INFLUENCE OF BARREL EROSION ON THE BALLISTIC PARAMETERS AT ARTILLERY FIRING

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Abstract: *The erosion of barrels ends up in reduced gun performance. The damage spreads forwards toward the muzzle because the gun is unemployed ceaselessly. Worn barrels area unit objectionable because of they permit gas to flee past the shot therefore reducing speed, vary and accuracy. Because the muzzle begins to wear the shot loses directional stability. Its worth depends on the scale of the gun, the specified accuracy and the issue of safety that must be maintained against harmful fatigue failure. on the average barrels area unit condemned once the bore diameter will increase by concerning five-hitter. Wear depends not solely on the thermal load however additionally on the surface scientific discipline of the bore and the chemical interactions between the propellant gas and also the bore surface. The erosivity of {various} propellants are investigated over the years mistreatment various numerical ways and a few works have tested propellants or propellant gases in some style of simulated gun.*

1. Introduction

The capacity of the barrel walls to resist a certain pressure of the gases that form inside it is called the barrel resistance. In order not to increase the weight of the barrel, they are built to withstand a pressure 1.5 - 2 times higher than that to which they are normally subjected. Since gas pressure is not uniform over the length of the barrel channel during drawing, then the thickness of the barrel walls is not uniform but thicker at the back and thinner at the front.

If for various reasons the gas pressure inside the barrel has values much higher than those for which its resistance has been calculated, then swelling or even explosion may occur. In most cases, swelling of the tube occurs due to the presence of foreign bodies inside it. The projectile moving on the barrel channel, when meeting these foreign bodies, decreases its speed. The gas that follows the projectile, when it suddenly decreases its speed, is rejected backwards. The influx of gas flowing in the opposite direction produces an instantaneous increase in pressure, which leads to swelling or sometimes even to the explosion of the barrel.

Under the influence of all these factors, the channel of the barrel is widened and the surface of the barrel changes, which is why it increases the possibility of gas leakage through the projectile and the wall of the pipe channel, the initial projectile speed decreases and the scattering surface is increased.

Erosion of the gun barrel leads to poor performance and availability and increases the cost of barrel replacement over the life of an armament system. The wear of the gun barrels usually leads to an increase in the diameter of the pipe interior at the beginning of the riveting part. Wear progressively extends to the mouth of the barrel when firing continuously. The maximum wear point remains close to the beginning of the ribbed portion.

As the wear advances to the mouth of the barrel, the kick loses its steadiness in the direction. Total wear that can be tolerated is called usage limit. Its value depends on the size of the weapon, the precision required and the safety factor to be maintained due to the fatigue resistance of the material. On average, the barrels are compromised when the inside diameter of the pipe increases by about 5%. Wear depends not only on the thermal variation but also on the type of material at the surface of the pipe interior and on the chemical interferences between the loading charge and the surface of the barrel interior. The barrel’s internal erosion due to various drilling loads has been investigated over the years using various numerical methods, and in the course of some research, simulation load tests have been tested.

2. Theoretical and experimental study on the mechanical causes of wear

The mechanical contribution of wear comes from the action of gas jet and projectiles. Unwashed powder and small solid particles in the primary explosive and other sources are entrained in the rapid gas leakage and have an abrasive effect on the inside of the pipe. For a riveting pipe, mechanical wear occurs from the moment when the forcing grip is engaged. This process leads to considerable pressure on the pipe. The movement of rotation of the projectile as it progresses into the pipe causes additional mechanical wear. For the ribbed pressed pipes, the radial pressure between the guide rail and the interior of the pipe produces abrasive action.

The most important part of the wear occurs at the beginning of the barrel portion. However, a significant part of the wear can also occur at the mouth of the barrel due to the movement of the projectile, but also to the abrasive particles.

In order to increase the resistance of the barrel interior to wear caused by rubbing of the projectile, gas corrosion and erosion, and consequently the durability of the inner surface, it is coated electrochemically with a layer of hard chromium that adheres quite strongly to the metal.

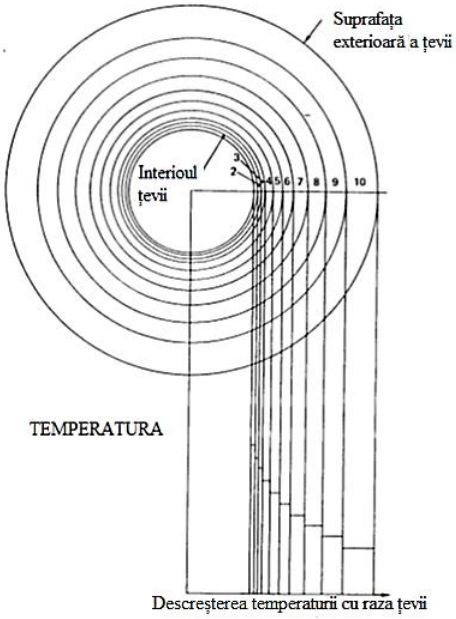

Figure 1. Decreasing temperature at the barrel level

Under ordinary atmospheric conditions, chromium theoretically does not corrode. Therefore, if the surface of the interior of the pipe could be covered with a continuous chrome layer, and if this layer would not be destroyed during drawing, the surface of the pipe interior would be perfectly protected against corrosion. However, it is not possible to deposit a hard, pore-free chrome layer on the steel. During the deposition of chrome, small cracks can occur, which in some places reach to the basic material of the pipe, through which gases and humidity can penetrate the steel, causing its corrosion.

At the time of firing, the maximum barrel temperature rises to almost 1800K at about the same time as the gas reaches the maximum pressure. The temperature rise is highest at the beginning of the ribbed part and corresponds to the maximum wear point. The increase in temperature at the surface of the barrel also produces a decrease in surface hardness. The layer of the removed material can vary between 0.1µm and 100µm per shot, depending on the kinetic energy of the gases, the thermal level and the surface hardness. It is assumed that the erosion area extends as the projectile advances toward the mouth of the barrel.

Calculation of the layer friction from the surface of the barrel interior and the heat flow inside the barrel begins with the following slightly modified equations (the case without the material erosion of the barrel).

$$\tau_{wo} = \frac{1}{2} \cdot C_{fo} \cdot \rho_{\infty} \cdot |u_{\infty}| \cdot u_{\infty} \qquad 1)$$

$$q_{wo} = \frac{1}{2} \cdot C_{fo} \cdot \rho_{\infty} \cdot |u_{\infty}| \cdot \left[\left(e_{\infty} + \frac{p}{\rho_{\infty}}\right) \cdot \left(1 - \frac{T_W}{T_{\infty}}\right) + \frac{u_{\infty}^2}{2}\right] \qquad (2)$$

where:

τ_{wo} - friction at the surface of the barrel interior;

C_{fo} - the coefficient of friction on the surface of the inner wall of the barrel;

ρ_{∞} - the average density of the material of the inner wall of the barrel;

u_{∞} - the average velocity inside the barrel;

q_{wo} - the heat flow inside the barrel;

e_{∞} - the average energy inside the barrel;

p - the average pressure inside the barrel;

T_w - temperature at the surface of the barrel;

T_{∞} - the temperature inside the barrel.

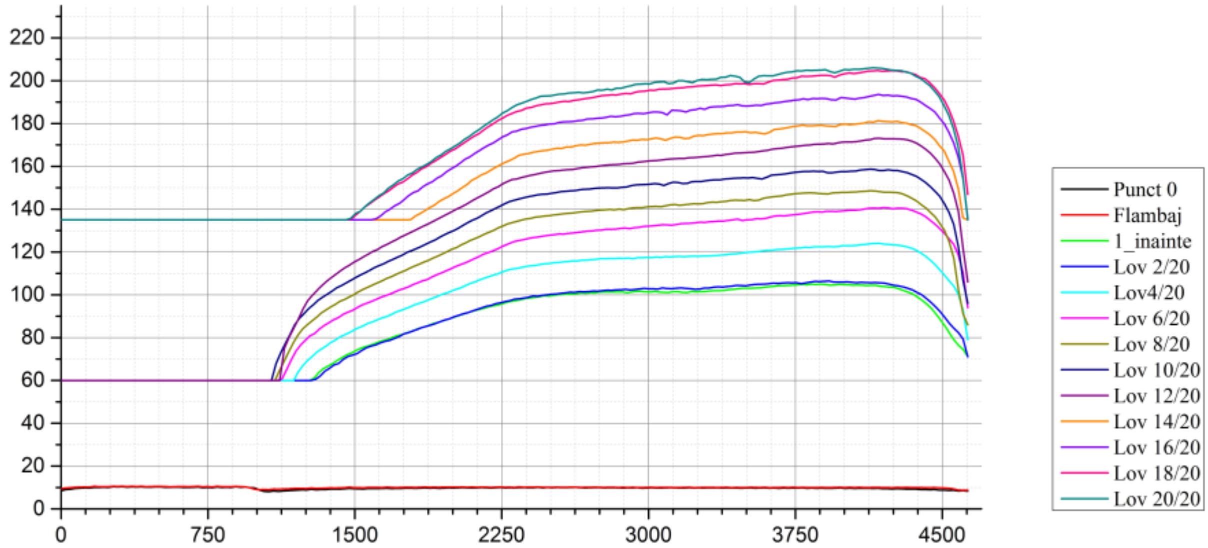

Figure 2. Temperature at the barrel level

3. Conclusions

Understanding all of the above mentioned mechanisms can lead to the development of various means of reducing the wear of the pipe. The most commonly used tools for erosion eradication are: the development of less erosive tailings, the use of protective coatings, improved pipe treatment materials, additives and lubricants to reduce erosion.

The following recommendations can be made to reduce the wear of armor systems barrel: the use of low-temperature firing loads; avoiding the use of lubricants that help reduce the amount of hydrogen; use of viable materials for the surface protective layer, such as chrome, non-metallic coatings such as foam, special powders that reduce wear; the use of nitrogen-loaded sanding loads.

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