25 – Dust Mitigation

SUMMARY

The best way to deal with dust is to simply avoid it. This chapter describes several easy ways of doing that.

The Moon is covered with dust from meteorite and micrometeorite bombardment. The fluffiest part of the dust is in the top few inches making the surface "squishy" according to the Apollo astronauts.

When landers land, their exhaust velocity can be double lunar orbital speeds thereby causing sandblasting of structures within the area.

Problems with Dust

As astronauts walk in the dust and as rovers drive over it, it kicks up and deposits on everything. This dust is very fine and gets into everything. It can get into the joints of moving parts thereby causing wear and even seizing up. It can be electrostatically charged and so sticks to equipment and space suits.

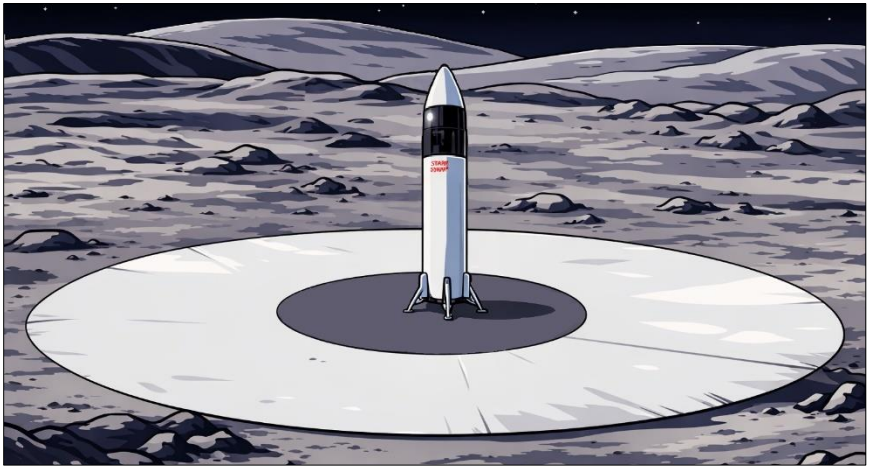
Worse yet, if the dust is tracked into a habitat, it can be inhaled by the crew. Since it is so fine, it can be breathed in and lodged within the lungs causing health problems.

However, one can envision straightforward solutions to each of these problems.

Solution #1: Landing Pads

For the problem of structures being sandblasted with landers, the very first lander won't have this issue due to the lack of anything else being in the area at that time. A lot of concepts are being developed to produce berms and sintered create pavers for landing pads on the Moon.

Conceivably, thin tarps could be delivered as payload and then telerobotically secured to the lunar surface. From the payload, a telerobot could pull out a small, blast-resistant tarp and secure it to the ground underneath the lander. But, for a longer-term solution, telerobots could use microwaves to sinter (i.e. fuse) the lunar dirt or even make bricks and configure them into a robust landing pad. Telerobots could also make berms to help redirect and reduce the blast.



A ceramic pad with peripheral tarp protects from blast and exhaust interactions.

Solution #2: Equipment Wear

For the problem of equipment wear due to the exposure of dust, it is important to remember there is no wind on the Moon. So, instead of dust floating up in the air, it falls in a ballistic (parabolic) trajectory. This helps somewhat.

Telerobots can be designed to move slowly so that the dust isn't kicked up very high. Parts can be designed to keep telerobotic joints far from the dust being kicked up. The speed at which robots drive and work can also keep the dust down. The mining industry on Earth has a lot of experience designing equipment in abrasive environments so it is a matter of iterative engineering to figure out the best designs.

Solution #3: Roads

The Apollo program demonstrated that their crewed rovers would kick up "rooster tails" of dust when their vehicles bounced on an uneven surface. A solution for this would be to create basic dirt roads in which telerobots would smooth out a road and using a vibrating "steam roller" compact the dirt so that, as vehicles drive over it, they don't bounce and kick up dirt. For much more discussion of lunar roads, click here.

Solution #4: Don’t Go Outside

"A clever person solves a problem. A wise man avoids it. -- Albert Einstein

Too much of our thinking of astronauts is about them being in space suits, walking around on the surface, and picking up rocks. Sure, there's

a place for that. But if we are going to stay, then much of the work will be indoors and not in a space suit.

Between the Soviet Union (on the Moon) and the United States (on Mars) teleoperated rovers have driven up to 22 kilometers. So, a lot of scientific exploration can be done using rovers at lower cost and must lower risk. With the Moon only three seconds time delay, rovers can accomplish things more quickly than on Mars. So, there isn't going to be that great of a need to send crew out to walk around in the dust.

NASA Surface Exploration Vehicle has a clear bubble in the front where crew, while remaining inside the vehicle, can get a close-up view of a rock and could even use mechanical manipulators to grab samples and bring it into the vehicle through an airlock.

Solution #5: Leave the Suits Outside

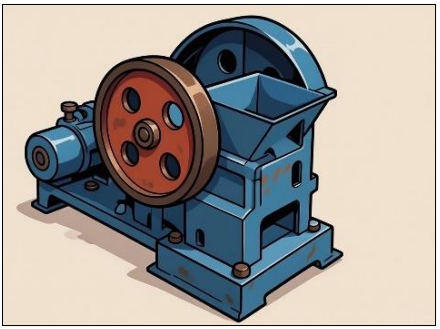
NASA has developed an ingenious solution to prevent dust from getting inside either the crew vehicle or the habitat. Rear-entry space suits ensure that any dust on the suit is left outdoors. This is where the suit is attached to the outside and the crew enters and exits from the back of the suit.

Clear plastic suit liners.

If a network of roads and trails are telerobotically produced, then, even when explorers (such as international astronauts and tourists) do walk out on the surface, dust would largely be limited to the boots. If these paths were sintered using microwaves, little if any dust would be able to get on to the suit. Finally, coveralls could be used to keep dust off the suits.

Solution #6: Gravel Bed Hydroponics

Hydroponics is an approach to growing plants in a controlled environment. Nutrient solutions are used instead of soil. But for things such as fruit trees and tree nuts, non-dusty soil can be produced by taking rocks, washing them from dust, crushing them into dirt, and then tumbling to round their edges.



Rock crusher keeps regolith out of the hab.