Central European Journal of Energetic Materials, **2009**, *6*(2), 211-216.
ISSN 1733-7178

The Reacting of Gun Shot Residues in the Dependence on the Gun Barrel Lenght

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Abstract: Currently, the study of gun shot residues constitutes a wide and a very interesting problem as from the shooter´s view so as from the design enginneers´ view and furthermore possibilities, which influence the conditions of the products formation process. Currently, one direction of the investigation of gun shot residues proceeds the study of morphology and thereby even possibilities of improvement of firm particles and further physical conditions, which influence for instance on their stability in the surveyed environment or scatter particles. This problem is investigated by research police institutes above all. The detection of the shot place from the specific cartridge of a concrete weapon is the objective of their investigation. The lay formation of gaseous gun shot residues and their possible toxicity is interesting from the gunner´s view. We have been dealing with this problem for 5 years. This research paper is intented the problem of the dependence of composition of gaseous gun shot residues on the gun barrel lenght.

Keywords: gun shot residues, ammunition, analysis

Introduction

The definition, formation and factors influencing the quality of gun shot residues

Gun shot residues are defined as particulars, which arise during a combustion of an ignition composition and a propellant. These products interact each other in the shot process depending on the pressure and the temperature. Other components (for instance binders of ignitation compositions, a painting of

the surface primers, surface finishes of cartridge components, a hermetical cartridge design, eventually also lubricating stuffs from the industrial process of components) affect the process of formation of gun shot residues. Gaseous products, firm particles from the burned ignition composition and further unburned and partly burned particles of the propellant and as well as particles, which arose with the abrasive wear bullet rise during the shot. These products after the shot, mainly in the gaseous state, escape from the weapon with the gun barrel, the weapon close and leakages and they form a drift of gun shot residues in the surrounding of the weapon [1]. The behaviour of gun shot residues during the shot and emission in the environment while the shot from the gun barrel is shown in the Figure 1 [2].

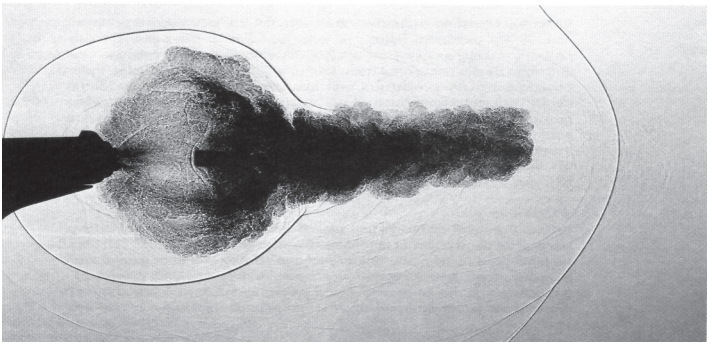

Figure 1. The convection around the gunpoint influx [2].

An important factor, which influences on the final composition of gun shot residues, is the pressure in the magazine and the gun barrel, as it was already noted in the previous clause, where it frequents to reacting of starting compounds. The composition of dissociative products is not standing and constant for the existing kind of the propellant. The pressure in the gun barrel is closely connected with the energy content, the quality of the propellant, the process period and with the ignition.

Poppenberg and Stephan engaged in the dependence of the pressure and the temperature on the bullet trajectory, found out, that the content of carbon dioxide and methan in dissociative products increase with an increasing pressure and the content of carbon oxide and hydrogen with decreases. Further they remarked, that the pressure interacts with the system much more than the temperature and thereby the content of carbon dioxide increases and the content of carbon oxide decreases while movement of the bullet in the chose [3].

The quality of gun shot residues is affected by following factors [4]:

- the character and the quality used while producing cartridges,
- the propellant type, its composition, the surface treatment, the propellant quantity in the cartridge,
- the ignition composition type and the quality of ignition,
- the inside conformation of the cartridge case and the bullet pull,
- the projectile weight and the material of the bullet jacket,
- the hermatical cartridge design (used paints, asphalts),
- the used weapon (the calibre, the gun barrel lenght, the wearing and the weapon design),
- the shooting mode,
- the cleaning of the weapon and used cleaning materials.

The distribution of gun shot residues in the surrounding of the shooter

Generally it is proved, that the biggest settlement of firm and liquid gun shot residues sets in the direction from the shooting weapon from 0.5 to 6 metres. Considerably the sedimentation rate of gun shot residues differs in the dependence on the particle size and the material, the kind of used cartridge and the weapon in special publications. Currently, the research lines proceed, to engage with the problems of the settlement, the distribution and the time dependence of gun shot residues in the environment [5].

The distribution of gaseous gun shot residues passes off as folows: a ball formation on gun shot residues establise (when the shot) in front of the chose (from 15 to 30 centimetres), which swirland and expand into all directions. The products expand into the distance of 1.5 metres for one minute. Especially this behaviour is important from the viewpoint of the gunner and the solution of the workplace of closed shooting ranges [6]. The behaviour of gun shot residues in the environment is pictured in the following Figure 2.

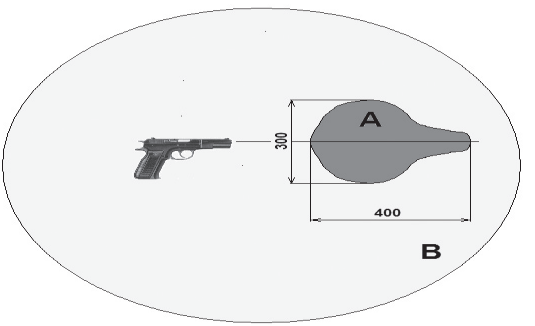

Figure 2. The behaviour of gun shot residues in the environment.

Materials and Methods

This research paper is an initial proceeding in the investigation of the problems of the quality dependence of gaseous gun shot residues on the gun barrel lenght, the actual pressure changes in the gun barrel and other influences pertinent to the construction of cartridges.

The setup for the measurement of gaseous gun shot residues, the measurement principle and used samples of the cartridge 9x19 mm Luger

The check principle of the dependence of the gun barrel on the quality of gun shot residues consisted in the use of four weapons for the cartridge 9x19 mm Luger with various gun barrel lenght. Following weapons were used for the measurement, see the Table 1.

Table 1. Used weapons

The marking of the weapon	The gun barrel lenght [mm]
UZ-NATO	200
CZ 75	120
COMPACT	98.5
HK	95

The setup for the measurement of gun shot residues consists of the used weapon and the chamber, which is made of stainless steel. There are three draws of pipes for the interposition probe on the upside of the chamber. There is special material on the base of plastic in the backside of the chamber. After the penetration through this material the opening after the cartridge is closed at once and gun shot residues cannot escape. The schematic setup drawing, see Figure 3.

This chamber was proved in previous works and the acquired results were published at some conferences. A wide database of results was gained with the measurement for the cartridge 9x19 mm Luger with various combinations of an ignition type, a propellant, a construction of the bullet etc.

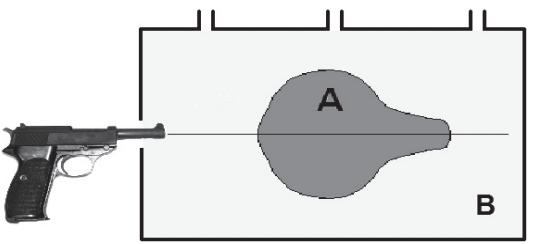

Figure 3. The schematic setup drawing.

Two samples of the cartridge 9x19 mm Luger with a single base propellant and a double base propellant (the producer Explosia, a.s., Pardubice), the cartridge total full metal jacketed (TFMJ) (weight 7.5 gram) and the primer NONTOX (the producer Sellier&Bellot, a.s., Vlašim) were prepared for the obtaining basic information about proposed results direction (the quality of gun shot residues in the dependence on the gun barrel lenght).

Equipments and methods of assessment of individual investigated substances (total content of organic carbon (TOC), CO, NO_x) were used for the measurement of gun shot residues as in previous works.

Results and Discussion

It is noticeable from primary results (Tables 2 and 3), that there is the dependence between the gun barrel lenght and the composition of gun shot residues, let as say between the pressure dependence and their reacting in the gun barrel.

Table 2. Measuring values of substance CO, NO_x, TOC

The marking of the weapon	Sample 1 (a double base propellant [w= 0.395g], the primer NONTOX)			Sample 2 (a single base propellant [w= 0.345g], the primer NONTOX)		
	(c±Δc) CO (ppm)	(c±Δc) NO_x (ppm)	(c±Δc) TOC (ppm)	(c±Δc) CO (ppm)	(c±Δc) NO_x (ppm)	(c±Δc) TOC (ppm)
UZ-NATO	2304±112	40±3	124±25	2052±160	18±3	74±28
CZ 75	2187±136	39±6	76±48	2059±105	18±3	16±7
COMPACT	2226±127	35±3	20±6	2049±140	18±2	7±1
HK	2288±122	33±4	10±1	2174±145	17±2	6±1

Table 3. Recounted values of substance at 0.1 gram propellant

The marking of the weapon	Sample 1			Sample 2		
	(c±Δc) CO (ppm)	(c±Δc) NO_x (ppm)	(c±Δc) TOC (ppm)	(c±Δc) CO (ppm)	(c±Δc) NO_x (ppm)	(c±Δc) TOC (ppm)
UZ-NATO	583±28	10±1	31±6	595±46	5±1	21±8
CZ 75	554±34	10±2	3±12	597±30	5±1	5±0
COMPACT	564±32	9±1	5±2	594±41	5±1	2±0
HK	579±31	8±1	3±0	630±42	5±1	2±0

It is noticeable from tables that carbon oxide does not prove this dependence markedly, however when the appreciation of the quantity values of TOC, it is evident, that carbon oxide, pyrolysis propellant products from the ignition composition and organic products react on the resulting products − carbon dioxide.

It is obvious from primary performed measurements, that the pressure of gun shot residues in the gun barrel takes an important part in the final product composition. A special gun barrel lenght 500 mm with a magazine for the cartridge 9x19 mm Luger will be produced for the clearing of supposed dependence and required points for the measurement of the pressure in the magazine and on the own gun barrel. The gun barrel will always be reduced for 100 mm after the final measurement test of cartridge samples. The pressure course by means of a few probes in the dependence on the time and at the same time the quality and the quantity of chosen substance for every gun barrel lenght will be measured.

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