THE ANNALS OF "DUNAREA DE JOS" UNIVERSITY OF GALATI
FASCICLE IX. METALLURGY AND MATERIALS SCIENCE
N°. 4 – 2014, ISSN 1453 – 083X

EXPERIMENTS ON BALLISTIC TESTS FOR IMPROVING PERFORMANCE OF A NEUTRALIZING GAS DYNAMICS SYSTEM

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ABSTRACT

Neutralizing improvised explosive devices (handmade) by mechanical separation of the elements which are part of their composition can be achieved by the following methods:

- generation of shock waves by means of the impact method between a projectile or a jet formed from diverse disrupting backgrounds and the improvised explosive device. It is known that after impact we must have at the interface projectile (jet)–target the same pressure and material speed; they characterize the equilibrium that is established at the interface;

- generation of shock waves by detonating explosives placed in direct contact with parts subject to shock. This method is destructive and it must take into account the combined effects of explosive load that we want to neutralize and cargo of explosives used in neutralization; it can be used only in special places which can provide a range of effective safety;

- generation of shock waves using lasers; at this stage, this method is only used in laboratories through fundamental research.

The most used method for neutralization of an improvised explosive device is the first one. The neutralization systems (gas-dynamics systems) that propel the kinetic projectiles using explosives are used to transmit large shocks to various inert or reactive targets. These shocks have a significant impact on the targets, transmit changes in state and kinematic parameters, leading to either dismantling of targets or initiating explosive charges receivers. Initiating the explosive to the receiver detonation devices that can be parts of improvised explosive devices happens because the incident shock wave has exceeded the critical threshold of initiation. The initiation of detonation is, generally, an undesirable event, as explosive charge mass, although part of it, may not make it possible to take appropriate safety distances and thus material damage and human injury can be induced.

Given the complexity of improvised explosive devices, the impossibility of knowing the exact explosive charges and the initiation ones in their composition, we cannot say that there existsa neutralizing thruster jet to meet all technical requirements specified above. In an attempt to simplify and systematize the study, we are going to present a summary classification of explosive jet engines means, capable of being used to neutralize improvised explosive devices.

KEYWORDS: ballistic, neutralizing gas dynamics system

1. Propelling jets with gas-dynamics devices, using deflagration of colloidal powder

Disruptors with water jet have been used since the Second World War by British sappers when they had to find a way to defuse aviation bombs with delay mechanisms, which were found in great number in Europe, as an alternative to the use of detonating wicks. At the end of the war, the disrupters demand dropped until the 70s, when Canadians used them because of bombs placed by the Quebec Liberation

Front - a terrorist group. Initially, they were used in hand until a modern disruptor was invented which, placed on a tripod, could be used remotely.

Research programs have been developed by various companies, which have sought to respond to the current needs. Recently, due to new threats, tests were also made for neutralizing bombs which contain harmful agents (nuclear, chemical or biological). Reboundless disruptor is another innovation that can be used on remote controlled robots. There are calibre-disruptors 12.5 mm and 20 mm, and 12.5 mm versions, 20 mm, 29 mm.

Although the targets are very different, they can be successfully used for neutralization. Given the events, also studied is the possibility of using them for the packages with hard walls, by using projectiles. Disruptors of 12.5 mm were successfully used to neutralize mines with external warheads, being considered a leader in this technology. It can be used manually or mounted on the robot. It is power supplied to the 24V/1A, and may be used from the battery of the robot. The preparation time for drawing is 2.5 minutes. The maximum firing distance is 3 m.

If we add the fact that the distruptors are "collective weapons systems" and through them a "hidden" struggle is led with the most varied and dangerous targets, we can conclude that the importance of their projection is motivated.

It is in the interest of the intervention forces to know the weapons and ammunition they are confronted with. This information can give them confidence that the system used is effective, safe and more than that it is not used against their own forces.

In other words, the system needs to be dismantled using physical or functional improvised explosive device and it should not be opened unintentionally. This is possible only through proper knowledge of its properties.

2. Determination of existing ballistic cartouche

To determine the performance characteristics of the disruptor, experimental studies and shootings were made.

We determined:

- initial velocity of the projectile (agent of disruption being water);
- variation of the pressure in the pipe with respect to time;
- geometry of the water jet;
- influence of various parameters on the operation of the disruptor (plugs, the amount of water etc.);
- intensity of the sound wave emitted from the operation of the system.

The experimental configuration used to determine the ballistic characteristics, initial velocity and pressure is shown schematically in Figure 1.

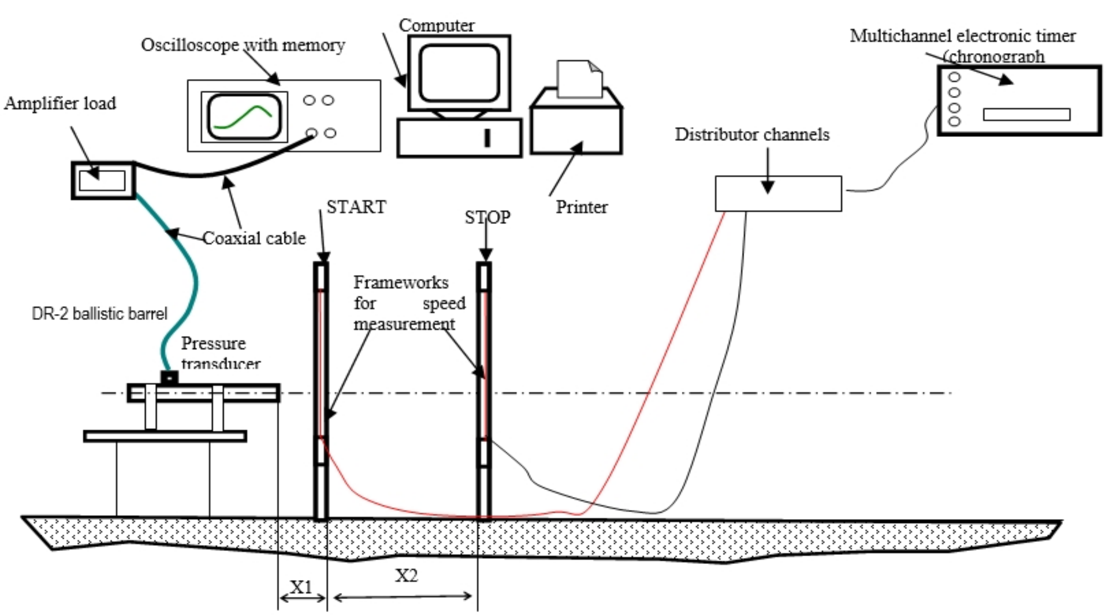

Fig. 1. *Scheme of the experimental set*

3. Experimental test results

As regards the ballistic tests, we considered: materials used, initial conditions, jet speed, pressure, noise level. Pictures of the geometrical configuration of the water jet propelled by the disruptor during shooting, for first shooting, are presented in Figure 2.

Shooting 1
Image water jet after 40 ms

Shooting 1
Image water jet after 80 ms

Shooting 1
Image water jet after 120 ms

Shooting 1
Image water jet after 160 ms

Shooting 2
Image water jet after 40 ms

Shooting 2
Image water jet after 80 ms

Shooting 2
Image water jet after 120 ms

Shooting 3
Image water jet after 40 ms

Shooting 3
Image water jet after 80 ms

Shooting 4
Image water jet after 40 ms

Shooting 4
Image water jet after 80 ms

Shooting 5
Image water jet after 40 ms

Shooting 5
Image water jet after 80 ms

Shooting 6
Image water jet after 40 ms

Shooting 6
Image water jet after 80 ms

Shooting 7
Image water jet after 40 ms

Shooting 7
Image water jet after 80 ms

Fig. 2. *Analysis of the geometrical configuration of jets: images of the water jet*

4. Conclusions

Analyzing the used cartouche configuration and given the deficiencies found, the following assumptions can be made:

- The colloidal powder used is Vufl, which explains the incomplete combustion of powder granules in some cases (especially when not using plugs).

- The use of retaining plugs of the disruption agent has an important role in the interior ballistics of the cartouche, but they are propelled at high speed along with the stream of the disruption agent; if water is used, the characteristics of the shock induced in different targets are amplified by the shock characteristics of the materials which the corks are made of; we can say, therefore, that the initiation of the explosive caps is produced by the action of the plugs and not by the water jet.

- It is possible to provide an adequate initial speed to the stream of water propelled by the disruptor if a new type of colloidal powder is used, easily inflammable and a high combustion speed; this can ensure the complete combustion of the powder grains before they enter the water column disposed in the disruptor pipe.

- In order to ignite the flinging load, it is possible to imagine another damper with combustion temperatures higher than those given by the black powder used in the electric damper of the cartouche in operation.

- Sealing the cartouche has a major importance in developing the phenomena following its subsequent ignition; it is possible to replace the existing stopper plug (plastic) with a different constructive solution, for example by means of a glass (stopper) with a very small weight, which can be assembled to the cartouche by means of an epoxy resin; this solution can solve the problem of the cartouche tightness in a proper manner, without inducing significant shocks to the targets.

Given the assumptions presented, the following results were obtained:

- exploration of the possibility of replacing the cartouche cal. 12.7 mm commonly used;

- study of the ballistic characteristics of the existing cartouche:

- initial speed of the jet and its geometric configuration;

- pressure value in loading chamber versus time;

- noise level produced at the load flinging initiation;

- identification of a powder for the load flinging whose combustion is complete;

- determining the load flinging mass ensuring ballistic performance similar to existing cartouche (initial speed while preserving the maximum level of pressure);

- replacement of the electric primer by using a new ignition composition, charged in a different configuration;

- finding a viable solution for the new cartouche seal;

- complete removal of restraint plugs of the disruption agent in the disruptor pipe;

- interaction between water jet propelled through the new cartouche with an electric detonator (as a possible component of an explosive device); the latter should not be initiated.

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