НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ ТОМСКИЙ ГОСУДАРСТВЕННЫЙ УНИВЕРСИТЕТ

РОССИЙСКИЙ ФОНД ФУНДАМЕНТАЛЬНЫХ ИССЛЕДОВАНИЙ

ИНСТИТУТ ПРОБЛЕМ ХИМИКО-ЭНЕРГЕТИЧЕСКИХ ТЕХНОЛОГИЙ СО РАН

АО «ФЕДЕРАЛЬНЫЙ НАУЧНО-ПРОИЗВОДСТВЕННЫЙ ЦЕНТР «АЛТАЙ»

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НАУЧНО-ИССЛЕДОВАТЕЛЬСКИЙ ИНСТИТУТ ФАРМАКОЛОГИИ И РЕГЕНЕРАТИВНОЙ МЕДИЦИНЫ ИМЕНИ Е.Д. ГОЛЬДБЕРГА

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IMPROVEMENT OF PROJECTILE MUZZLE VELOCITY AT USING A TWO-SEGMENT TRAVELLING CHARGE

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Increasing the muzzle velocity of the projectile is one of the main tasks internal ballistic design, and one of the ways of its solutions, as described in the literature [1], is the use of the travelling charge (TC).

The purpose of this work was to determine the combustion laws of plastisol propellants used as a two-segment TC directly inside the projectile in experiments on a model ballistic installation with a caliber of 30 mm. Calculation of the maximum possible velocities of the projectile and the necessary shot configuration, which were determined by parametric studies with a fixed mass of the projectile + TC assembly.

To investigate the throwing scheme mentioned above, a mathematical model [2] developed in the 70th department at the RIAMM TSU was used.

In the course of the work, model experiments were conducted on the 30 mm ballistic installation at the RIAMM TSU. A model projectile was used as a throwing element. In experiments, the projectile muzzle velocity was measured by a velocity sensor, the maximum value of the pressure in the chamber was measured by the pressure sensor and the projectile velocity in the barrel was measured by the microwave radar.

To perform the work using [2] experiment conducted on 30mm Ballistic installation according to the shot classical scheme, where the projectile is accelerated only at the expense of powder (Fig. 1) was calculated to determine a shot-start pressure, initial velocity of powder combustion and the friction coefficient as matching parameters. That is, a series of calculations was carried out, where these parameters varied within a certain range in order to achieve the best agreement between the calculated and experimental data. These parameters were used to calculate the experiments for a non-traditional shot scheme with TC.

Calculations of experiments with a single-segment TC which is located directly in the projectile cavity (Fig. 2) were made in the same way [2].

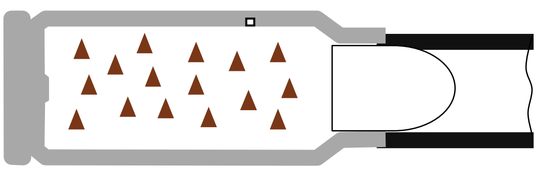


Fig. 1. The general scheme of charging chamber with the powder charge

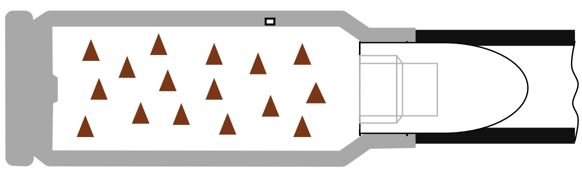


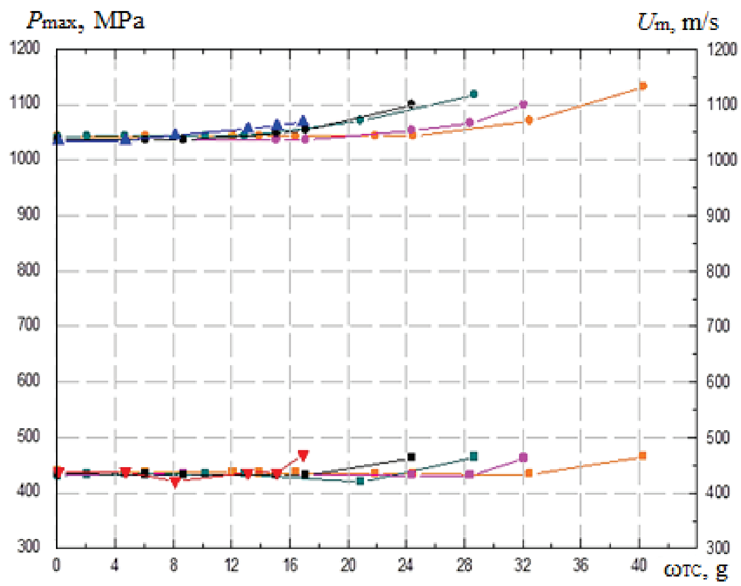
Fig. 2. Schematic representation of the projectile with the TC inside

From the experiments with single-segment TC, the parameters of the combustion laws of two different plastisol propellant (PP) were determined as the matching parameters. These combustion laws were used to calculate [2] shots with the two PP in the two-segment TC. In the projectile, they were located one after another: first, the PP-1 and then PP-2 were burned.

Based on the comparison with experimental data laws combustion of these PP were refined for their joint use and further study.

It is known that the muzzle velocity of the projectile is affected by the mass of the nominal charge in the chamber and the mass of the travelling. It is believed that the greater the mass of the charge, the higher the muzzle velocity of the projectile. But since for each installation there is a limit to the permissible maximum pressures, it need to know exactly how much can be increased the mass of the powder or PP, how can be changed the PP ratio, and what the maximum velocity can be obtained in this case. Initially, the influence of the amount of powder in the case on the projectile muzzle velocity was investigated. By increasing in the powder mass, the pressure in the case increased, which led to an increase the projectile velocity. After this, the ratio of plastisol propellant inside the projectile changed, the cavity size and the mass of the throwing assembly remained unchanged. And in the end, the cavity inside the projectile increased, which made it possible to add more TC.

All the dependences of the projectile muzzle velocity and the maximum pressure in the chamber on the ratio of the PP are reflected in Fig. 3. The maximum velocity of 1131.74 m/s at a maximum pressure of 465 MPa was obtained with the extension of the cavity wide part by 4 cm. As the TC, 0.1 g of PP-1 and 40.32 g of PP-2 were used, and as the charge in the chamber of 125 g powder. The muzzle velocity of the projectile was increased by 16.68 % relative to the value obtained in the experiment.



–▼– – P; –▲– – U_m; 2 cm, wide part 2 cm, narrow part
–■– – P(2 cm, narrow part); –●– – U_m(2 cm, narrow part);
–■– – P(4 cm, narrow part); –●– – U_m (4 cm, narrow part);
–■– – P(2 cm, wide part); –●– – U_m(2 cm, wide part);
–■– – P(4 cm, wide part); –●– – U_m (4 cm, wide part);

Fig. 3. Dependences of the maximum pressure in the chamber and the muzzle velocity of the projectile from the increase in the mass of TC

Main results of the work:

1. The analysis and the "processing" of the experimental data to determine the parameters of the mathematical model based on the comparison of the experimental and theoretical data.

2. For PP-1 and PP-2 plastisol propellants in the 30-mm caliber installation, the muzzle velocity of the projectile could be increased by 10.2% with the given burning surface and by 16.7% with the change in the combustion surface in the pressure range up to 600 MPa.

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ИССЛЕДОВАНИЕ ФИЗИКО-МЕХАНИЧЕСКИХ СВОЙСТВ ЛИСТОВОГО КОНСТРУКЦИОННОГО АЛЮМИНИЕВОГО СПЛАВА 1565

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Алюминиевый сплав 1565 (химический состав: 91,62 масс.% Al – 5,34 масс.% Mg – 1,05 масс.% Mn – 0,56 масс.%, < 1,43 другие примеси) применяется в судостроении, производстве цистерн, емкостей, конструкций ответственного машиностроения. Этот сплав получил широкое распространение за отличную коррозионную стойкость даже в условиях работы в морской воде и высокие показатели прочности, превышающие свойства многих известных алюминиевых сплавов. Современные справочники свойств материалов находятся в легком доступе, но до сих пор не обладают полной информацией о свойствах материала. Так большинство листовых сплавов, подверженных технологии прокатки на стадии производства обладают анизотропией механических свойств, в том числе в области пластического течения [1]. В частности, учет анизотропии свойств при проектировании конструкций и условий их производства необходимо учитывать на стадии компьютерного моделирования. Целью данной работы было исследование физико-механических свойств листового сплава 1565 и обнаружение их анизотропии, относительно направлениям прокатки.