10th International Research/Expert Conference
"Trends in the Development of Machinery and Associated Technology"
TMT 2006, Barcelona-Lloret de Mar, Spain, 11-15 September, 2006

REGARDING THE BALLISTIC DESIGNING OF FIRE EXTINGUISHING SYSTEM

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ABSTRACT

In this paper are presented main aspects concerning ballistic designing of new system for extinguishing of fire. This system consists of launcher with one or many guidance tubes and anti-fire ballistic system. The fire extinguishing system is a recoilless ballistic system. The establishing of main ballistic characteristics is done with the aid of numerical simulation using an interior ballistics software for such system.

Keywords: ballistic system, interior ballistics software, recoilless ballistic system, extinguishing fire.

1. INTRODUCTION

There are many systems and procedures for extinguishing of fire. It is known that actual systems for extinguishing of fire are realized on the bases of principle of fire extinguishing from exterior to interior of affected zone, acting gradually, at the beginning for limiting of this zone, then, for diminution and, finally, for extinguishing of fire. The main disadvantages of extant systems for extinguishing of fire consist of their using only in neighborhood of fire, affecting integrity of intervention personnel as well as only act from exterior to interior of affected zone, being impossible to act in zone with difficult positions (high levels or inside of buildings, mountain zone etc.). These disadvantages can be avoided by using a new system for extinguishing of fire. The new system for extinguishing of fire consists of launcher with one or many guidance tubes and anti-fire ballistic system. The role of launcher is to orientate the anti-fire ballistic system in direction of affected zone and to initiate propulsion device of ballistic system. The anti-fire ballistic system (Fig. 1) can have in its structure one stabilizing block 3, two useful containers 4, two disperses 5 and shock device 6.

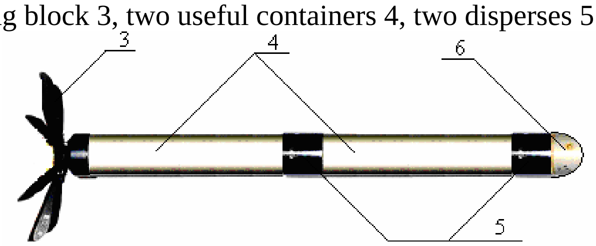

Fig. 1. Anti-fire ballistic system

The portable fire extinguishing system is consisted of from individual launcher 7 and anti-fire ballistic system 2 (Fig. 2). The functioning of anti-fire ballistic system inside of affected zone is possible due to two igniting devices 9 which exist in useful containers 8.

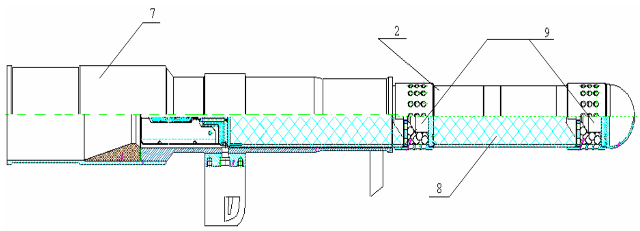

Fig. 2. Portable fire extinguishing system

2. ESTABLISHING OF MAIN DESIGNING PARAMETERS

The establishing of main designing parameters was realised by numerical simulation [4,5]. For that was used an interior ballistics software of a recoilless ballistic system, which was validated with the aid of an extant similarly ballistic system [1,2,3]. On the bases of this software were determined the values of chosen designing parameters for that the main ballistic characteristics have got suitable values, in the case of an anti-fire recoilless ballistic system of 60 mm calibre with the mass of. grenade 5.5 kg, the muzzle velocity 90 m/s and the nozzle throat section 0.214 dm^2. During of numerical simulation were modified in the possible limits the following designing parameters: the mass of powder ω; the force of powder f; the threshold pressure p_0; the volume of charging chamber W_0. The interior ballistics software allows to study the influence of the variation of these designing parameters over the following ballistic characteristics: the grenade muzzle velocity v_g; the muzzle kinetic energy E_g; the maximum pressure of powder gases $p_{\max}$; the ballistic efficiency[1] r_g; the piezometric efficiency[2] η_g; the characteristic of powder utilization η_ω; the pressure at the ending of powder burning p_k; the displacement of grenade at the ending of powder burning ℓ_k; the maximum acceleration of the grenade a and so on. With the aid of this interior ballistics software was obtained the curves of variation of these ballistic characteristics versus named designing parameters. From these curves can be find these values of chosen designing parameters for which the ballistic characteristics have got suitable values, without the exceeding of the imposed designing parameters values. A part of these results of this study was presented in Figure 3-6.

2.1. Variation of the powder charge mass

In Figure 3 it can see that the muzzle velocity of the grenade v_g, the muzzle kinetic energy E_g, the maximum pressure $p_{\max}$ increase with the increasing of powder charge mass. From the graphic of muzzle velocity of the grenade versus powder charge mass, it is observed that a muzzle velocity of the grenade of 90 m/s, suitable value for proposed goal in this case, it is obtained for a mass of powder charge of 0,240 kg. For this powder charge mass corresponds a maximum pressure of approximately 510 daN/cm^2. In function of this value of powder charge mass result from graphics the values of another ballistic characteristics.

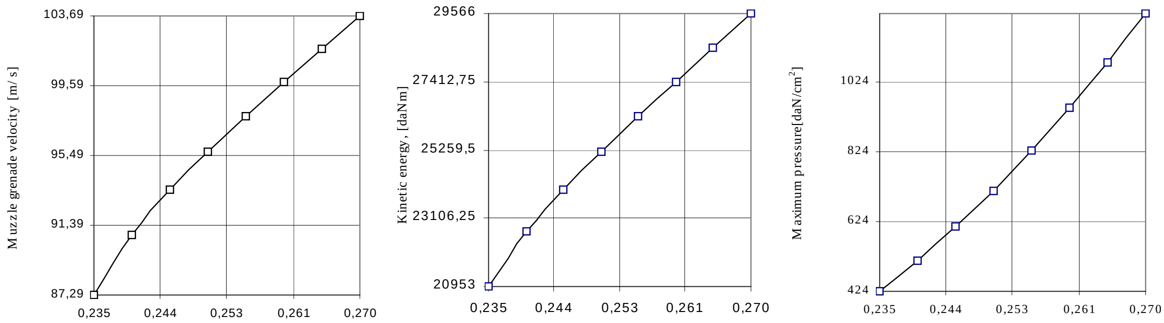

Fig. 3. Variation of the main ballistic characteristics with variation of the powder charge mass

2.2. Variation of the powder force

In the graphic of muzzle velocity of the grenade versus powder force, from Figure 4 it can see that at value of 90 m/s of the muzzle grenade velocity corresponds the value of 1100000 daNdm/kg for powder force. From the graphics, for the value of 90 m/s for the muzzle grenade velocity, the kinetic energy of the grenade is 22700 daNm and the ballistic efficiency is 22 %.

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[1] Defined as the ratio between the shot out kinetic energy of the grenade and the total energy of the powder;

[2] Defined as the ratio between the mean pressure that acts on the grenade in the launcher and the maximum pressure.

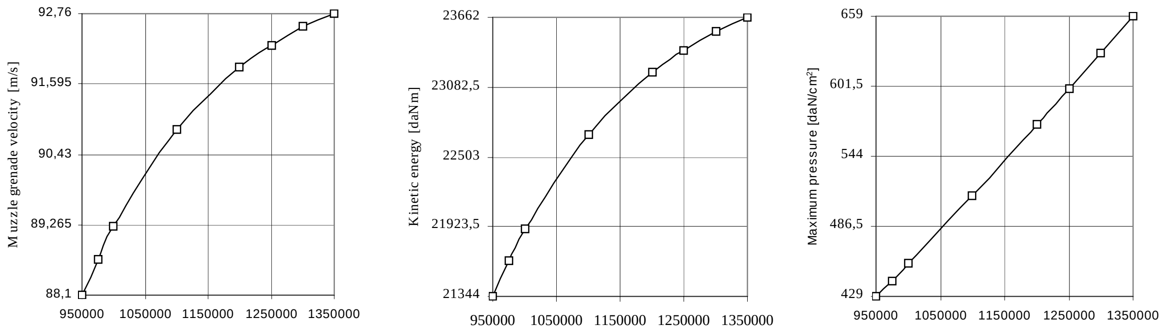

Fig. 4 Variation of main ballistic characteristics with variation of the powder force

2.3. Variation of the threshold pressure

If the value of 510 daN/cm^2 of the maximum pressure is considered suitable, than for this value, from the graphic of maximum pressure versus threshold pressure, Figure 5, results the value of 80 daN/cm^2 for the threshold pressure. For this value of the threshold pressure correspond the values of 94550 daNm/kg and 70 % for powder efficiency and piezometric efficiency respectively.

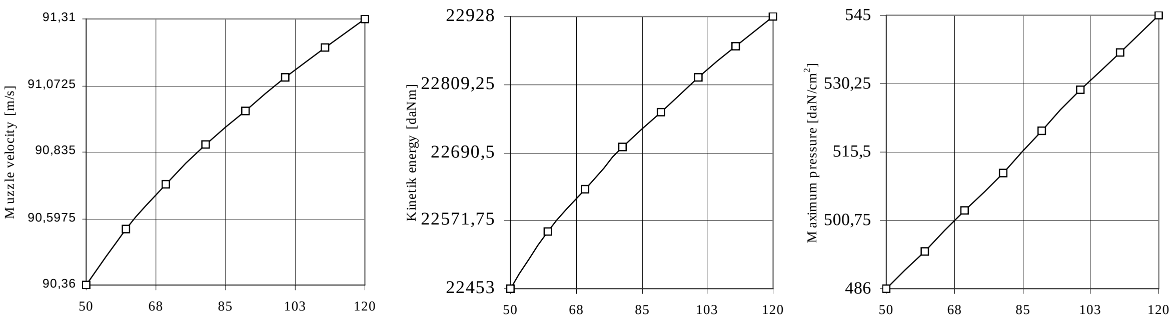

Fig. 5 Variation of the main ballistic characteristics with variation of the threshold pressure

2.4. Variation of the charging chamber volume

From Figure 6, graphic of maximum pressure versus charging chamber volume, it is observed that for charging chamber volume of 0,4 dm^3 corresponds the value of 510 daN/cm^2 of the maximum pressure. For this value of the charging chamber volume result the values of 400 daN/cm^2, 1,5 dm and 25650 m/s^2 for the burning end pressure, displacement and acceleration respectively.

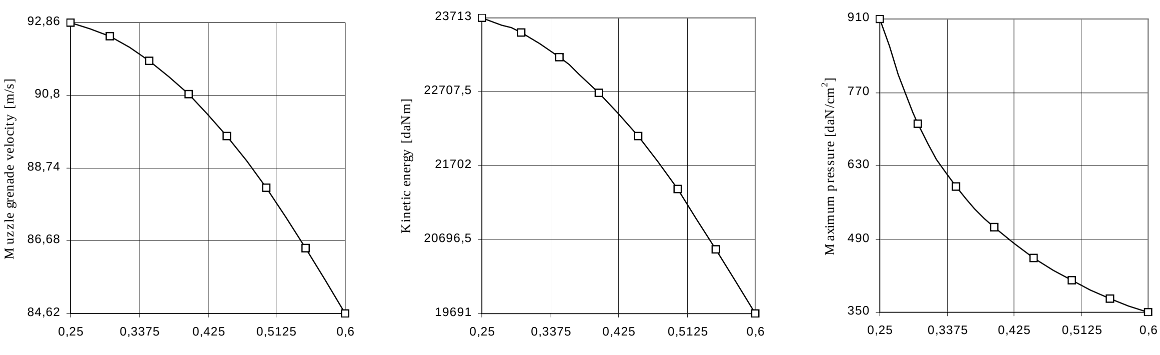

Fig. 6 Variation of main ballistic characteristics with variation of the charging chamber volume

3. RESULTS AND CONCLUSIONS

Using the elaborated interior ballistics software, were established the values of studied designing parameters for which the main ballistic characteristics have got suitable values, without the exceeding of the imposed designing magnitudes. The obtained values of these parameters with the aid of numerical simulation are following: the powder charge mass ω=0.24 kg; the powder force f=1100000 daNdm/kg; the threshold pressure p_0=80 daN/cm^2; the charging chamber volume W_0=0.4 dm^3. In the case of the recoilless ballistic system of 60 mm caliber which has got these designing parameters, the main ballistic characteristics are following: the maximum pressure of powder gases p_{max}=510 daN/cm^2; the muzzle grenade velocity v_g=90 m/s; the piezometric efficiency η_g=70 %; the ballistic efficiency r_g=22 %; the kinetic energy of the grenade E_g=22700 daNm^2/s^2; the characteristic of powder utilization η_ω=94550 daNm^2/s^{2}kg; the gases pressure at the ending of powder burning p_k=400 daN/cm^2; the displacement of grenade at the ending of powder burning ℓ_k=1.5 dm; the maximum acceleration of the grenade a=25650 m/s^2. For the recoilless ballistic system of 60 mm caliber with these main ballistic characteristics was solved the fundamental problem of interior ballistics that consists of the variation of gases pressure and grenade velocity versus time and displacement of the grenade inside of the launcher system. In Figure 7 and 8, it is presented variation of the gases pressure and grenade velocity versus time and versus displacement respectively.

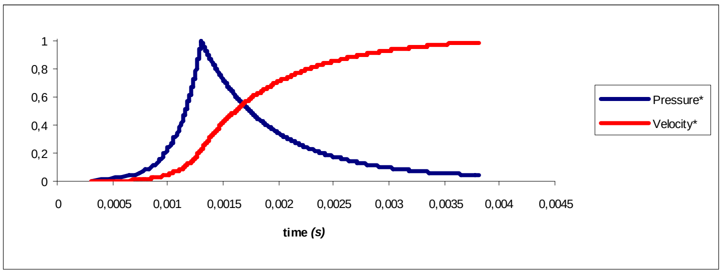

Fig. 7. The variation of pressure and velocity versus time

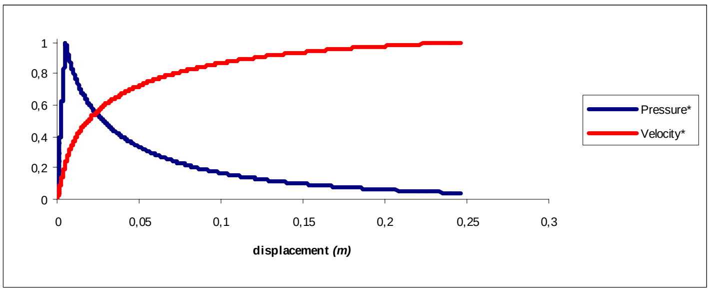

Fig. 8. Variation of pressure and velocity versus displacement

In both graphics from Figures 7 and 8 were used relative variables that were obtained as the ratio between the value of current variable and its maximum value.

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