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The aim of this paper is to compare calculated impulse characteristics of solid-propellant detonation rocket engines with test results. The paper describes the principle of operation and the design of impulse rocket engines that use an explosive as solid propellant. Calculated estimates of the impulse characteristics of solid-propellant detonation rocket engines (SPDREs) with a cord explosive charge are presented. Parameters of energy conversion in the combustion chambers of SPDREs in conditions of their possible use are considered. The isentropic exponent of combustion product expansion is calculated for shock processes. Calculated combustion product exhaust velocities and relative specific impulses for various explosives are presented. The calculations were made for a wide variety of explosives. All the calculated results are original. SPDREs were tested on specially made earth-banked benches. The test engines differed in dimensions, detonating cord placement in different combustion chambers, and nozzle shape and dimensions. The engines had detonating cords of different types and dimensions.

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A model nose cone separation and removal system with a solid-propellant detonation engine was tested. The SPDRE test methods are described. The calculated results agree with the firing test results obtained on the testing ground of the Institute of Technical Mechanics of the National Academy of Sciences of Ukraine and the State Space Agency of Ukraine. The SPDRE energy characteristics calculated and verified by experiment may be used in the design of systems for rocket nose cone separation and removal in the dense atmosphere and in the design of explosive pushers, which are employed for the same purposes and use the same explosives.

Keywords: cord explosive charge, combustion chamber, specific impulse, temperature, explosive.

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	-	-	-	-6	-12
	5,8	5,8	6,1	4,2 ± 0,5	5,0 ± 0,5
	50 ± 0,5;		100 ± 1,0		
	6500			6200	
	12,5 ± 0,5		14 ± 0,5	6,0 ± 0,5	12 ^{+0,5} _{-1,0}
	-				
	-28...+50		-35...+60		-50...+65

1, -12 -
 . 2 [2].

2 - [2]

	-		/	/
227	$4 \text{ C}_3 - (\text{N}_2) =$ $= 12 \text{ C}_2 + 10 \text{ C}_2 + 6\text{N}_2 + \text{O}_2$	6535	715	
152	$2 \text{ C}_4 (\text{NO}_2)_2 =$ $= 2 \text{ C}_2 + 2 \text{ C}_2 + \text{N}_2$	7120	738	
227	$2 \text{ C}_2 (\text{NO}_2)_3 =$ $= 5 \text{ C}_2 + 7 \text{ C}_2 + 7 \text{ C}_2 + 3\text{N}_2$	3455	750	
80	$2\text{N}_4\text{N} = 4 \text{ C}_2 + 2\text{N}_2 + \text{C}_2$	1425	980	
218	$10 \text{ C}_6 (\text{N}_2)_2 = \text{C}_2 + \text{C}_2 + \text{N}_2 + 9$	2500	750	
1053	$22,5 \text{ C}_{28,8} 36,1\text{N}_{8,7} =$ $= 14,4 \text{ C}_2 + 21,7 \text{ C}_2 + 0,8 \text{ C}_2 + 4,35\text{N}_2$	3395	936	
222	$3 \text{ C}_6\text{N}_6 = \text{C}_2 + 3\text{CO} + 3\text{N}_2$	5700	890	
316	$5 \text{ C}_8 (\text{N}_2)_4 =$ $= 4 \text{ C}_2 + \text{C}_2 + 2 \text{ C}_2 + 2\text{N}_2$	5950	790	
287	$2 \text{ C}_6 6 (\text{N}_2)_4 = 3\text{N} =$ $= 5 \text{ C}_2 + 6 \text{ C}_2 + 8 \text{ C}_2 + 5\text{N}_2$	4870	740	
-	$(\text{NO}_2)_4 = \text{C}_2 + 2\text{N}_2 + 2\text{NO}$	-	-	

[3].

$$\Delta Q = T \cdot \Delta S, \quad (1)$$

$T -$; $S -$. 2.

$$P = 295/330 = 0,89 \quad (4)$$

$0,0822, P -$
 $P = 10,82$.

n ,
 $y_t, 0,7 - 0,8 [5],$
 $n = 2.$ n

$$y_t = 1 - (P/P)^{\frac{n-1}{n}} \quad (2)$$

) [4]

$$m = \sum m_i = 0,6, \quad (3)$$

$m_i -$

$$T \approx 8,69 (\cdot) / .$$

$$m \cdot \Delta Q = E -$$

$$\sqrt{2 \cdot E} = \check{S} -$$

$$\check{S} / g = I -$$

$$g -$$

. 3.

[4],

	m_i	0	I	\check{S}
	116	1281,19	201,8	1980,0
	84	1003,11	210,68	2066,8
	74	916,21	146,76	1439,79
-	78	950,97	94,25	924,66
	74	916,21	124,84	1224,7
	74	916,21	145,48	1427,23
	68	864,07	188,51	1849,32
	106	1194,29	192,6	1889,44
	74	916,21	174,24	1709,3
	114	1263,81		

8,69 () / , .3.

[6]

$$\check{S} = \sqrt{\frac{2n}{n-1} RT_{\kappa} [1 - (P_a / P_{\kappa})^{\frac{n-1}{n}}]}, \quad (4)$$

$$R = 8,32 \cdot 10^3 \text{ (} \dots \text{)} - \dots$$

$$I \cdot y_t = 192,6 \cdot 0,8 = 154,08$$

$$I = 154,08 \cdot \sqrt{2} = 218$$

[7].

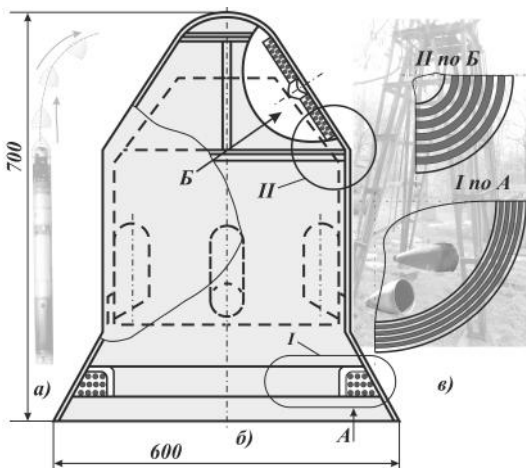


. 1 -

200

(6196-78), - (6196-78), -200 (84-711-83), -12
 $d \approx 5,5$,
 $u \approx 0,6$, = (6200 ÷ 6500) / .

(1:5) « » [8],
 (. 2)



(6196-78).

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.2-

$$I = (120 - 150) ,$$

[8].

1. ,1972. 364 . -
2. ,1980. 392 . -
3. 3- -
4. ,1969. 824 . -
5. 2. 2002. . 64-70. -
6. : 1983. . 59. -
7. : ,1990. 292 . -
8. 2016. 1. . 34-45. -
8. 27354 . / () ; 3143488/40-23; 15.05.1986. -

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