

# Finite Element Analysis of Accelerating Projectile Inside Vacuum Bazooka

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## Abstract

Different modules and capabilities of COMSOL Multi-physics software i.e. Fluid Flow, Moving Mesh and Global ODEs/DAEs are combined and applied to study the accelerating of a projectile inside a so-called "vacuum bazooka". Initially, the projectile is at rest in a partially vacuumed tube. Single Phase Fluid Flow is applied to analyze the transient air flow and pressure fields inside the tube caused by the removal of the wall at one end of the tube. The Moving Mesh module is used to let the model follow the change in geometry as the projectile moves. The pressure on the projectile surface is integrated to evaluate the force applied on the projectile at any time. Newton's second law is applied using Global ODEs/DAEs node to calculate the projectile displacement. The physical phenomena leading to the accelerating of the projectile inside the tube are discussed by post-processing the results. It is observed that the initial net inflow of air gives the projectile an initial velocity. Consequently, the air flow switches into sound waves propagation that applies zero time-averaged force on the projectile and brings it to a limiting velocity. This study also exemplifies the kind of projects conducted by the presenter at the School of Physical and Mathematical Sciences, Nanyang Technological University (NTU), Singapore where students - of different backgrounds - are taught to apply COMSOL software in a reasonably short duration of time for their application-oriented academic projects. The teaching method which is based on the COMSOL software structure and its related resources e.g. Application Gallery is explained. Unique features of COMSOL software for education and research are discussed and some suggestions are offered for better utilization.

## Figures used in the abstract

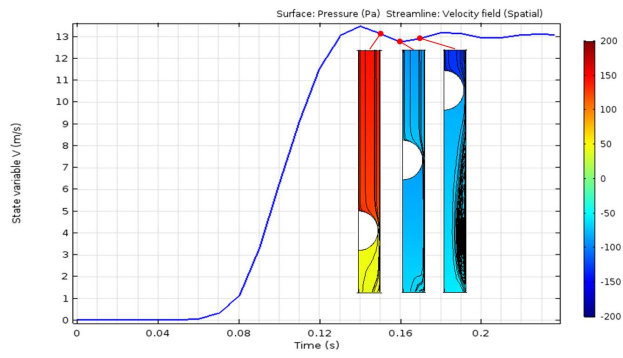


Figure 1: Accelerating of the projectile inside a vacuum bazooka to a limiting velocity.