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Performance Improvement of Modified Single Base Propellant with a Special Compound

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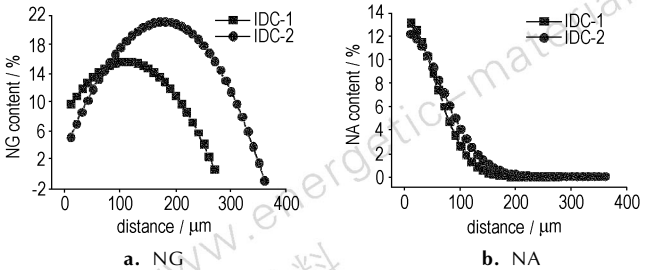
The modified single base propellant is generally prepared from single base propellant grains by impregnation with a blasting oil nitroglycerine (NG), following by deterring with a polyester (NA). In our recent research, the performances of the propellant were improved significantly through adding a special compound at the second step. Samples without and with the compound was denoted as IDC-1 and IDC-2, respectively. The performances of the propellant IDC-2 and IDC-1 was compared as following.

Firstly, the loading density of IDC-2 is enhanced from 0.921 g·cm^{-3} to 0.949 g·cm^{-3}.

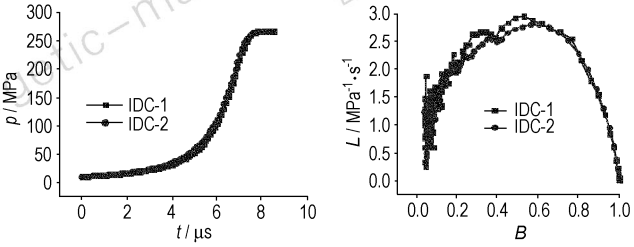
Secondly, the diffusion depth of NG and NA are deeper. The NG and NA concentration profiles are measured by FTIR microspectroscopy (See Fig. 1). From Fig. 1, compared with that of IDC-1, the diffusion depth of NG for IDC-2 increases from 270 μm to 360 μm. The depth corresponding to the maximal value of concentration increases from 110 μm to 180 μm. The diffusion depth of NA for IDC-2 increases from 270 μm to 360 μm.

Thirdly, the sample of IDC-2 burns more progressively. The burning characteristics of two kinds of propellants are tested by the closed vessel and the corresponding curves of *p-t* and *L-B* are obtained (See Fig. 2, Table 1). From Fig. 2, there is not obvious difference between the curves of *p-t* for IDC-1 and IDC-2. However, for the curves of *L-B*, there exist a fast drop for IDC-1 and a slow drop for IDC-2 in the last period. From Table 1, compared with that of IDC-1, the value of p_r for IDC-2 increases from 0.3630 to 0.4450, which shows the better combustion progressive characteristics of IDC-2 than that of IDC-1.



a. NG **b.** NA

Fig. 1 Concentration profiles of NG and NA in two kinds of propellants



a. *p-t* curves **b.** *L-B* curves

Fig. 2 *p-t* Curves and *L-B* curves for two kinds of propellants

Table 1 The values of p_r for two kinds of propellants

sample	L_S	B_S	$L_{0.1}$	$L_{0.3}$	p_r
IDC-1	2.9515	0.5287	1.6710	2.6273	0.3630
IDC-2	2.8053	0.6048	1.4124	2.4003	0.4450

Note: L is the vivacity in closed-bomb test. B is the relative pressure in closed-bomb test. B_s is the B value corresponding to grain splitting. L_s is the L value corresponding to grain splitting, MPa^{-1}·s^{-1}. $L_{0.1}$ is the L value corresponding to $B=0.1$, MPa^{-1}·s^{-1}. $L_{0.3}$ is the L value corresponding to $B=0.3$, MPa^{-1}·s^{-1}. p_r is the progressive index calculated with literature which published in the *Chinese Journal of Explosives & Propellants*, 2009, 32(3): 71-74.

$p_r = B_s \times L_s/(L_{0.1}+L_{0.3})$. $L = \frac{dp_i}{dt}/p_i p_m$. $B = p_i/p_m$. Where p_i is the pressure at time t, p_m is the maximum pressure in closed-bomb test.

Finally, the sample of IDC-2 has better interior ballistics. Two kinds of propellants are tested with 14.5 mm gun firing tests (See Table 2). From Table 2, compared with that of IDC-1, the muzzle velocity of IDC-2 increases 3.1% and the kinetic energy increases 6.3%.

Table 2 Interior ballistic test of two kinds of propellants

sample	propellant mass /g	muzzle velocity /m·s^{-1}	maximum pressure /MPa	increasing of muzzle velocity	increasing of kinetic energy
IDC-1	33.0	1021.6	275.1	–	–
IDC-2	34.0	1053.7	276.4	3.1%	6.3%

Key words: physical chemistry; modified single base propellant; loading density; combustion progressively; muzzle velocity

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