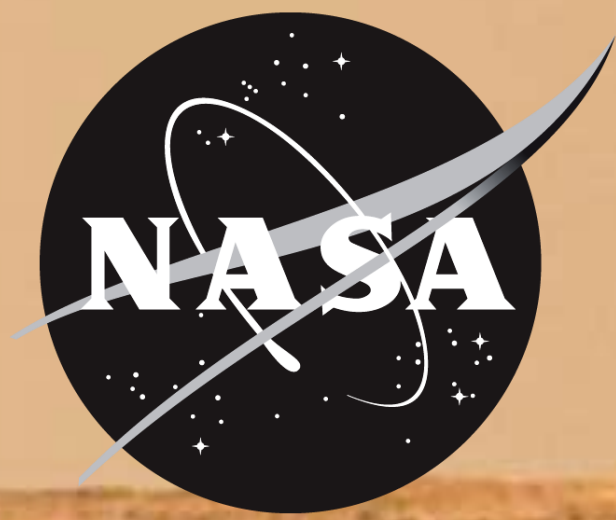


# Advanced Filter Technology For Nuclear Thermal Propulsion



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The Scrubber System focuses on using HEPA filters and carbon filtration to purify the exhaust of a Nuclear Thermal Propulsion engine of its aerosols and radioactive particles; however, new technology may lend itself to alternate filtration options, which may lead to reduction in cost while at the same time have the same filtering, if not greater, filtering capabilities, as its predecessors. Extensive research on various types of filtration methods was conducted with only four showing real promise: ionization, cyclonic separation, classic filtration, and host molecules. With the four methods defined, more research was needed to find the devices suitable for each method. Each filtration option was matched with a device: cyclonic separators for the method of the same name, electrostatic separators for ionization, HEPA filters, and carcerands for the host molecule method. Through many hours of research, the best alternative for aerosol filtration was determined to be the electrostatic precipitator because of its high durability against flow rate and its ability to cleanse up to 99.99% of contaminants as small as 0.001 micron. Carcerands, which are the only alternative to filtering radioactive particles, were found to be non-existent commercially because of their status as a "work in progress" at research institutions. Nevertheless, the conclusions after the research were that HEPA filters is recommended as the best option for filtering aerosols and carbon filtration is best for filtering radioactive particles.

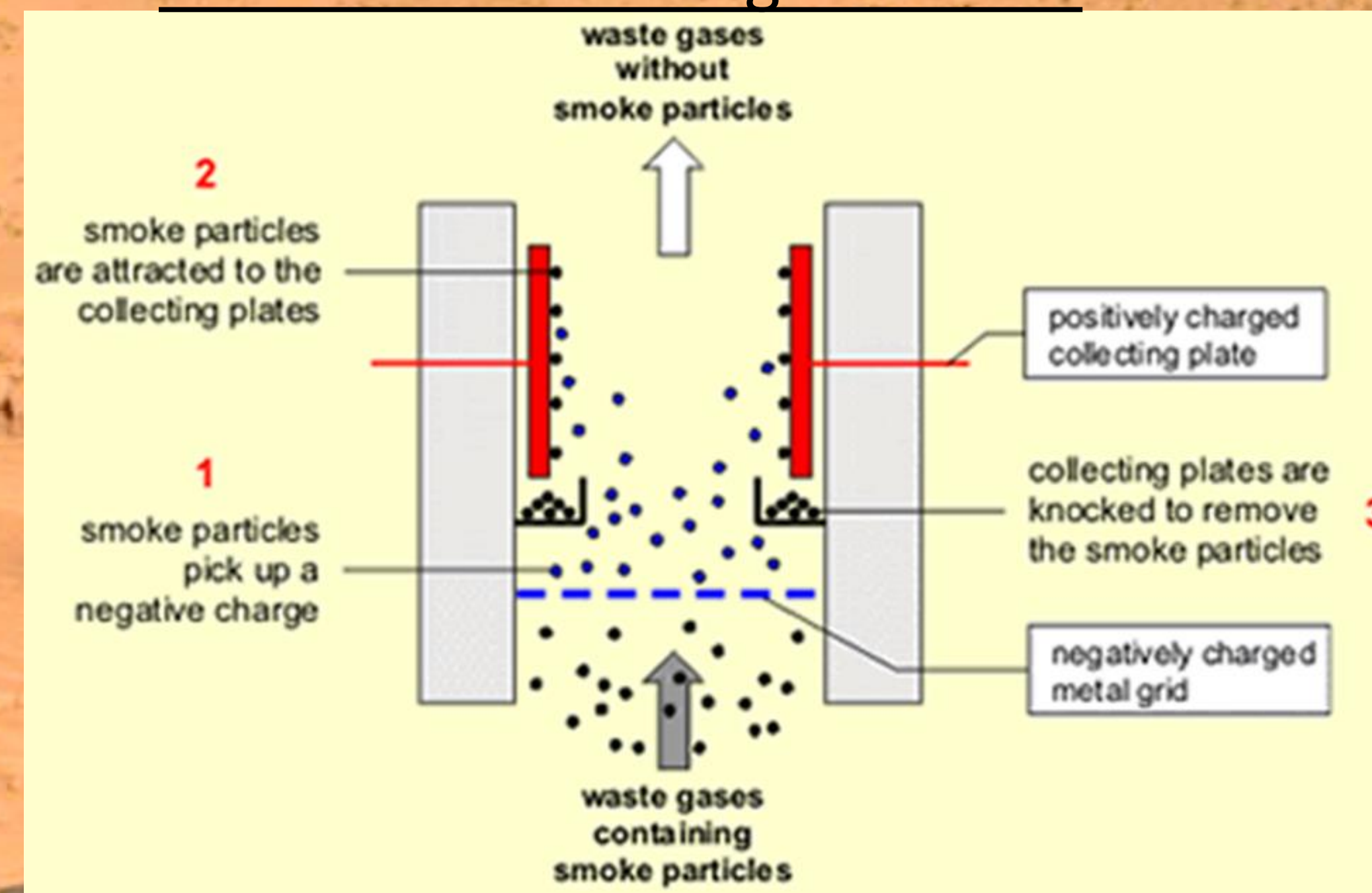
## Introduction

- Nuclear Thermal Propulsion (NTP) is the best way to get Mars.
- Testing NTP is challenging due to the radioactive exhaust it produces even with existing technologies.
- The task of this project was to determine alternative technologies for aerosol and noble gas filtration.

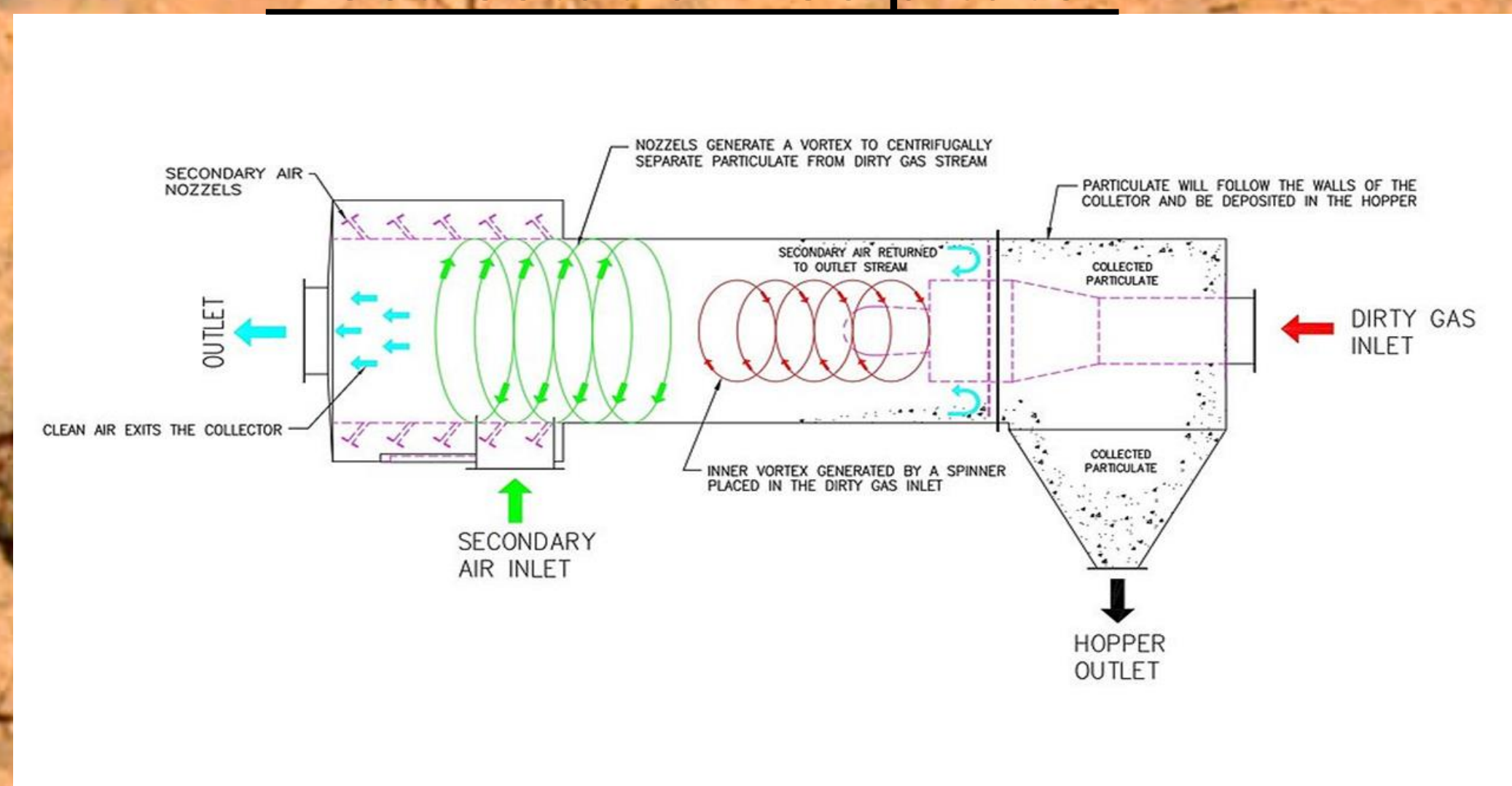
## Objectives

- The focus of the project was to determine alternative methods for filtering aerosols (HEPA) and noble gases (charcoal) through research on nuclear and coal factories.
- Research cost, flow rate, size, efficiency, and max operating temperature for each method.
- Determine which alternative technology would be the best option, if possible.
- Risks were taken into consideration such as hydrogen embrittlement and maintenance.

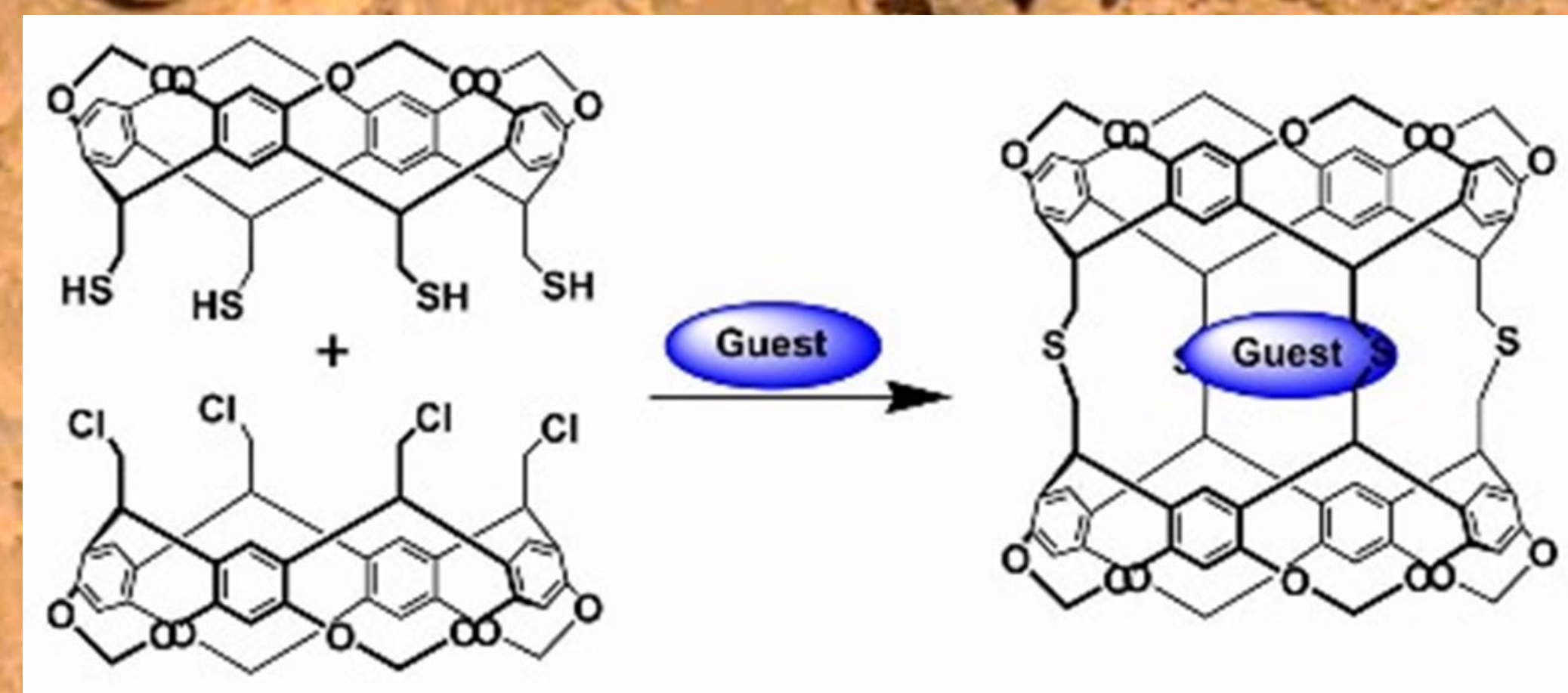
## Alternative Filtering Methods



Electrostatic Precipitator



Cyclonic Separator



Carcerands

## Outcomes

- Four alternatives were found:
  - Electrostatic Precipitators
  - Cyclonic Separators
  - HEPA Filters
  - Carcerands
- Electrostatic Precipitators can withstand higher temperatures, have a higher efficiency, and are more durable than HEPA Filters.
- No alternative was found to be suitable for filtering radionuclides at extreme temperatures.
  - Carcerands requires further research and testing.

## Summary

- Alternate methods were discovered for radioactive NTP exhaust filtering through research.
- Identified several alternate technologies for filtering NTP exhaust.
  - Electrostatic Precipitators were found to be a viable alternative to filtering aerosols.
  - No alternative option was found suitable for filtering radionuclides.

Acknowledgements: David Coote, Justin Junell, Richard Wear, Rebecca Junell, Sam Byer, Evan Richard

Top Picture: [http://www.school-for-champions.com/science/static\\_uses.htm#.VYh2YPn4-Uk](http://www.school-for-champions.com/science/static_uses.htm#.VYh2YPn4-Uk)

Middle Picture: <https://en.wikipedia.org/wiki/Cyclonicseparation>

Bottom Picture: [https://en.wikipedia.org/wiki/Carcerand#/media/File:Synthesis\\_of\\_a\\_Carcerand\\_Cartoon.jpg](https://en.wikipedia.org/wiki/Carcerand#/media/File:Synthesis_of_a_Carcerand_Cartoon.jpg)