Peaceful Ballistic Missiles: A New Outlook

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Abstract

An intercontinental ballistic missile (ICBM) is a ballistic missile with a range of upwards of 11000 kilometers (~6800 miles) and often reaches altitudes of 1500 kilometers (~900 miles). A Minuteman III ICBM, more specifically, is an American ICBM in current use. Previously, the military has used Minuteman II rockets and Peacemaker rockets for satellite launches. The purpose of this study is to observe and modify a repurposed Minuteman III ICBM for use in satellite transportation. The research is performed via computational fluid dynamics. It was found that the rocket can be slowed down by the addition of air-brake structures. By attaching multiple air brakes to the edge of the rocket body, it was able to increase its drag and open up different ways to reuse and save the rocket. This opens up a possibility for future research in this topic and proves the feasibility of this idea.

Keywords: **Computational Fluid Dynamics, Rocketry, Reentry, Modification, Missile, Sustainability**

Introduction

The study of thermonuclear warfare and the chilling efficiency of modern nuclear missiles stand as humanity's darkest corner, capable of the destruction of entire cities and the poisoning of vast regions. However, an intriguing question arises on how can these destructive instruments be transformed into tools for fostering peace? A nuclear missile comprises several components, each with potential alternative applications. For instance, the warhead, designed for devastation, could be repurposed for issues such as terraforming endeavors, presenting an opportunity to utilize its possible capabilities for constructive purposes. Furthermore, the launch vehicle, after completing its destructive mission, holds the potential for an entirely different function. As previously demonstrated by the US and Soviet militaries, these launch vehicles can be converted into orbital launch vehicles, offering a glimpse of a transformative path towards more peaceful applications. Notably, historical instances, such as the conversion of Peacekeeper missiles into tools for launching government satellites into orbit, have set a precedent for these adaptations. Leveraging this sophisticated technology inherent in ICBMs, it becomes feasible to launch satellites with a total mass exceeding 1 ton using a single rocket. The efficiency and cost-effectiveness of this approach have been shown by previous launches utilizing repurposed Peacemaker missiles. These rockets, having been mass-produced, present an opportunity for post-mission recovery and a subsequent reintegration into production lines for repurposing. With an addition of a feature, known as air brakes, the recovery of the ship would be much more likely, providing a more effective and simple way of reusing ships. More specifically, these air brakes assist in both stabilization of the rocket and the slowing down of it. With the rocket having a slower velocity than usual, it will help the rocket maintain stability, rendering it far easier to land and retrieve. This transformative technology holds the promise of revolutionizing the space industry, potentially rendering space launches more economically and sustainably viable as compared to their current state. Therefore, the exploration of thermonuclear warfare and nuclear missiles unveils a potential path of turning instruments of war into agents of peace. By recovering and mass repurposing these rockets, we may unlock a cost- effective and efficient approach to space exploration, paving the way for a brighter, more peaceful future.

Methods and Experimental Design

U.S. Customary was used for the dimensions of the rocket since all sources specified dimensions in these units.

The rocket will be simulated in a 28 ft by 28 ft air box. The simulation will be run at full size. Since each simulation consists of 100 iterations, one trial will suffice.

The rocket will go through a simulated wind tunnel at 4500 m/s. This speed was chosen due to it being both a hypersonic speed and just below the speeds that would be required of the rocket to bring a payload to an altitude where it can propel itself to low-earth-orbit.

The rocket will be simulated at 0 and 15 degrees Angle of Attack (AoA) in order to simulate the rocket rolling and oscillating while falling. 15 degrees was chosen due to a reasonable assumption that the rocket would not tumble further than that with the modifications attached to it. This can be seen as a NASA rocket booster was jettisoned and did not tumble or break up. A higher AoA may lead to unintended results from the rest of the body exhibiting drag.

The performance computer used was a modified computer located in one of the researchers' homes.

Procedures:

1. Prepare the 3d model of the Minuteman rocket.
2. Start the fluid dynamics software.
3. Set up the fluid simulation.
4. Begin the simulation of 0 degrees Angle of Attack(AoA) and 4500 m/s.
5. Record the data.
6. Repeat steps 3-5 with 15 degrees AoA.
7. Repeat steps 3-6 with air brakes added.
8. Analyze the data using the air speed and turbulence cross-sectional overlay and its color scale to find the action of drag and its effect on the design.

Materials:

1. Performance Computer (4.3GHz 8-Core CPU, 8 GB VRAM, 32 GB RAM)
2. 3d Model of LGM-30G Minuteman III Missile 1st Stage
3. Computer assisted dynamics program

Data

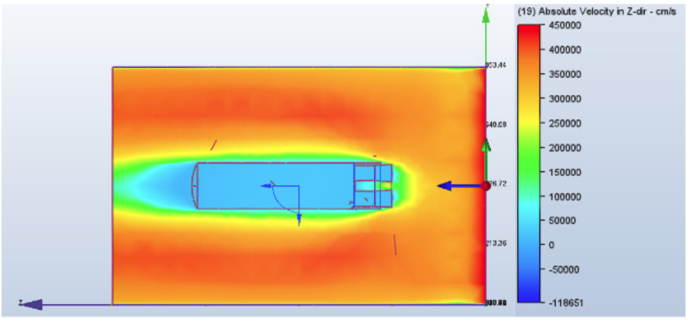

Fig. 1.1. Bare Rocket 0 AoA (Color Scale: Red-Blue Airspeed based on fastest in the positive direction being red, and fastest in the negative direction being blue. Negative direction is facing away from any horizontal arrows in the diagram)

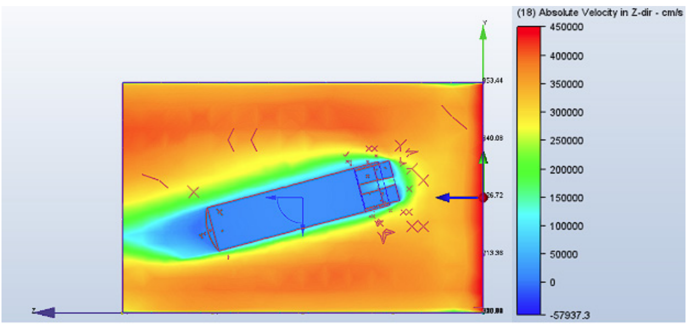

Fig. 1.2. Bare Rocket 15 Degree AoA (Color Scale: Red-Blue Airspeed based on fastest in the positive direction being red, and fastest in the negative direction being blue. Negative direction is facing away from any horizontal arrows in the diagram)

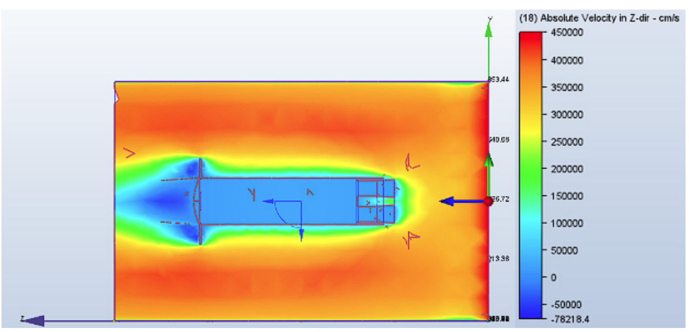

Fig. 2.1. Modified Rocket 0 AoA (Color Scale: Red-Blue Airspeed based on fastest in the positive direction being red, and fastest in the negative direction being blue. Negative direction is facing away from any horizontal arrows in the diagram)

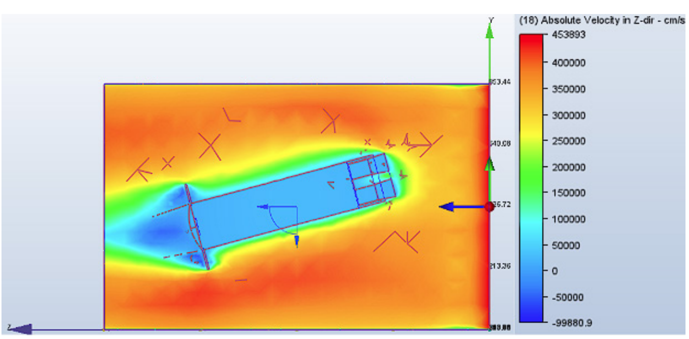

Fig. 2.2. Modified Rocket 15 Degree AoA (Color Scale: Red-Blue Airspeed based on fastest in the positive direction being red, and fastest in the negative direction being blue. Negative direction is facing away from any horizontal arrows in the diagram)

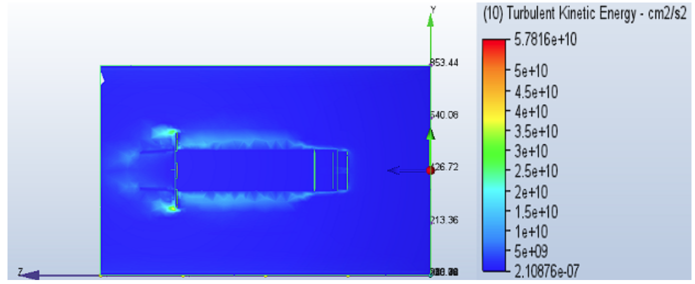

Fig. 3.1. Modified Rocket 0 AoA Turbulence (Turbulence is shown by the lighter blue colors, while the darker blue colors are less turbulent

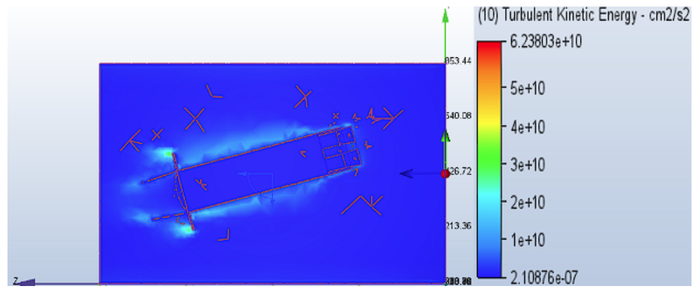

Fig. 3.2. Modified Rocket 15 Degree AoA Turbulence (Turbulence is shown by the lighter blue colors, while the darker blue colors are less turbulent)

Analysis

The results of the first simulation of the stage without any air brakes added to it went as predicted. With the shape that it had been built in, it was bound to be aerodynamically stable, but lacking significant amounts of drag. Even with the rocket tilted 15 degrees off of the direction of the airflow, it was still stable and not producing much drag. However, once the air brakes had been added, an immediate noticeable difference was found. A large area of negative pressure is created behind the rocket, allowing further stability and rapid deceleration. We can tell that there is negative pressure existent because we can observe that the airspeed reverses direction from the normal flow of air. This slows down the rocket rapidly, compared to the much smaller negative pressure zones created by the fuselage without the air brakes. By looking at the lowest values on the graph, we can see that the simulations with the airbrake had a significant increase in highest negative air velocity, indicating a success in the design. The majority of the air reversing within the models with the air brakes seems to be moving at around -500 m/s as opposed to the base model which has almost no air reversing within it. The model having negative pressure behind it creates a difference in pressure, causing it to rapidly decelerate. With the simulations of turbulence, it also shows that there is significant turbulence at the ends of the air brakes, ensuring that there will be increased amounts of drag from the addition of the air brakes other than the usual drag from an increased profile. Other angles could be tested for further data collection, but these two angles were chosen to test two different but likely scenarios.

Conclusion

The project worked as intended and developed a quick and simple way to slow down a Minuteman III rocket first stage for reclamation. Slowing these rockets down will allow secondary systems such as parachutes to deploy safely and allow people to recover the rocket for reusing. This can be used for sustainable, cheap rockets in the near future. Since the Minuteman III is getting retired soon, these rockets will soon be used by the government anyway to launch satellites. While this is but a single part of a system needed to reclaim these rockets, it provides some valuable insight into the feasibility of this option. By having a proof of concept such as this around, the government will be able to look into lowering costs by making a reusable rocket for quick orbital launches. Future research into this topic could include the control systems required to return it safely and the composite materials required to protect the airbrake and body. There could also be research done to test the performance of this system in other conditions such as at slower speeds and if it could stabilize itself should it start tumbling (which would entail simulating it at different AoAs).

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