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# Experimental Assessment of Primer Pressure in 9 mm Pistol Ammunition

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**Abstract.** In theoretical simulations of internal ballistics phenomena, the value of pressure generated by the ignition system is required. Typically, the ignition pressure value is assumed to be 3 - 5 MPa. The work presents a measurement stand using a "micro closed vessel", designed to determine the ignition pressure for 9 mm pistol ammunition. Pressure measurements were made for two types of ammunition, differing in the construction of the ignition system. The results of measurements indicate that the value of the ignition pressure is twice as high as usually assumed. In addition, the mass of the ignition charge was determined, which is used in selected models of internal ballistics. The mass value was at the level of 0.02 g.
**Keywords:** closed vessel test, ignition pressure, ignition charge mass

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## 1. INTRODUCTION

The value of pressure produced by a primer is one of the input parameters used in the theoretical models of interior ballistics [1, 2]. This parameter strongly influences the propellant burning rate in the first phase of the combustion process.

In the available literature there is a lack of data on the initial conditions used in internal ballistics models. The most commonly used values of the ignition pressure are on the level of 3 - 5 MPa [1, 3]. In paper [4], the parameters on the blast wave front, generated by explosive material included in the primer, were investigated. According to the obtained results, the pressure reaches the value of approx. 3 MPa. The publication [5] presents pressure values generated by the primer in an empty, closed case. Here, the values of several MPa (c.a. 5 - 6 MPa) were also obtained. However, it seems that the use of this value in internal ballistics models may result in an erroneous assessment of the pressure course and the course of combustion in the initial phase of the shot process. The loading conditions for pistol round are significantly different from the conditions of the conducted tests. High value of the loading density, results in small value of free volume for the igniter gases. Consequently, it may cause a noticeable increase in the ignition pressure in comparison with previously conducted investigations. In experiments described in this work we tried to take it into account and to obtain a more realistic assessment of the ignition pressure value.

## 2. EXPERIMENTAL STAND AND RESULTS

To estimate the gas pressure produced by the primer, a so called “micro closed vessel”, adjusted to the investigated ammunition (case), was used. Scheme of the applied device is shown in Fig. 1. The device consists of the following elements: stopper with firing device, vessel, pressure transducer and case. The measurement stand is supplemented by a charge amplifier and a personal computer, equipped with the analog – digital converter. The measurement chain is presented in Fig. 2. The propellant presence was simulated by a metal cylinder, having the same volume as the propellant in conditions of a shot. The measurements were conducted for two variants of 9 mm FMJ Parabellum rounds, produced by two producers – MESKO S.A. (Poland) and Sellier & Bellot (Czech Republic). For each type of case, 5 tests were conducted. Representative, limit courses of pressure in the case as the function of time, are shown in Fig. 3.

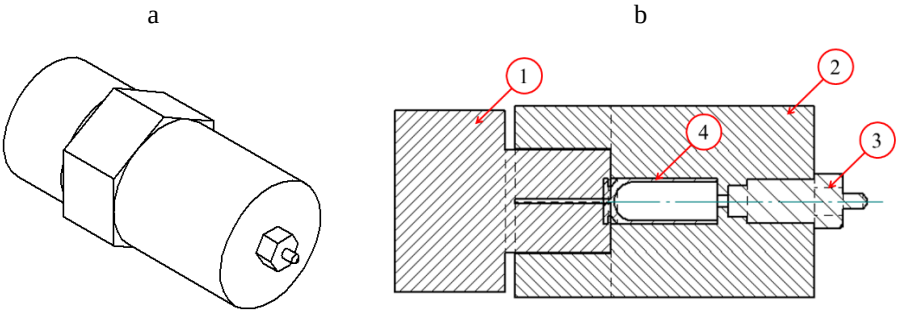


Fig. 1. The scheme of micro closed vessel: 1 – stopper with firing device; 2 – vessel; 3 – pressure transducer; 4 – case

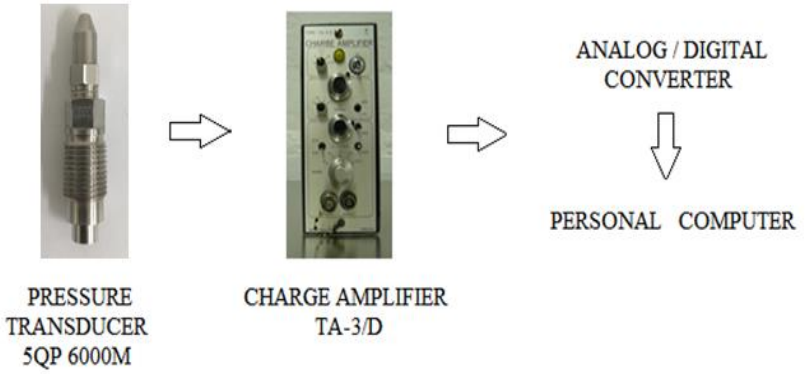


Fig. 2. The measurement chain for experimental stand

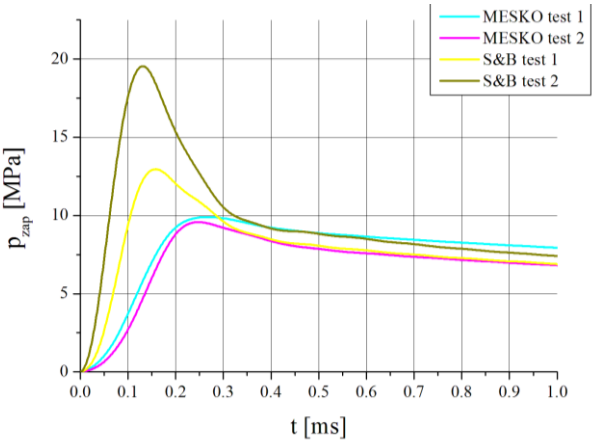


Fig. 3. The courses of pressure generated by the primers in the micro closed vessel

As it is shown in the figure, there is a serious difference between pressure courses for both rounds. Hypothetically, the main reason of the observed discrepancy, is the location of the firing channels (orifices in the bottom of the case). In case of S&B, the one centrally located orifice is present (Fig. 4). This orifice was approximately concentric with the metal cylinder imitating the propellant. In this case, the shock wave generated by the detonation of explosive included in the igniter, directly impacts the pressure transducer, which causes a visible peak of the pressure. In the case of MESKO round, two firing channels, characterized by a smaller diameter, are present. This solution "smooths" the front of the shock wave and it additionally causes interaction between gases and the metal cylinder.

Fig. 4. Firing channels of two investigated cases (left – S&B, right – MESKO S.A.)

During conducted investigations, the mass of the primer explosive was estimated. To obtain reliable data, the mean value of 7 primers for 9 mm ammunition was calculated. As a result, the value of 0.021 ± 0.002 g was evaluated.

## 3. CONCLUSIONS

The conducted investigations were focused on the estimation of pressure generated by the primer in the conditions of a pistol round. The measurements revealed that the value of the ignition pressure is approximately equal to 10 MPa, which is twice as high as usually assumed one. Additionally, the ignition charge mass was assessed. In this case, the value of approx. 0.02 g was obtained.

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# Eksperymentalna ocena wartości ciśnienia zapłonu 9 mm amunicji pistoletowej

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**Streszczenie.** W symulacjach zjawisk balistyki wewnętrznej układów miotających wymagana jest znajomość wartości ciśnienia wytwarzanego przez układ zapłonowy. Wartość ta jest istotna z punktu widzenia opisu procesu spalania materiału miotającego w początkowej fazie strzału, co wynika z znaczącego wpływu ciśnienia gazów prochowych na szybkość spalania materiału miotającego. Ten fakt z kolei przekłada się na maksymalną wartość ciśnienia w przestrzeni zapociskowej. Zazwyczaj przyjmowaną wartością ciśnienia zapłonu jest wartość na poziomie 3 – 5 MPa. Niestety w dostępnej literaturze uwidacznia się brak oszacowań wartości ciśnienia generowanego przez spłonkę amunicji strzeleckiej. Biorąc pod uwagę ten fakt, w pracy przedstawiono stanowisko pomiarowe, wykorzystujące mikrokomorę manometryczną, przeznaczone do pomiaru ciśnienia zapłonu dla 9 mm amunicji pistoletowej. Dokonano pomiarów ciśnienia dla dwóch rodzajów amunicji, różniących się budową układu zapłonowego. Otrzymane rezultaty wskazują, że wartość ciśnienia zapłonu jest dwukrotnie wyższa niż zazwyczaj przyjmowana. Ponadto określono masę ładunku inicjującego, która wykorzystywana jest w wybranych modelach balistyki wewnętrznej. Wartość masy kształtowała się na poziomie 0,02 g.
**Słowa kluczowe:** badania pirostatyczne, ciśnienie zapłonu, masa materiału inicjującego