STUDY ON JET FORMATION of Shaped Charge with Truncated-liner Structure

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Abstract

In order to verify the jet forming characteristics of the shaped charge with a truncated-liner, numerical simulation and X-ray experimental research were carried out. The behavior of the truncated-liner and the top velocity, diameter and morphology of the jet were obtained, and the outcomes were compared with the characteristics of the jet formed by the traditional shaped charge. The results show that the numerical simulations are almost consistent with the results obtained by the X-ray test. The morphology of the two is nearly the same, and the data deviation is less than 6%. The truncated-liner can effectively improve the velocity of the jet head, which can reach more than 10km/s by structural optimization. In addition, the truncated-liner can decrease the diameter of the slug, meanwhile, increase the length of the jet and the quality utilization of the liner.

1 Introduction

The traditional shaped charge generally has the disadvantage of the low-quality utilization rate of the liner. Most of the material of the liner forms a slug with a lower penetration ability. In order to both improve the velocity and mass of the shaped-charge jet head, it is necessary to make the collapsed angle of the liner equal to or greater than 180º .Therefore, an additional external impulse must be applied to the liner to increase its axial movement speed. It can not only make the collapsed angle of the liner equal to or greater than 180º but also increase the speed of the jet head. In this paper, we take the shaped charge with truncated-liner as the research object and combine numerical simulation and X-ray experimental to carry out research on the characteristics of the jet formation process. By comparing the forming process of the jet with the traditional shaped charge, the forming rule of the truncated-liner is verified, which provides technical support for the subsequent optimization of the hyper-

2 Numerical simulation analysis of forming characteristics

2.1The numerical simulation model are shown in Fig.1 and Fig.2.

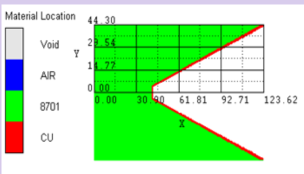

Fig.1Simulation model of the traditional shaped charge

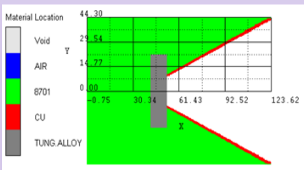

Fig.2 Simulation model of a hyper-cumulation shaped charge with truncated-liner

2.2 Material model and specific parameters

In order to facilitate analysis, the Euler calculation method is used for numerical simulation. Johnson-Cook constitutive model and Shock equation of state are used for both the liner and the additional body. Explosive is described by the JWL equation of state, and the air is described by the Ideal Gas equation of state.

2.3. Simulation results and analysis

Traditional Shaped charge The jet is completely formed at 50us, the head speed of the jet is 6830m/s, and the shape is good. However, the diameter of the slug is large, and the quality utilization rate of the liner is low.

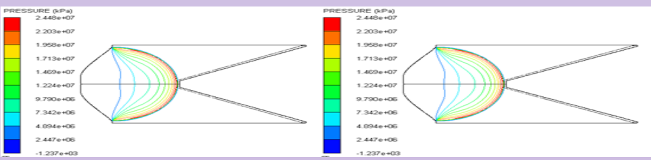

Fig.3Pressure cloud diagram of the shaped charge at 5us and 10us.

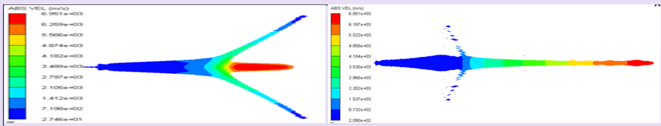

Figure 4. Cloud diagram of jet velocity at 20us and 50us.

Shaped charge structure with truncated-liner. When using the truncated-liner (with the additional body which has the diameter of ϕ44mm and the thickness of 11mm), the jet velocity increased significantly, the head velocity reached 9497m/s, the gradient of jet velocity is also increased. Meanwhile, the utilization rate of the liner material improved.

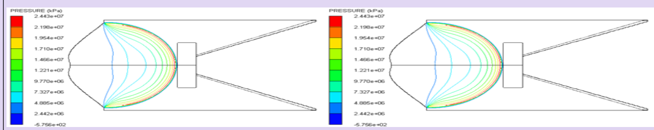

Figure 5. Pressure cloud diagram of the shaped charge at 5us and 10us.

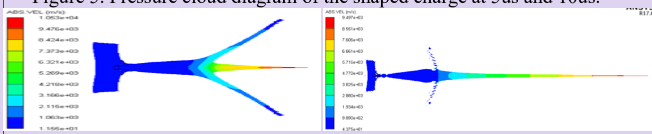

Figure 6. Cloud diagram of jet velocity at 20us and 50us.

3 Experimental Research on Forming Characteristics

3.1. Test method

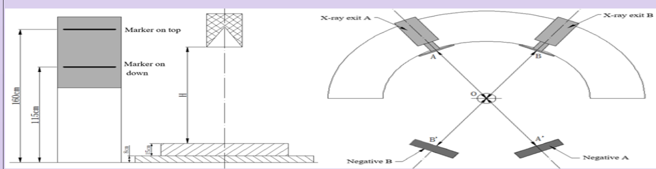

Figure 7. Schematic layout of the X-ray test.

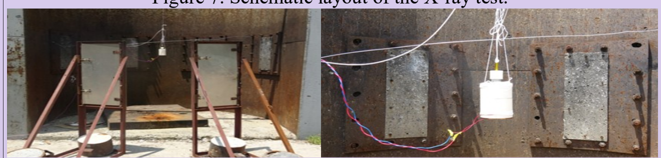

Figure 8. X-ray test site layout.

3.2. Experimental results

The type of the shaped charge	*H* （cm）	t_B (us)	t_A (us)	Δt (us)	BB' (cm)
Traditional	127	10	20	10	276
With truncated-liner	127.5	10	15	5	279

BO (cm)	AA' (cm)	AO (cm)	k_B	k_A
142	284	135	1.9437	2.1037
141	282	135	1.9787	2.0889

4.Conclusion

This paper mainly studies the jet forming characteristics of the shaped charge with a truncated-liner. By comparing with the results of jet formation with the traditional shaped charge, the following conclusions are obtained:

1) In the numerical simulation, the results of the jet formation with the traditional shaped charge and the shaped charge with truncated-liner are basically consistent with the results obtained by the X-ray test, and the shapes are basically the same.

2) Research shows that on the basis of the traditional shaped charge, adding an additional body after cutting off the top of the liner can make it have enough acceleration space during the initial crushing process, and collapse at a higher speed on the axis. The additional body can provide