Study on the Thermodynamic Characteristics of the High-Pressure Gas in Reciprocating Mechanism

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Abstract

The counter-recoil mechanism is a kind of reciprocating mechanism. Through compressing the high-pressure gas closed in it, counter-recoil mechanism can accumulate the recoil kinetic energy and send the recoil part back by gas expansion. The dynamic characteristics of the high-pressure gas closed in it are very complicated. Polytropic state equation for perfect gas is always used to describe the gas. Common view considers that the characteristics of polytropic process are between isothermal process and adiabatic process. However repeated experiments indicated that this would make the theoretical result deviate from the actual gas pressure and cause people underestimating the gas pressure. This paper studied the thermodynamic characters of the gas closed in artillery counter-recoil mechanism in transient working processes. Basing on the actual characters of the gas, the whole process is seposatal into four specific processes. Through analyzing the thermodynamic characters of the four processes, the author considered that because of the effect of the energy dissipation caused by fast compression in the first process and the exchange of heat between the boundaries, the polytropic exponent ranges of the four specific processes were different, and the theoretical values of them might be larger than the adiabatic exponent 1.4 of nitrogen. Using the theory of four specific processes and the inequality of Clausius, further confirmed the analysis about the gas, meanwhile explained the mechanism of how the gas dissipating the artillery recoil energy. To prove the correctness of the theories in this paper, we measured the pressure and the volume of the gas chamber in the transient processes by experiment. Piecewise fitted the actual pressure-volume curve with exponential curves and got polytropic exponents of the four specific processes. The result proved that the theories in this paper were coincident with the fact. These theories are valuable to the design and safety working of the artillery counter-recoil mechanism.

Figure: Comparison between actual pressure and theoretical pressure

REFERENCES

1. Gao SZ, Chen YS, Zhang YL, Zheng JG. Artillery recoil mechanism design. *Armament Science*, 1995; 102-114 (in Chinese)
2. Shen WD. Engineering thermodynamics. *Advanced Education*, 1983; pp.126-131, 295-297 (in Chinese)