mł. asp. mgr inż. Rafał Kotapka
ekspert badań broni i balistyki LK KWP w Olsztynie
mgr inż. *Henryk Juszczyk*
ekspert badań broni i balistyki CLKP

Comparison of characteristics of bullets fired from home-made and commercially manufactured guns

Introduction and aim

The shooting incidents very often involve the use of home-converted shotguns produced on the basis of air shotguns. The purpose of the study was to measure and compare the characteristics of bullets fired from commercially manufactured guns and from home-made guns converted from commercially manufactured guns. The examination item involved cal. 22 home-made shotgun based on HATSAN model 60 cal. 5.5 mm shotgun, which is commonly available on the market. The examined gun was adapted to fire cartridge of cal. 22 long rifle rimfire and DIABOLO cal. 5.5 bullets with use of signal cartridge of cal. 22 long rifle rimfire. The examiners utilized CZ model 2 cal. 22 long rifle as a commercially manufactured gun.

Home converted HATSAN model 60 cal. 5.5. mm air shotgun

Due to its construction HATSAN model 60 cal. 5.5 mm air shotgun can be easily adapted to fire the cartridge of cal. 22 long rifle rimfire. Fig. 1 shows cal. 22 home-made shotgun based on HATSAN model 60 cal. 5.5 mm air shotgun. It is equipped with 4 x 40 HAKKO rifle scope, which was manufactured in Finland.

The following home-made transformations were introduced to the examined air shotgun:

- a cartridge chamber was constructed from the side of the barrel inlet,
- home-made firing pin was fixed on the front of air piston.

In order to construct a cartridge chamber, the barrel of air shotgun was drilled with 6 mm diameter drill bit on 20 mm lengths. The back of the barrel was filed so that the barrel could be locked when the cartridge is loaded into the chamber. Consequently, it was possible to load long rifle cartridges of different manufacturers into a cartridge chamber.

In order to determine the parameters of barrel bore of transformed air shotgun, the replica of barrel bore fragment was made with Mikrosil silicone (Fig. 4.). This replica was examined with MST 131 stereoscopic microscope equipped with MOZ–07VIS adapter for precise measurement, in order to determine the rifling direction as well as the number and depth of lands. The results of examination indicated that the transformed HATSAN model 60 cal. 5.5 mm air shotgun has right twist rifling with twelve lands and grooves. The width of lands is contained between 0,97 mm and 1,14 mm, where as the depth of grooves – in 0,07–0,13 mm range.

The piston of the commercially manufactured HATSAN air shotgun consists of a piston core with plastic gasket on its external surface and pilot sleeve with a catch. In order to construct a striking mechanism, a gasket was taken off, the front surface of piston was filed and gasket seat was removed. Subsequently, the seat of firing pin was produced in the piston core by drilling a 2,5 mm diameter hole, which was rifled. A fragment of steel nail was utilized to create the firing pin, which was also rifled at its end. The firing pin was driven into the hole in the piston core. In order to prevent the piston core from spinning around the pilot sleeve, a 3 mm diameter hole was drilled at the point of their connection. Then a brass bolt was fixed in the hole. This operation was essential as otherwise the spinning piston core could damage the firing pin. Additionally, the front surface of nipple was equipped with a 'shock-absorber', made from a leather belt in order to reduce the striking force of released nipple.

The external surface of a barrel outlet of commercially manufactured air shotgun has a plastic muzzle with a protective shield, which also protects the barrel outlet. In order to improve the visibility of a target the front sight and a fragment of protective shield were removed and the remaining part of the shield was adapted to perform the function of protective shield of beveled edge of barrel outlet.

The examination allowed to conclude that shotgun mechanism is in a good operation condition and it is capable of firing cartridge of cal. 22 long rifle rimfire as well as DIABOLO cal. 5.5 bullet with use of signal cartridge of cal. 22 long rifle rimfire. During the test firing of HATSAN air shotgun, the bullets were able to penetrate a wooden bullet trapper.

CZ model 2 cal. 22 long rifle

CZ model 2 cal. 22 long rifle is a repeating bold action rifle with the open-view of front and rear sight (Fig. 8.). The whole rifle is 1085 mm long with 2,9 kg mass (without a rifle scope). CZ model 2 has a 630 mm long rifled barrel. Metal components of this shotgun are oxidized. The magazine can contain up to 5 cartridges. The upper surface of the receiver bears a milled bar of the rifle scope, which is 16 mm wide. CZ model 2 has lower handguard made of varnish wood adapted to right-handed shooters. The butt stock is ended with a plastic buttplate.

In order to determine barrel bore parameters of the examined CZ model 2, the replica of a barrel bore fragment was made with Mikrosil silicone. This replica was examined with MST 131 stereoscopic microscope equipped with MOZ–07VIS adapter for precise measurement, in order to determine the rifling direction as well as the number and depth of lands. Basing on the examination, it was concluded that CZ model 2 cal.22 long rifle has right twist rifling with twelve lands and grooves. The width of lands is contained between 1,17 mm and 1,24 mm and the depth of grooves – in 0,05–0,06 mm range.

The ammunition used for examination involved a cartridge of cal. 22 long rifle rimfire, which belongs to standard CZ model 2 ammunition. These cartridges enjoy popularity and their initial mass is compressed in the head interior. The cartridge is fired when firing pin hits the head interior. The examined cartridges are of the same construction as the cartridge presented in Fig. 9.

Test firing of transformed air shotgun covered also the firing of DIABOLO cal. 5.5 bullet with use of signal cartridges of cal. 22 long rifle rimfire. The construction and principle of operation of signal cartridges of cal. 22 long rifle rimfire corresponds to the construction and principle of operation of cal. 22 long rifle rimfire cartridges. The only difference is that signal cartridges are deprived of a bullet and cartridge case top is star shaped (Fig. 10.)

During the test firing the examiners utilized lead DIABOLO cal. 5.5 bullets. These bullets can be fired from examined (transformed) air shotgun and they consists of two main parts: point and main body which can be of various shapes depending on the application. Round-point bullets are utilized for long range shooting as they overcome air resistance more easily than in case of flat-point bullets. The function of the main body is to carry the bullet through the barrel bore and to seal the barrel bore when the bullet is moving towards its outlet. The bullets utilized for velocity measurement are presented in Fig. 11.

TEST FIRING FROM HOME TRANSFORMED AIR SHOTGUN

The measurement of velocity and determination of kinetic energy of bullets originating from cartridges of cal. 22 long rifle rimfire fired within the distance of 1 and 5 meters from a barrel outlet.

In order to determine the velocity of bullets, twelve cartridges of cal. 22 long rifle rimfire were fired from home-made air shotgun on the test shooting range belonging to the police forensic laboratory in Olsztyn. The cartridges with lead alloy bullets (Thunderbolt) were produced by REMINGTON. The average mass of bullets was 2,58 g. The measurements were taken with the BP-02 photoelectric gates within the distance of 1 and 5 meters from the barrel outlet. The shots were fired into the tank filled with cotton wool. The results of the measurements of velocity of bullets and corresponding kinetic energy values have been presented in the Tables 1–2.

The analysis of findings allowed to conclude that the velocity of 2,58 g bullets originating from the cartridges of cal. 22 long rifle rimfire fired from home-converted air shotgun within 1 meter distance from barrel outlet varies between 352,4 m/s and 365,3 m/s, which corresponds to kinetic energy in the range between 160,2 J and 172,1 J. The velocity of bullets fired within 5 meters distance from barrel outlet varies between 342,1 m/s and 361,1 m/s, which corresponds to kinetic energy in the range between 151,0 J and 168,3 J.

On the basis of average values of energy of fired bullets (Table 1, 2), the examiners calculated the percentage decline of average kinetic energy within 5 meters distance from barrel outlet and the average kinetic energy within 1 meter distance from barrel outlet. The decline in kinetic energy of bullets fired from home-converted air shotgun within the distance from 1 to 5 meters from barrel outlet amounts to 9,5 J (5,65%).

The measurement of velocity and determination of kinetic energy of DIABOLO cal. 5.5 bullets with use of signal cartridges of cal. 22 long rifle rimfire fired within the distance of 1 and 5 meters from the barrel outlet of home-converted air shotgun.

In order to determine the velocity of bullets, twelve lead DIABOLO cal. 5.5. mm bullets produced by German manufacturer UMAREX were fired from home-made air shotgun on the test shooting range belonging to the police forensic laboratory in Olsztyn. The average mass of bullets was 0,86 g. DIABOLO bullets were fired with use of signal cartridges of cal. 22 long rifle rimfire produced by Italian manufacturer FIOCCHI. The measurements were taken with BP-02 photoelectric gates within the distance of 1 and 5 meters from the barrel outlet. Shots were fired into the tank filled with cotton wool. The results of measurements of velocity of bullets and corresponding kinetic energy values have been presented in the Tables 3,4.

The analysis of findings allowed to conclude that the velocity of 0,86 g cal. 5.5 DIABOLO bullets fired from home-converted air shotgun with use of cartridges of cal. 22 long rifle rimfire within 1 meter distance from barrel outlet varies between 511,4 m/s and 639,0 m/s, which corresponds to kinetic energy in the range between 112,5 J and 175,6 J. The velocity of bullets fired within 5 meters distance from barrel outlet varies between

518,7 m/s and 570,3 m/s, which corresponds to kinetic energy in the range between 115,7 J and 139,9 J.

On the basis of average values of energy of fired bullets (Tables 3, 4), the examiners calculated the percentage decline of average energy of bullets within 5 meters distance from barrel outlet and the average energy within 1 meter distance from barrel outlet. The decline in kinetic energy of bullets fired from home-converted air shotgun within the distance from 1 to 5 meters from barrel outlet amounts to 13,5 J (9,3%).

TEST FIRING FROM CZ MODEL 2

The measurement of velocity and determination of initial kinetic energy of bullets fired from CZ model 2

In order to determine the velocity of bullets, twelve long rifle cartridges of cal. 22 long rifle rimfire were fired from CZ model 2 on the test shooting range belonging to the police forensic laboratory in Olsztyn. The cartridges with lead alloy bullets (Thunderbolt) were produced by American manufacturer REMINGTON. The average mass of bullets was 2,58 g. The measurements were taken with BP-02 photoelectric gates within the distance of 1 and 5 meters from the barrel outlet. The shots were fired into the tank filled with cotton wool. The results of measurements of velocity of bullet and corresponding kinetic energy values have been presented in Tables 5,6.

The analysis of findings allowed to conclude that the velocity of 2,58 g bullets originating from cartridges of cal. 22 long rifle rimfire fired from CZ model 2 within 1 meter distance from barrel outlet varies between 375,1 m/s and 395,6 m/s, which corresponds to kinetic energy in the range between 181,5 J and 201,9 J. The velocity of bullets fired within 5 meters distance from barrel outlet varies between 370,9 m/s and 387,1 m/s, which corresponds to kinetic energy in the range between 177,5 J and 193,3 J.

On the basis of the average values of energy of fired bullets (Tables 5, 6), the examiners calculated the percentage decline in average energy of bullets within 5 meter distance from barrel outlet and within 1 meter distance from barrel outlet. The kinetic energy decline amounted to 6 J (3,11%).

CONCLUSIONS

Generated results indicate that the average kinetic energy of bullets originating from cartridges of cal. 22 long rifle rimfire fired from home-converted shotgun within the distance of 5 meter from the barrel outlet is 12,81% lower then the average kinetic energy of bullets fired from commercially manufactured CZ model 2 within the same distance. When bullets are fired within the distance of 5 meters from the barrel outlet, the average kinetic energy of the former is 15,1% lower than the average kinetic energy of the latter. The above results are caused by an increased resistance of forcing the bullets through the barrel bore of transformed air shotgun and consequently the bullets are slightly extended as the diameter of a barrel bore is 0,1 mm smaller than the barrel bore of commercially manufactured shotgun.

The examination pointed to the fact that the average kinetic energy of DIABOLO cal. 5.5 mm bullets fired with use of signal cartridges of cal. 22 long rifle rimfire within the distance of 1 meter from barrel outlet of transformed air shotgun is 13,68% lower than the average kinetic energy of bullets fired with use of cartridges of cal. 22 long rifle rimfire. When the bullets are fired within the distance of 5 meters from the barrel outlet, the average kinetic energy of the former is 17,02% lower than the average kinetic energy of the latter. Despite much higher velocity, the kinetic energy of DIABOLO cal. 5.5 mm bullets is lower due to three-fold smaller mass in comparison with the cartridges of cal.22 long rifle rimfire.

The following graph shows the decline in value of average kinetic energy and distance from the barrel outlet, where:

- green line represents the decline of average kinetic energy of bullets fired from CZ model 2 with use of cartridges of cal. 22 long rifle rimfire;
- red line represents the decline of average kinetic energy of bullets fired from transformed air shotgun with the use of cartridge of cal. 22 long rifle rimfire;
- blue line represents the decline of average kinetic energy of DIABOLO cal. 5.5 bullets fired from transformed air shotgun with the use of signal cartridge of cal. 22 long rifle rimfire.

The plot shows also that the decline of average kinetic energy of bullets fired from examined guns within the distance of 1 meter and 5 meters from the barrel outlet is similar. In order to provide objective assessment of this observation, the measurements of velocity of bullets would need to be performed at greater distances.