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RDX/HMX Effects on Combustion Performance of Boron-based Fuel-rich Propellant

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RDX/HMX is often used as oxidizer in the propellant to improve the specific impulse and decrease the smoke and erosion of the rocket motor because of its higher specific volume and the lower combustion temperature [1-2]. Boron-based fuel-rich propellant is believed to be the best energy source for the solid rocket ramjet because of the highest energy per unit volume among all the solid propellants[3-4]. But its combustion performance such as the low combustion temperature, eject efficiency and pressure exponent, could not satisfy the requirement of the solid rocket ramjet, so, RDX/HMX is added to increase the pressure exponent of propellant which is benefit for the adjustment of the gas flow rate of the fuel. In this paper, five boron-based fuel-rich propellants containing RDX/HMX were prepared to explore the effect of RDX/HMX on the combustion performance of the boron fuel-rich propellant.

The formulation of the five propellants is shown in Table 1. The burning rate (u,mm · s^{-1}) at 0.2, 0.5, 1, 2, 4 MPa, the explosion heat, the combustion gas generation rate and the combustion temperature were tested, and the results are given in Fig. 1 and Table 2.

From Figure 1, we can see the propellant without RDX or HMX (sample 1#) obey the Vieile combustion rate equation. And HMX increases the burning rate of the propellant at the low pressure of less than 1 MPa, and decreases the burning rate at high pressure of 1 – 4 MPa. And the more HMX is added, the more changes of the burning rate. Different from HMX, RDX make the burning rate increase at the low pressure, while the burning rate at the high pressure stays almost the same.

From Table 2, it is clear that whether HMX or RDX has a little effect on the explosion heat, the combustion temperature and the gas generation of the propellant. HMX can improve the combustion performance of the boron-based fuel-rich propellant in some extent through the increase of the explosion heat, the combustion temperature and the gas generation rate. Different from HMX, RDX decrease the explosion heat and the combustion temperature which is unfavorable to the combustion performance of the propellant.

Although the molecular structure of RDX and HMX is similar, the energy characteristics of HMX is higher than that of RDX which results in the stronger heat feedback of the flame to the propellant that unburned and the higher combustion temperature, so RDX and HMX have different influence on the combustion performance of the born-based fuel-rich propellant.

Table 1 Formulation of the propellants %

sample	HTPB	AP	GFP	B	MA	other
1#	24	33	4	32	7	0
2#	24	30	4	32	7	HMX 3
3#	24	27	4	32	7	HMX 6
4#	24	30	4	32	7	RDX 3
5#	24	27	4	32	7	RDX 6

Note: GFP is catocene; MA is magnesicsm ailuminum alloy.

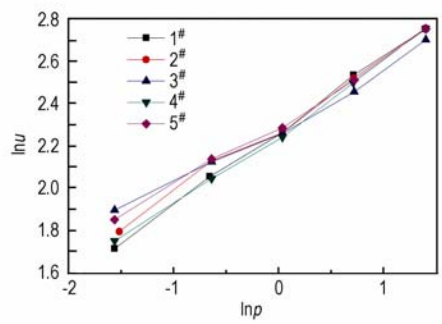

Fig. 1 Burning rates of different propellant sample

Table 2 Combustion parameters of the boron-based fuel-rich propellants

No.	combustion temperature T/℃	explosion heat Q/J · g^{-1}	gas generation rate η/%
1#	1669	4550	29.35
2#	1710	4602	30.13
3#	1722	4616	30.75
4#	1633	4471	29.92
5#	1634	4503	30.06

Key words: physical chemistry; boron-based fuel-rich propellant; RDX; HMX; combustion performance

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References:

[1] Naminosuke Kubota. Combustion mechanisms of nitramine composite propellants[C]// Symposium (International) on Combustion, Pittsburgh, 1981,18(1):187 – 194.

[2] Menke Klaus, Eisele Siegfried. Propellants with Reduced Smoke and High Burning Rates[J]. *Propellants, Explosives, Pyrotechnics*, 1997, 22(3):112 – 119.

[3] LIU Lin-lin, HE Guo-qiang, WANG Ying-hong. Research on the combustion heat testing of the boron with double base propellant as combustion improver[J]. *Solid Rocket Technology*, 2012, 35 (4):513 – 515.

[4] LIU Lin-lin, HE Guo-qiang, WANG Ying-hong. Effect of fuels on primary combustion of boron-based fuel-rich propellant [J]. *Chinese Journal of Energetic Materials(Hanneng Cailiao)*, 2012, 20(4):475 – 478.

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