measured using optical pyrometer.

Gases formed in the results of burning of mixtures were determined by using gas chromatography of the brand «Crystal Chromatech 5000».

Results and their discussions

Pyrotechnic gas-generating mixtures based on oxidizer and nano aluminum combustible additives were investigated. Burning rate depending on the content of nanoaluminum was determined. Mixture, №1, mass, %: AN – 94; NA – 0,5; depleted material (10% bitumen + 90% used oil) – 5,5%. Ammonium nitrate is granule, it was not milled. The investigation was carried out 6 times for each obtained result. Then it was chosen the average value. Obtained data are presented in Fig. 1 (Table 1).

Burning rate of investigated pyrotechnic mixture made up from 0,15 to 0,7 mm/sec.

Mixture №2, mass, %: AN – 84,5; NA – 0,5; DC – 10; Mg – 10. Obtained data are shown in Fig. 2 (Table 1). Burning rate of investigated pyrotechnic mixture made up from 0,18 to 0,6 mm/sec.

As is seen in Figs. 1 and 2, the burning rate of mixtures increases with increasing of the content of nano aluninum. While the gas generator is working, the pyrotechnic mixture must burn in a short time. Presented data shown in Table 1 showed that, the optimal mixture for pyrotechnic gas generator are mixture №1: AN – NA – depleted material, because this mixture has high burning rate.

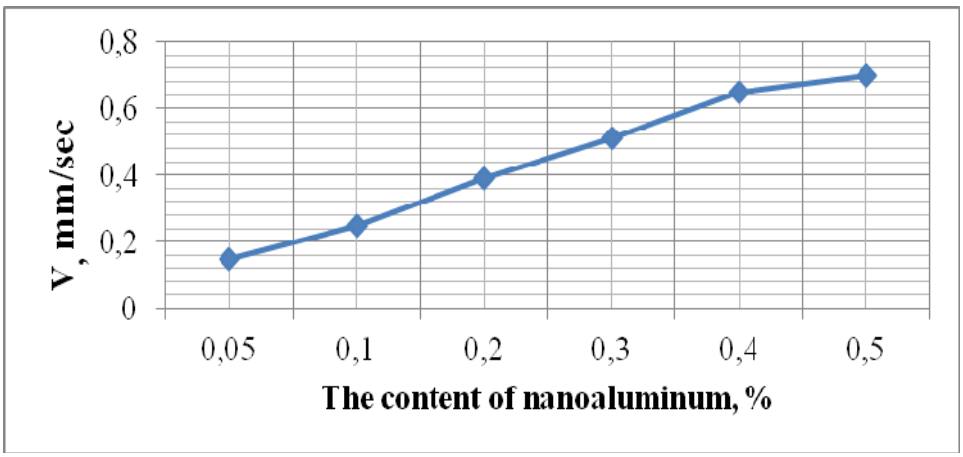


Fig. 1. Dependence of the burning rate on the content of nanoaluminum in the mixture of AN – NA – depleted material

Table 1. Burning rate of mixtures depending on the content of nanoaluminum.

AN – NA – depleted material		AN – HA – DC – Mg	
Content of nanoaluminum, %	Burning rate, mm/sec	Content of nanoaluminum, %	Burning rate, mm/sec
0,05	0,15	0,05	0,18
0,1	0,25	0,1	0,28
0,2	0,39	0,2	0,39
0,3	0,51	0,3	0,44
0,4	0,65	0,4	0,53
0,5	0,7	0,5	0,6

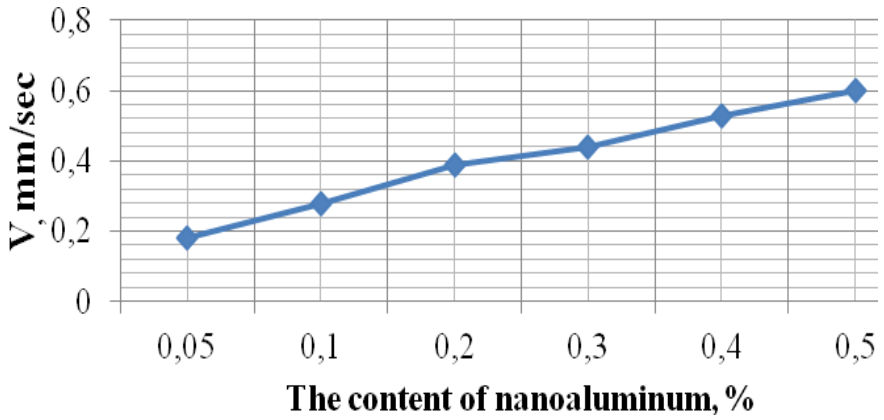


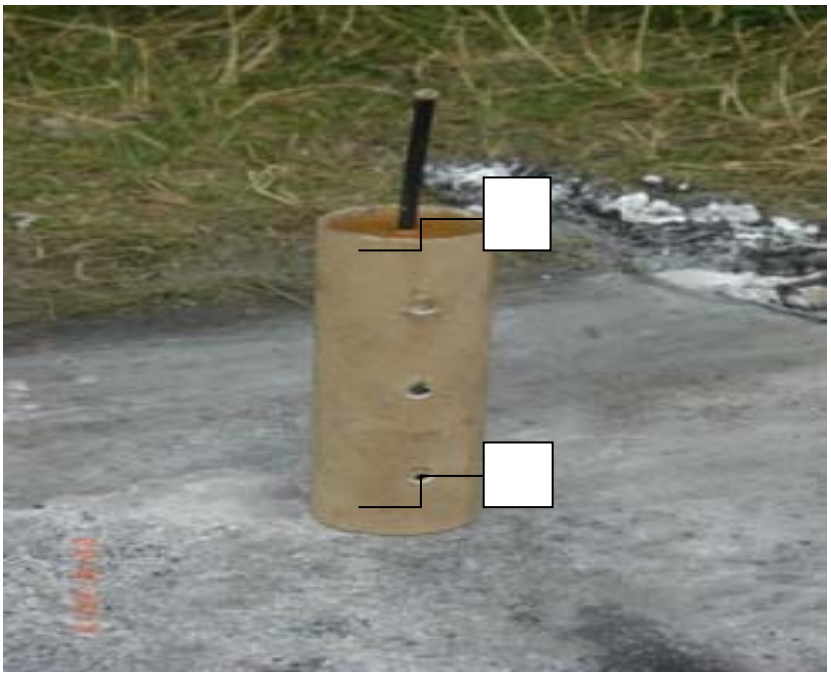
Fig. 2. Dependence of the burning rate on the content of nanoaluminum in the mixture of AN – NA – DC-Mg.

Flash point of pyrotechnic components was measured in the one minute delay of the pyrotechnic mixtures. Results of investigation are shown in Table 2. Flash point of mixture №1 AN – NA – depleted material was measured, it is 351 °C in the one minute delay.

Table 2. Flash point of pyrotechnic components

AN, T °C	Mg, T °C	NA, T °C
338	623	750

Construction of chemical gas generating cartridge are shown in Fig. 3. This construction includes a pyrotechnic mixture and water-resistant latex shell.



1 – safety fuse, 2 – cardboard casing

Fig. 3. Construction of chemical gas generating cartridge.

Chromatographic analysis was carried out for mixture №2: AN – NA – DC – Mg – 10. Gases formed while the gas generator is working include following: methane, ethane, ethylene, propane, isobutane, butane. The amount of formed gases are not so much, as it does not exceed the maximum permissible concentration of harmful substances in the working area.

Gases obtained by blasting in the calorimeter bomb was determined by using gas chromatography. Results of investigation are shown in Table 3, Fig. 4.

As is seen in Table 3 and chromatogram, in the results of investigation, there are not toxic substances in composition of mixture such as carbon monoxide and nitrogen oxides.

Conclusion

In the results of investigation, the pyrotechnic mixture in the composition of oxidizer and nano aluminum combustible additives was obtained. The burning rate of AN – NA – depleted material is 0,7 mm/sec, which corresponds to the requirement of developed chemical gas-generating mixture. Flash point of this mixture is 351 °C in the one minute delay. Flash point of nano aluminum was measured, it is 750 °C. The regularities of combustion of pyrotechnic composition depending on the content of nanoaluminum have been studied. In the results of chromatographic analysis, it was found that there are not toxic substances in the composition of gases such as monoxide and nitrogen oxides.

Table 3. The calculation of the components of chromatographic analysis (AN-DC-NA-Mg)

Time, min.	Component	Area	Height	Concentration	Unit concentration	Amount
3,077	Methane	1304,002	540,155	0,000919	ml	1
3,275	Ethane	133,636	54,276	0,000050	ml	1
3,462	Ethylene	910,782	363,138	0,000384	ml	1
4,188	Propane	5,843	2,200	0,000001	ml	1
4,865	Isobutane	25,923	2,013	0,000004	ml	1
6,250	Butane	589,231	33,290	0,000070	ml	1

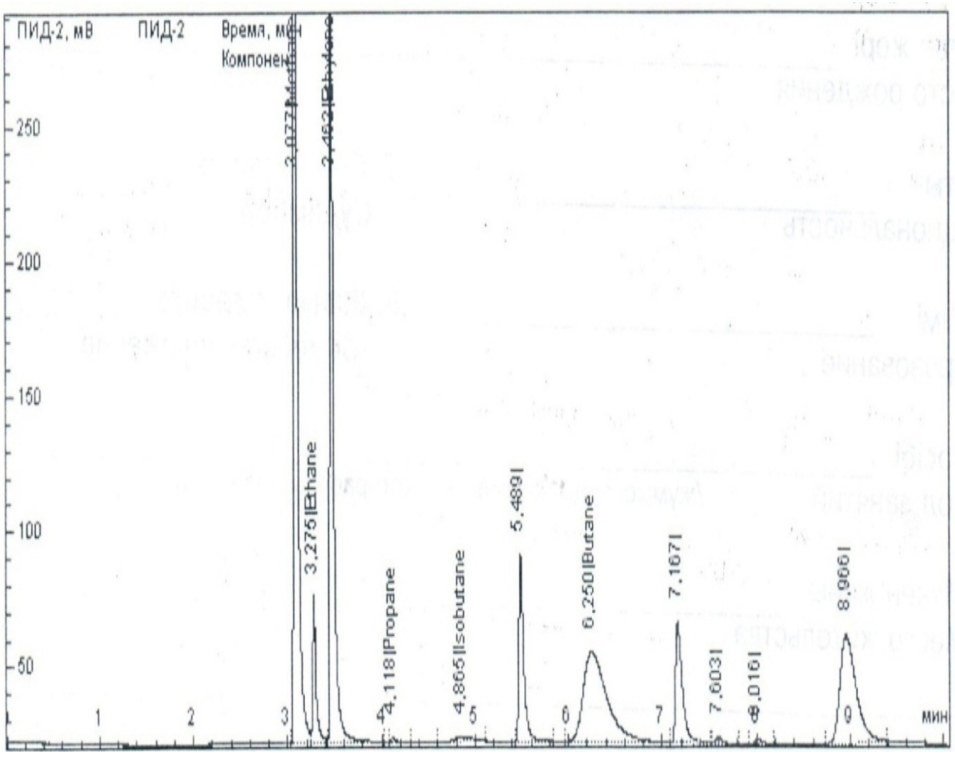


Fig. 4. Chromatogramm of mixture AN- NA-DC-Mg.

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ИССЛЕДОВАНИЕ ПРОЦЕССА СГОРАНИЯ В ХИМИЧЕСКИХ ГАЗОГЕНЕРАТОРНЫХ КАТРИДЖАХ (ГГК) В СОСТАВЕ КОТОРЫХ НИТРАТ АММОНИЯ И НАНОАЛЮМИНИЕВЫЕ ГОРЮЧИЕ ДОБАВКИ

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Аннотация

Были изучены закономерности горения пиротехнического состава в зависимости от содержания наноалюминия. Проводили хроматографический анализ для состава №2: AN-NA-DC-Mg. Была определена температура вспышки пиротехнического компонента.

Ключевые слова: пиротехника, композиты, горение, хроматография

ҚҰРАМЫНДА НАНОАЛЮМИНИЙЛІ ЖАНҒЫШ ҚОСПА ЖӘНЕ АММОНИЙ НИТРАТЫ БАР ХИМИЯЛЫҚ ГАЗОГЕНЕРАТОРЛЫ КАТРИДЖДЕ (ГГК) ЖАНУ ПРОЦЕСІН ЗЕРТТЕУ

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Аннотация
Құрамындағы наноалюминийге байланысты пиротехникалық құрамның жану заңдылықтары зерттелді. №2: AN-NA-DC-Mg құрамы үшін хроматографиялық анализ жүргізілді. Пиротехникалық компоненттің жарқ ету температурасы анықталды.
Түйінді сөздер: пиротехника, композиттер, жағу, хроматография