Stand-Alone Dust Sprinkler Facilities

Technical Overview

PROGRESS IN ENVIRONMENTAL SIMULATION TECHNOLOGIES

Dust-Distribution Mechanism

A distributing mechanism for the dust particles (unbaked and uncharged) can be designed to 'sprinkle' the dust onto surfaces and facilitate investigation of dust deposition and adhesion phenomena while under vacuum and temperature conditions. The basic dust particles' source shown in Fig. 1 includes a lunar soil simulant container, a dust refill compartment, and all of the necessary filters to prevent dust from entering the vacuum and from leaving the chamber.

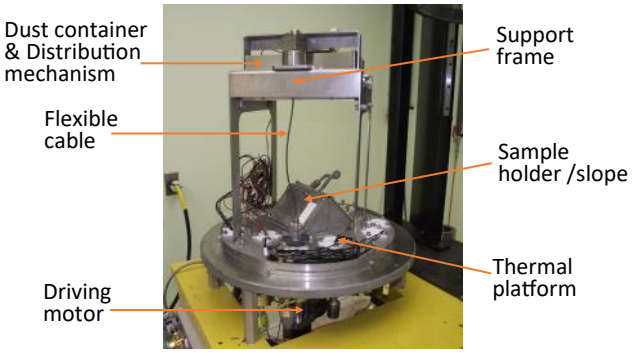


Fig. 1: Basic design of the Dust Sprinkler Mechanism

The Dust Sprinkler contains a sieve (fine mesh or holed metal plate) which is agitated by a driving motor (see Fig. 1). In this way, dust particles are uniformly distributed onto the unit under test (materials samples, bearing unit, mechanical system, etc.) mounted on the Sample Holder (eventually, positioned with a slope to represent different dust adhesion conditions) located on the Thermal platform below the Dust Sprinkler.

Alternative to the sprinkling mode, dust simulant could also be applied to the samples under test by direct submersion. The test conductor would pile a significant amount of dust and cover the area of interest on the surface of the sample, thereby carrying out the test and monitor the corresponding metrics to study the impact on the tested sample performance when subjected to full submersion of dust.

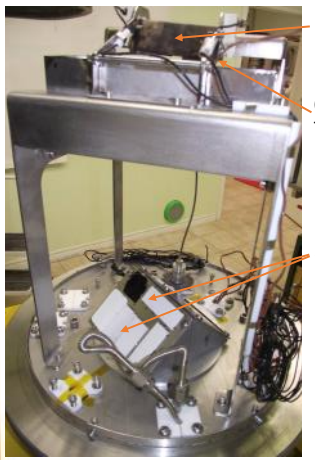


Fig. 2: General view of the experimental set-up designed for the white-painted samples coupons testing after it was installed in the Dust Sprinkler chamber.

The IR lamp shown in Fig. 2 is used for baking, degassing, and pre-treatment of lunar soil simulant loaded into the dust container prior to starting the Dust Sprinkler Mechanism. Figs. 3 and 4 show the top and bottom view of the Dust Sprinkler mechanism holding and distributing dust particles through a dust sieve agitated by a driving motor. The motor is mounted outside the vacuum chamber. Rotation is transmitted into the chamber due to a rotary feedthrough and a flexible cable connected to the cam actuator which drives the Dust Shaker (Fig. 4).

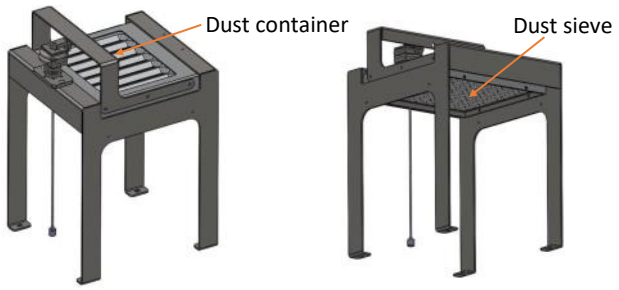
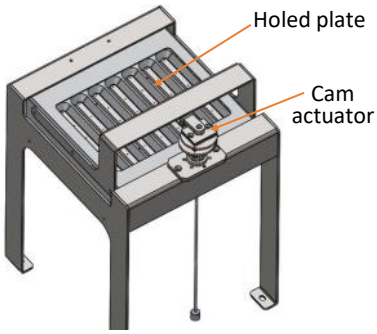


Fig. 3: Design pictures of the Dust Sprinkler (top view and bottom view)

Fig. 4: Design of the dust compartment and dust shaker mechanism



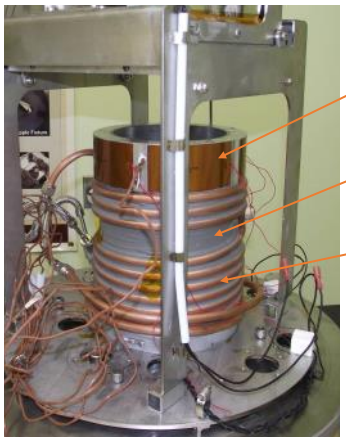


Fig. 5: Thermal shroud/ Rotary set-up for lunar dust testing of a large bearing

The system shown in Fig. 5 includes a thermal shroud and a rotary feedthrough can be used for testing rotary devices such as bearings in simulated conditions of lunar dust.

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Facilities Overview

This section provides a description of an optional test facility which can be used to accommodate the proposed Dust Sprinkle Mechanism.

The Dust Sprinkle Mechanism can be installed in a test facility as shown in Fig. 6 which includes a detachable bell jar chamber and a flat base plate with a number of CF flanges and all necessary electrical, control, and motion feed-throughs. A chassis for mounting all these components and their support equipment in a single platform to consolidate the experiment setup can be design.

Fig. 6: Conceptual Configuration of Lunar Dust Simulator Facility (left) and Thermal control platform with TVAC dust tester (right)

The main components of the system include:

- Temperature-Vacuum chamber
  - ◊ Sample holder/Test Rigs mounting on a thermal platform
  - ◊ Dust particles source mechanism
- Thermal control heat exchanger
- Vacuum Pumping system
- Support electronics & Software

T-Vac Chamber

The T-Vac Chamber could be made of a simple glass jar as a cover on a base plate. The base plate acts as an interface between the chamber and any external equipment. Inside the chamber is where the vacuum and temperature would be maintained. The size of the chamber is shown in Fig. 7.

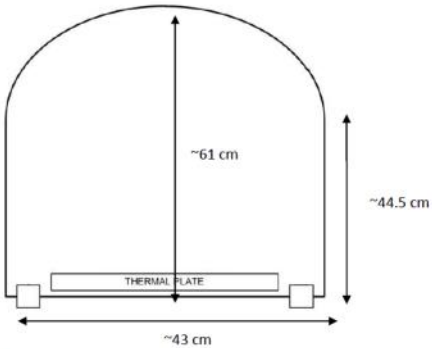

Fig. 7: Overview of Bell Jar dimensions for dust testing

A number of interface ports are available in the chamber base plate (see Fig. 8). The interface ports are compatible with both mechanical and electrical feed-through. The center has a large inlet for the vacuum-pump connection, with a build-in compartment for filter that minimizes contaminants getting to the oil-free pumping system.

Fig. 8: T-Vac Chamber base plate

A thermal-controlled plate is located inside the chamber. Heating and cooling of the thermal control plate is be controlled through a PC. The thermal shroud is able to provide additional heat-exchanging capabilities inside the vacuum environment inside the chamber.

Fig. 9: Test facility for accommodation of the Dust Sprinkler, Thermal shroud, Thermal platform, and the Chamber base plate

This test facility (see Fig. 9) would allow for combined thermal, vacuum, and dust testing. The facility can be equipped with drive systems for translational and rotational movements and with thermal-vacuum test rigs to allow for mechanical testing and life time evaluation of different mechanical devices (bearings, connectors, etc.) and systems. Electrical and instrumentation interfaces for operating the item under test and for making the required measurements on specified parameters could be configured as required.

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