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Electrical Characteristics of the Mars Electrostatic Precipitator

Kennedy Space Center

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Introduction

- NASA's next generation Mars missions will include chemical processing plant to convert Martian atmosphere into consumable products to support astronaut activities
- The ever-present dust in the Martian atmosphere could potentially foul the chemical process or reduce purity of the product
- Electrostatic precipitator (ESP) is one possible solution to remove dust particles from the ingested Mars atmosphere
- ESP uses high voltage to charge aerosolized particles and deposit them on collector electrodes

Overview

- The Electrostatics and Surface Physics Laboratory at NASA's Kennedy Space Center has developed an ESP testbed to understand the intricacies of corona discharge in Mars atmospheric conditions
- Current-voltage (IV) trends have been established for a number of precipitator flow conditions
- Corona onset voltage and streamer onset voltage trends have been established versus different pressure

Theory

Potential difference > Corona onset voltage
Gas Molecules are ionized and electron/ion pairs are generated

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The presence of electron/ion pairs charge the dust particles

Particle Diameter > 7 μm	Particle Diameter < 3 μm	Intermediate sized particles
Corona field charging. Relies on the electron/ion pairs to be accelerated by the electric field and deposited on the surface of the dust particle	Thermal Diffusion charging. Relies on the thermal collision between electron/ion pairs and dust particles.	A combination of both corona field and thermal diffusion charging.

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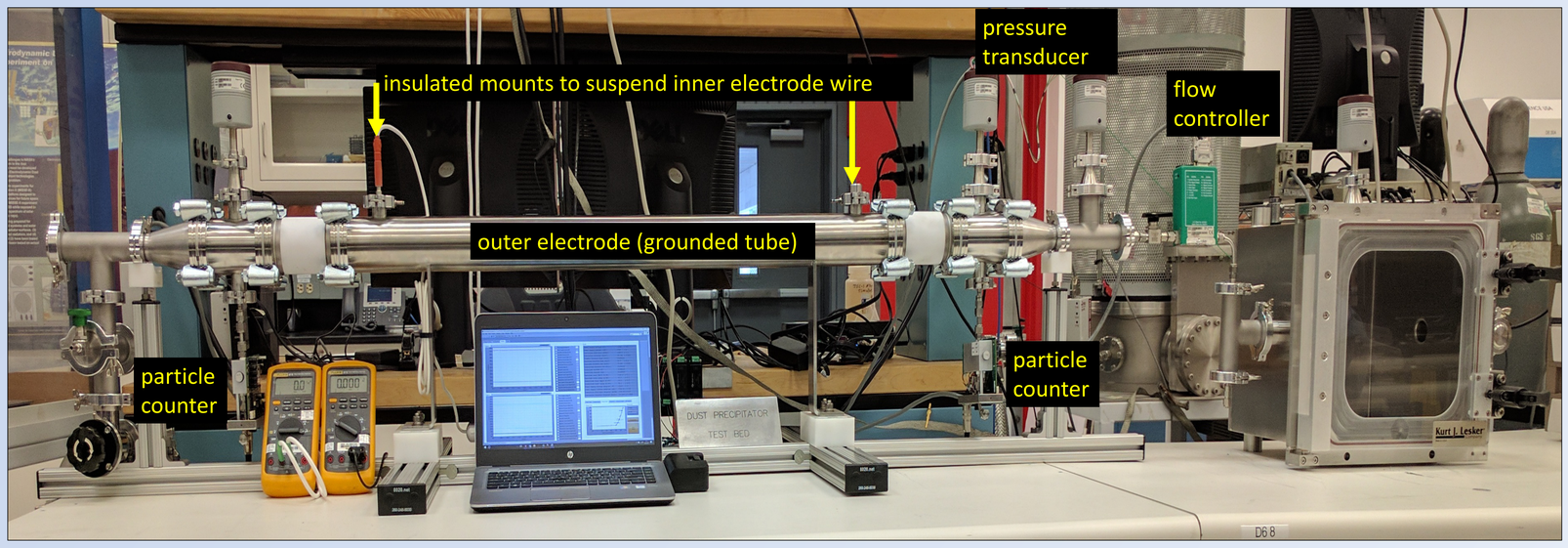
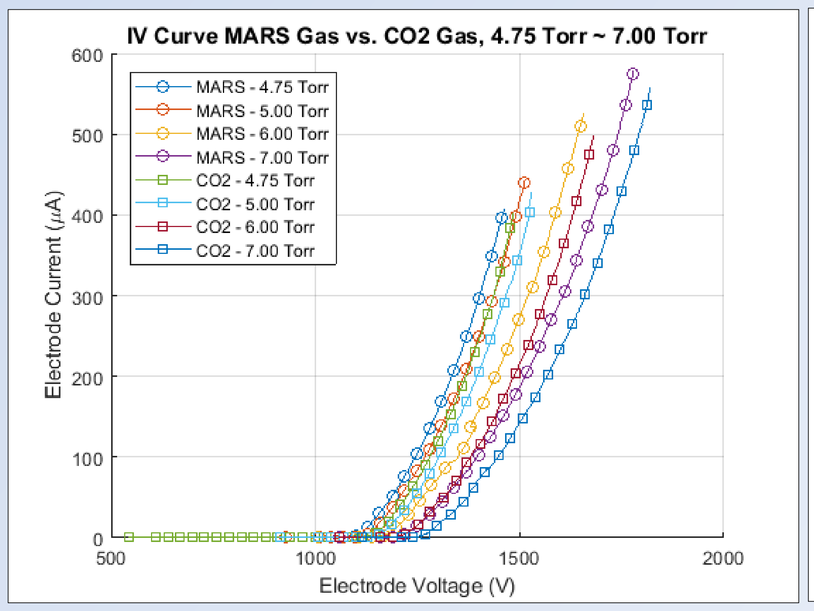
The electric field accelerates the charged dust particle toward to the collection electrode

Experimental Setup

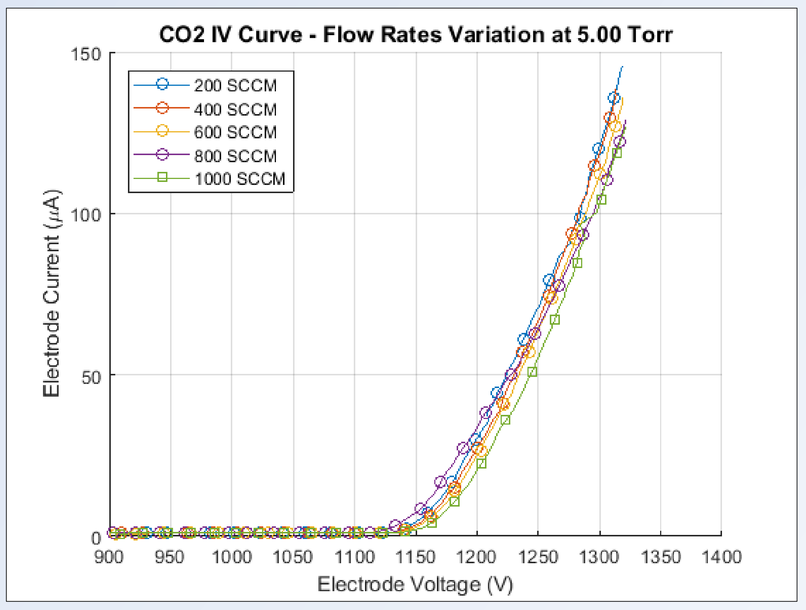


- The ESP testbed consists of a stainless steel tube that is 1 m long
- A 125 μm diameter stainless steel wire is suspended at the center of the tube, acting as the electrode
- The testbed uses a combination of upstream flow controller and downstream pressure controller to maintain an average Martian atmosphere pressure
- The testbed is capable of generating up to 2 SLPM of flow rate

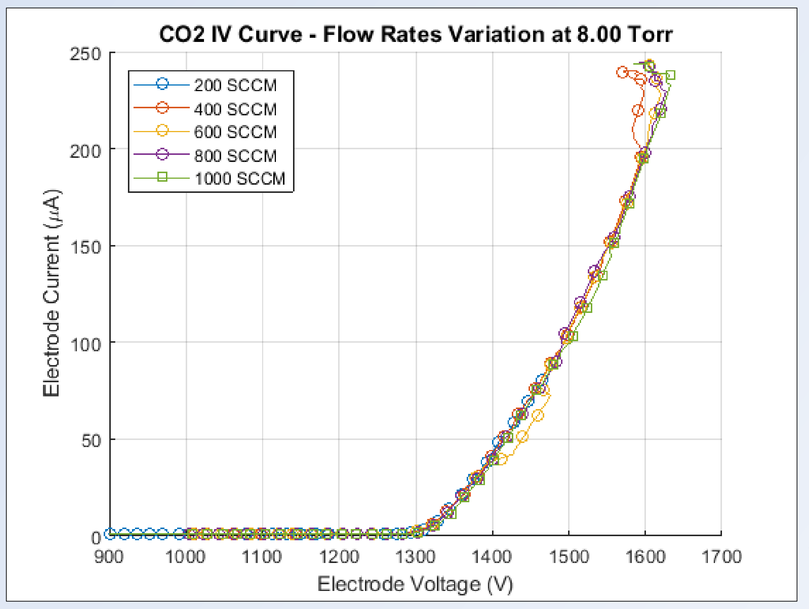
Experimental Results



IV curve relationship, comparison between Mars gas and pure CO_2. As expected, the corona onset voltage increases as well as the streamer onset voltage with increase in pressure



IV curve relationship for a 7.1 cm diameter tube with a coaxial 125 μm wire. The increase flow rate at 5 torr has minimal impact



IV curve relationship for a 7.1 cm diameter tube with a coaxial 125 μm wire. The increased flow rate at 8 torr has minimal impact

Future Work

- Incorporate Martian simulant dust into the CO_2 flow
- Geometry optimization for an ESP to enable future manned missions on Mars

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