PHYSICAL PROPERTIES OF AN ELECTROMAGNETIC COIL GUN

Josip Nino Pleh, Domagoj Smolić
Supervisor: MSc. Damir Štampar,
Technical School Čakovec, Čakovec, Croatia, josip_10@net.hr, doomppa@gmail.com

1. Introduction

An electromagnetic coil gun is a device used for accelerating ferromagnetic objects. The main components of this device are a source of electric energy and a coil. Capacitors are used as the source of electricity. When there is a current flow through the coil, an electromagnetic field is formed around it. This field magnetizes the projectile and accelerates it towards the centre of the coil. The goal of this project was to gain deep understanding of the working principles of electromagnetic coil guns and investigate the parameters that affect muzzle velocity of the projectile. Based on the results we plan on building a coil gun that would be able to launch projectiles at supersonic speed.

2. Experimental setup

For the purpose of measurements we used different coil and capacitor setups and different projectiles. With those setups we measured the effects that mass, shape and starting point of projectiles have on the muzzle velocity. The velocity was measured using two optical sensors. We also measured the voltage on the capacitors and the magnetic field of the coil using a Hall sensor and an extra coil, which resulted in indirect information about the current flow through the gun's coil. Moreover, we measured the acceleration of the projectile on its way through the coils.

3. Results

In Figure 1 we can see that the velocity rises greatly at the beginning and then starts to drop when the projectile passes the centre of the coil. Furthermore, when the current through the coil is the strongest, the acceleration is the biggest.

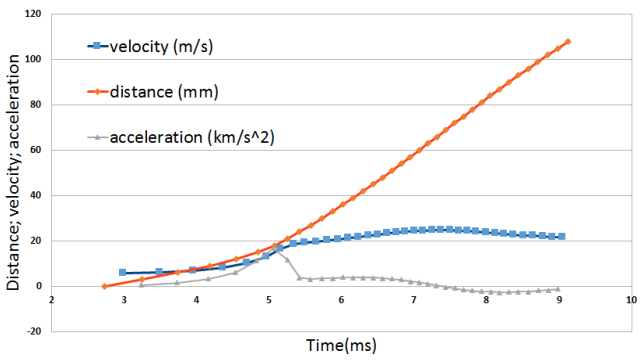

Figure 1. The distance, velocity and acceleration of a projectile in relation to time.

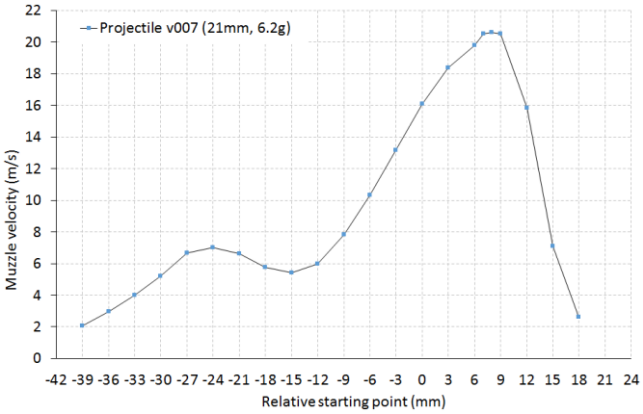

Figure 2. The dependence of the muzzle velocity in relation to the starting point of the projectile. The relative starting point refers to the distance of the projectile from the agreed position 0 on the starting point of the coil. The estimated error of the velocity measurements is 0.5m/s for smaller velocities and 0.2m/s for greater velocities.

Figure 2 shows that there is an optimal starting point of the projectile from which it develops the greatest velocity. Moreover, different masses and lengths of the projectiles have little effect on the maximum muzzle velocity.

4. Conclusion

We concluded that the force on the projectile depends on the strength of the magnetic field of the coil. When the projectile reaches the centre of the coil, the force on it will be zero and when it passes the centre the force will be negative, meaning the projectile is pulled back to the centre. In order to increase the maximum velocity of the projectile, discharge of the capacitor has to be synchronized with the movement of the projectile through the coil.

5. References

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