Exploration of High-Altitude Chemistry using an Ozonesonde, Turbine, and UV-Degradable Polymers

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Introduction

The 2026 "Orgosat" team developed a payload flown at approximately 84,000 feet on a high-altitude balloon to observe atmospheric conditions. The payload carried three experiments utilizing chemistry and engineering in space science. These student-designed projects investigated atmospheric conditions by measuring ozone concentrations, observing polymer degradation, and examining energy generation with a turbine.

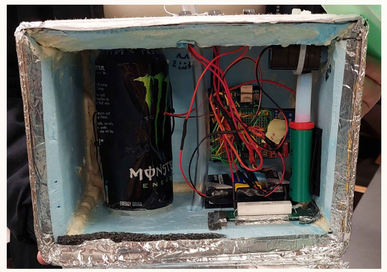


Figure 1 (left). *Exterior of the flight payload containing polymers.*
Figure 2 (right). *Interior of the flight payload.*

UV Degradation of Polymers

Three polymers were sent up on the exterior of the payload with various chemical vehicles and coatings to test UV degradation in upper atmosphere conditions. Both before and after the flight, each plastic was put through static testing to see which would fare best under these harsh conditions.

Table 1: *Stress Test Results of Polymers*

Plastic	Ground Test	Post- Flight Control	Post- Flight Experimental
PLA	2.78 lbs (Mineral Oil)	9.17 lbs (Mineral Oil)	6.61 lbs (Zirconium (IV) Oxide & Mineral Oil)
Nylon	5.02 lbs (Ethanol)	29.60 lbs before ripping (Ethanol)	41.20 lbs before ripping (Benzotriazoles & Ethanol)
ABS	1.45 lbs (Ethanol)	3.45 lbs (Ethanol)	2.68 lbs (Dibenzylidene Acetone & Ethanol)

Discussion

Statics testing implied that all the plastics had changes in chemical structure, becoming less crystalline and more amorphous. This is shown by increased flexibility and resistance to necking.

Percent of Change Reduced by Experimental Coatings:

- Nylon - 39.2% increase
- PLA - 27.92% decrease
- ABS - 22.32% decrease
  - Experimental ABS had the smallest deviation from ground, showing that the dibenzylidene acetone coating best preserved original properties.

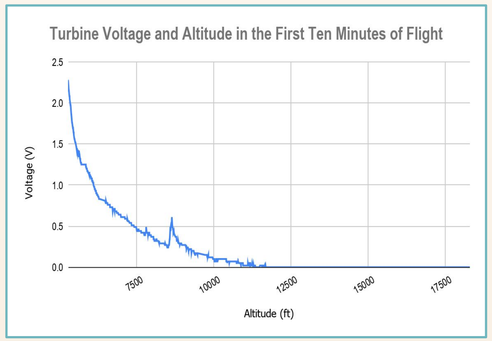
These thermoplastics do not seem to be ideal for external use on spacecraft, though they may be functional for internal use. Further research is needed on the usage of dibenzylidene acetone as a UV protectant for polymers, and on benzotriazoles and ethanol as methods of increasing flexibility.

Turbine

A turbine was used to approximate wind speed across altitude. The turbine produced voltage when spun during flight. There is an exponentially decaying relationship between voltage and altitude.

Data was recorded for the first ten minutes of flight, the inverse relationship is shown.

Fig 3. *Graph of Voltage vs Altitude*



Discussion

The turbine halted about 10 mins into flight, likely due to the following:

1. A payload from above crashed into the turbine and may have disconnected voltage sensor wires.
2. Ozonesonde electrolyte solution caused corrosion in the voltage sensor.

In conclusion, a turbine could be used as an alternative to create power for components of the payload. Additionally, the voltage inducted by the turbine could potentially be a secondary indicator of balloon movement and air pressure as altitude changes. As air pressure decreases, so did voltage output. See Figure 3.

Ozonesonde

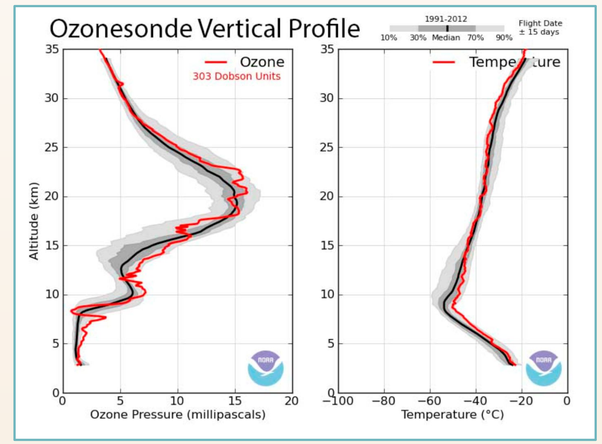


Fig 4. Average ozonesonde flight data from NOAA [1]

Discussion

The ozonesonde was tested for background voltage without ozone. Testing at ground level with an ozone generator indicated proper electrochemical cell functionality and detection of ozone.

During flight, collision with another payload seems to have caused the electrolyte solution to leak and corrode the voltage sensor. However, ground experimentation indicates a successful preliminary design for a functional ozonesonde at low cost and with readily available materials.

References

1. NOAA (2026). Ozone and Water Vapor - NOAA Global Monitoring Laboratory. Noaa.gov.

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