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Retro Propulsive Technology in high Powered Rocketry

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ABSTRACT: Today's generation students can't follow their passion in such particular field, because of some reasons. And they don't know how to follow their passion in particular field. So, awareness of space and rocketry program in students we are building high powered rocket with retro propulsive technology. By doing this project it will inspire students to building a rocket and do research in space technology. In this research program they will learn designing, avionics, management, propulsion, testing and launch of rocket. And using retro propulsion technology they will recover rocket on the ground after successful launch.

KEYWORDS: Rocketry program and retro propulsive technology.

I. INTRODUCTION

Like Stone Age, Bronze Age, Iron Age, atomic age, now it is time for Space age. Space race began during cold war between US and Soviet Union. With the launch of first satellite "Sputnik" soviets proved their superiority in technology. Then, President Kennedy announced first lunar mission and NASA sent first human to moon in the late 70's. Till date government agencies like ISRO, NASA, JAXA, CSA and ESA have conducted hundreds of space missions such as flyby missions, orbiter mission, lander and rover missions.

"There was a time when Space was for exploration, but now Space is open for business". Private agencies are SpaceX, Blue Origin, Rocket Labs, ARCA, Virgin Galactic and STAR are focusing on making space travel commercial by building commercially viable launch vehicles.

II. RELATED WORK

Existing Launch vehicle technology is very complex and needs a huge amount of investment of time and money to be built. Worldwide, there are launch vehicles Falcon 9, Haas 2CA and Electron that have reduced the launch cost of small satellites by using reusable and 3D printed technologies. India has no launch vehicles specifically designed for small satellites. We have still not implemented 3D printed or reusable technology in launch vehicles.

Vision: To make travel commercial by building easy, economical and efficient launch vehicle for small satellites.

Mission: To design and build a launch vehicle for small satellite that can carry and place a satellite of 100 Kg to Low Earth Orbit. Launch vehicle has different subsystems like: Structure and Material, Avionics, Gimbal, Recovery, propulsion and launch station.

III. METHODOLOGY

(1) Pyro Ignition system:

Pyro-Ignition System is a test for parachute ejection mechanism. The basic principle of Pyro-Ignition System is to eject parachute out of body-tube with the help of force generated by propellant of pyro- igniter. The main aim of making Pyro-Ignition System is to get recovery of body parts of rockets such as nose cone and body-tube with the help of parachute.

Apparatus used: Black powder (as propellant) Aluminium foil, Shrinker Lighter Wires Steel wool Battery, Bluetooth module for wireless ignition Parachute cloth and Dummy body-tube and nose cone setup.

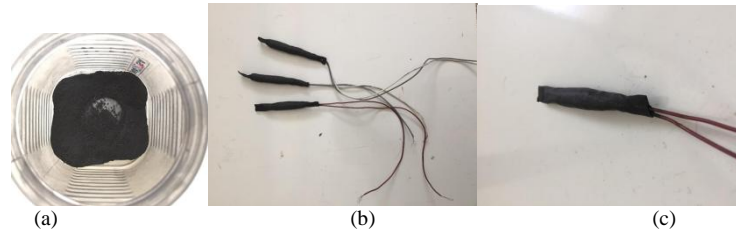


Fig. 1.(a) Black Powder Propellant, (b) Pyro igniters and (c)Closest view of Pyro igniter

Procedure adopted: First of all, take 4gm of black powder in a container. Cut two wraps of aluminium foil of 8cm x 7cm and put black powder in that. Igniter is made by connecting two wires by steel wool. Fold aluminium foil around black powder properly so it doesn't get spilled. Before completely packing up the aluminium foil put igniter in that, and then packed up the aluminium foil. Now take shrinker of 10mm diameter and put packed aluminium foil in it. The shrinker is pressed by heating it with lighter in such a way that no air gap should be formed in there, but precaution has to be taken while doing it. Any part of shrinker is not heated with very high temperature, it can make shrinker thick and air can get in. Igniter is assembling in dummy body-tube and nose cone setup while extended wires of igniters are connected to Bluetooth module and it is connected to battery.

Take great care while dealing with black powder, as it is explosive. While heating the shrinker, temperature should be maintained properly. Use safety parameters while performing the test. And this test has been successfully tested and has given desired outputs, without harming anything or anybody.

(2) Rocket Motor:

A propulsion device/component that is capable of delivering enough thrust to the rocket to propel it to a height (the height achieved is dependent on the type of propellant used, dimensions of the rocket motor casing, shape of nozzle, area of nozzle etc.) by ejecting out the burnt mass at a very high rate. The rocket motor works on the basic principle of energy conversion. When propellant inside the motor is ignited, the combustion of propellant causes the conversion chemical energy/internal energy of propellant mix into the kinetic energy. This kinetic energy is delivered to the burnt mass, which leaves the nozzle at a high speed. Further, conservation of linear momentum does its work. The exhaust mass causes the entire rocket to propel in the desired direction. Since, entire the rocket is dependent on the motor for moving up, rocket motor forms the basis of propulsion system for a rocket.

The following apparatus are used: the motor casing requires fibre tube, multipurpose sealant and pan head screws.

The propellant requires: containers, potassium nitrate, powdered sugar, sulphur, induction stove, conducting vessel, gloves and mask for safety spoons.

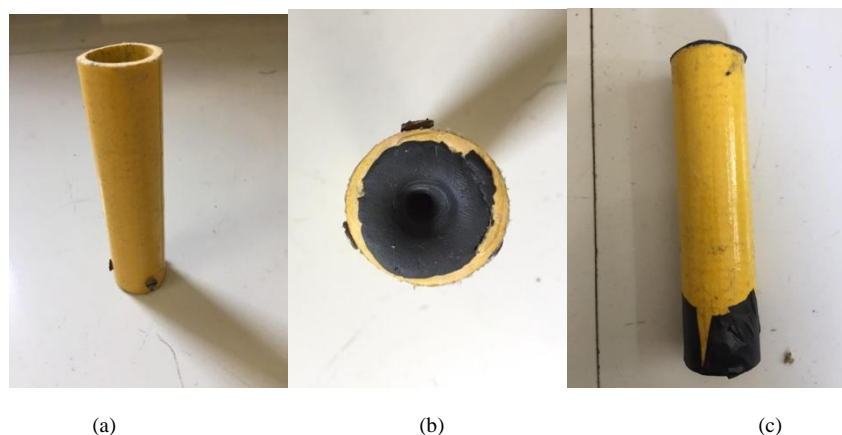


Fig. 2.(a) Rocket Motor Casing, (b) Rocket Motor Nozzle and (c)Rocket Motor

Procedure adopted: Cut a 12 cm tube from the fibre tube and shape the ends of the tube so that there are no irregularities on the ends. Drill holes on any one end of the motor separated by an angle of 120°. The holes must be at distance of 8mm from the nearest end of the motor casing. Once holes are done, prepare the sealant by mixing the hardener and resin in the ratio of 1:1. Now pack that end of casing with the help of this sealant, which has the drilled holes. Make sure that the sealant covers up the holes from the inside as well. Use a T-mould and a hammer to place the sealant at the end of the casing firmly. Screw the holes with the help of a pan head screws. The screws will hold the sealant properly in place. With the help of skewer, make a through hole in the sealant, while the sealant is not set and dry. Make sure that hole is exactly in the centre of sealant. With the help of a conical structure, broaden the sealant hole externally. This will result in a Diverging nozzle. The casing is now ready. Set aside and let it dry. Finally place the washer of desired diameter on the nozzle end from the inside.

The procedure for making the propellant: Measure the following chemical compounds in separate vessel: 65 grams of potassium nitrate, 34 grams of powdered sugar and 1 gram of sulphur.

Move out to an open place having accessibility to electrical connection. Setup the induction stove on the mode "Sauté" and the set the temperature on 80° C. Place the conducting vessel on the stove and dry out the moisture/ water present on the surface on the vessel. Now empty the entire potassium nitrate vessel into the conducting vessel and start the timer for 15 minutes simultaneously. Keep on stirring and crushing the potassium nitrate constantly for the next 15 minutes. There should not be any breaks while preparing the propellant i.e. avoid leaving the chemicals still, this will cause decomposition of the chemicals or might even result in explosions. After 15 minutes of stirring, empty the powdered sugar into the conducting vessel and mix potassium nitrate and sugar thoroughly. After a minute of mixing, add sugar to potassium nitrate and raise the temperature to 100°C. Keep on mixing this mixture constantly.

Once the caramelization starts, add sulphur. Now be careful while stirring the propellant, as it has turned into a potential explosive. Watch out for smoke. If the mix liberates smokes rapidly, take the vessel off the stove, keep on stirring, and then place back the vessel on the stove after the smoke ceases to liberate. Keep cooking the propellant till the propellant acquires the viscosity of a semi solid fluid (like honey).

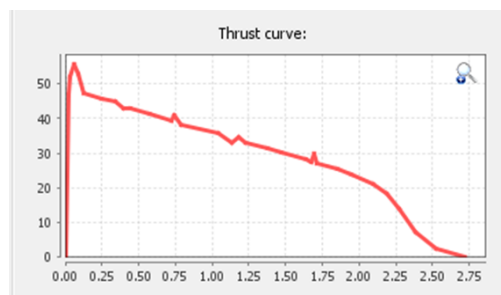


Fig. 3. Thrust Vs. Time Curve

Don't drill the holes at the joint of casing. This will result in weakening of motor casing and might result in development of cracks. Avoid over heating the propellant, as heating makes the propellant prone to explosions. Wear the gloves and put on a mask while cooking the propellant. Propellant should not stick on the conducting vessel. Ensure proper mixing of oxidiser and fuel.

This is a standard method of making rocket motors. And the motors deliver thrust which depends on the ratio of fuel and oxidizer, area of nozzle, diameter of washer used, dimensions of the motor casing and amount of propellant.

(3) Calculation:

$$\text{Distance } (D) = 100 \text{ meter}$$

$$\text{Flight Time } (t) = 3 \text{ second}$$

$$\text{Mass of Rocket } (M_p) = 950 \text{ gram}$$

$$\text{Specific impulse } (I_{sp}) = 115 \text{ seconds}$$

After calculation we get: velocity of rocket is $\Delta v = 66.66 \text{ m/s}^2$, fuel mass required is $M_f = 0.89544 \text{ kg}$, propellant mass required is $M_p = 545 \text{ g}$.

Therefore the average thrust produced by the rocket is $F_{avg} = 21.7088 \text{ N}$.

(4) Prototype Rocket Test:

It is a rocket which is used for testing, with same weight and payload capacity as the rocket which is planned to launch. Dummy Rocket is used for testing before the actual launch and get data which is required before the launch. The component for which data is required or the system which has to be tested is assembled in the dummy rocket and experiments are performed until expected result is not obtained. As the basic principle of Dummy Rocket Test is to do testing before the actual launch, that's why we need to do dummy rocket test. All the experiments that are required to perform are performed on the dummy rocket.

Apparatus required: Nose cone, dead mass (if required for mass adjustment), body tube, parachute, rocket motor, engine block, Fins of cardboard Screws, Glue gun Measurement scale Launch plug, Payload (if required), On-board computer (for communication) and Wireless Ignition System.

IV. EXPERIMENTAL RESULTS

Design appropriate rocket design in open rocket with desired stability, height and velocity as required. Dimensions of every component are pre-decided. Take the body tube of 100cm length of pine (0.48 gm/cm^3 density) material.

Inside the body tube assemble, payload (if required), parachute mechanism, engine block of 31g, 4.9 cm having diameter 4.8cm (thickness 0.8cm) and rocket motor. To fix the rocket motor, 3 screws are attached on outer parts. Attach three fins at 120° of cardboard having root part of 10cm, tip part of 5cm and 0.3cm thick at the end of the body-tube. Attach nose cone of 210gm weight, length 10.7 cm, base diameter 6cm, completely filled of material of 0.9 Gram/cm^3 density, with shoulder of length 4.3 cm, diameter 4.5 having thickness 2.75cm at the top of the body-tube. Attach launch lug of length 70cm to the body-tube with the help of glue gun. After assembly of rocket, set it on launch pad and setup ignition system properly. Check the systems properly before the launch. From a distance, switch on the ignition system and launch the rocket.

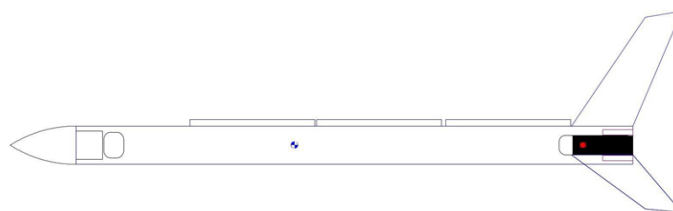


Fig. 4. Rocket design

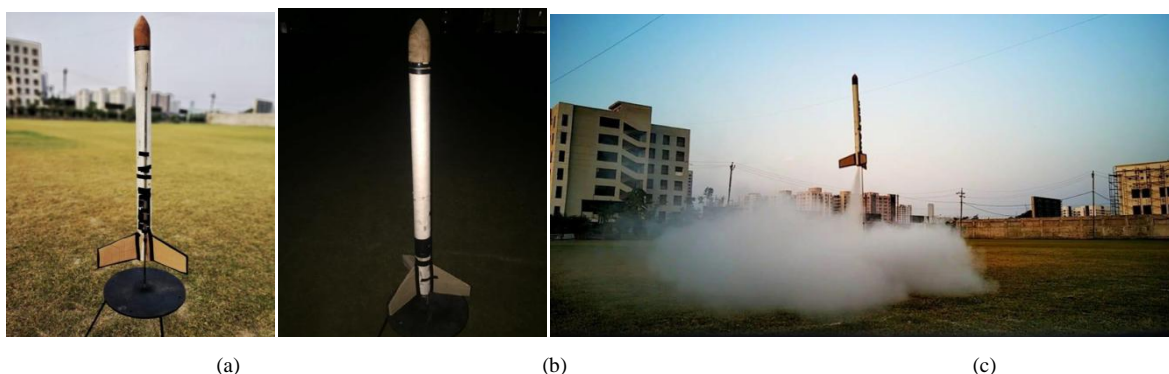


Fig. 5, during testing (a) Prototype Rocket on Launch pad, (b) Night Launch of Prototype Rocket and (c) Flight of Prototype Rocket



Before testing, all the connections should be checked properly. Launching is done when every team member is at safe distance. Place cameras at safe place and appropriate distance.

Every dummy test has given data which was required, appropriate height been achieved, path was mostly straight; just slightly parabolic. This is the standard method to make dummy rocket for testing purpose.

V. CONCLUSION

By performing the tests, we have got required thrust for rocket and every system is working nominally. We can successfully launch rocket from launch station and can put payload up to 200 gram and measures data about at that altitude. We also tested parachute mechanism on ground level. In future we are trying to recover rocket again by using different recovery system.

REFERENCES

- [1] Augenstein, B. W., and Harris, E. D, et al, "The National Aerospace Plane (NASP): Development Issues for the Follow-on Vehicle Executive Summary," RAND Corporation, 1993
- [2] Ward, Jr., J. E., "Reusable Launch Vehicles and Space Operations," Occasional Paper No. 12, Center for Strategy and Technology, Air War College, Air University, Maxwell Air Force Base, May 2010, AL
- [3] Tae-Ho Lee, I.-C. K., and Young-Kyu Park, 1993, a Study on the Low Pressure Burning Characteristics of the Composite Propellants. 31st AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit, Diego, CA, June 1993
- [4] Jie LI, Qiao JIANG, Xi-ning YU, Ying DU, 2010. Intelligent Temperature Detecting System, IEEE Conference on Intelligent System Design and Engineering Application, China, April 2010
- [5] A. Aziz, R. Mamat, W. K.Wan Ali, 2013. Low pressure strand burner for solid propellant burning rate studies, International Conference on Mechanical Engineering Research, Malaysia, 3rd July 2013
- [6] Olds, A. D., Beck, R. E., Bose, D. M., White, J. P., Edquist, K. T., Hollis, B. R., Lindell, M. C., Cheatwood, F. M., Gsell, V. T., and Bowden, E. L., IRVE-3 Post-Flight Reconstruction, Aerodynamic Decelerator Systems Technology Conferences, Daytona Beach, Florida, 28th March 2013



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