



Advanced Magnetic Materials Methods and Numerical Models for Fluidization in Microgravity and Hypogravity

Solid wastes can be gasified for the recovery of valuable resources.

Lyndon B. Johnson Space Center, Houston, Texas

To support long-duration manned missions in space such as a permanent lunar base, Mars transit, or Mars Surface Mission, improved methods for the treatment of solid wastes, particularly methods that recover valuable resources, are needed. The ability to operate under microgravity and hypogravity conditions is essential to meet this objective. The utilization of magnetic forces to manipulate granular magnetic media has provided the means to treat solid wastes under variable gravity conditions by filtration using a consolidated magnetic media bed followed by thermal processing of the solid wastes in a fluidized bed reactor.

Non-uniform magnetic fields will produce a magnetic field gradient in a bed of magnetically susceptible media toward the distributor plate of a fluidized bed reactor. A correctly oriented magnetic field gradient will generate a downward direct force on magnetic media that can substitute for gravitational force in microgravity, or which may augment low levels of gravity, such as on the Moon or Mars. This approach is termed Gradient Magnetically Assisted Fluidization (G-MAFB), in which the magnitude of

the force on the fluidized media depends upon the intensity of the magnetic field (H), the intensity of the field gradient (dH/dz), and the magnetic susceptibility of the media. Fluidized beds based on the G-MAFB process can operate in any gravitational environment by tuning the magnetic field appropriately.

Magnetic materials and methods have been developed that enable G-MAFB operation under variable gravity conditions. Ferromagnetic, porous cobalt particles were prepared for use as filtration media. Magnetic body forces can be used to consolidate granular ferromagnetic media into a bed forming a depth filter for the separation of particulate matter from a gas or liquid stream. During filtration, such a depth filter can be expanded using these magnetic methods to create additional void space into which waste particles can be confined, thereby increasing filtration capacity. At the end of the filtration event, the bed can be fluidized to release a concentrated slug of particulate matter for processing elsewhere or can be employed as a fluidized gasification reactor. When used as a filter, G-MAFB methods result

in a regenerable particle filter, since entrained particles are released during fluidization, and after re-consolidation of the magnetic media, the bed is available for another filtration cycle.

G-MAFB methods combined with ferromagnetic catalyst media provide the basis for highly efficient, fluidized bed, catalytic reactors in which solid wastes can be gasified for the recovery of valuable resources. As such, fluidization of ferromagnetic catalyst particles at high temperature offers higher rates of mass transfer than are achievable in other reactors, whether fluidized or not, since the degree of bed expansion can be controlled using the magnetic force to augment gravity regardless of flow conditions. G-MAFB methods may also be used in a wide variety of other processes in which fluidization is employed for a variety of unit operations.

This work was done by James Atwater, Richard Wheeler, Jr., and James Akse of UMPQUA Research Company; and Goran Jovanovic and Brian Reed of Oregon State University for Johnson Space Center. Further information is contained in a TSP (see page 1). MSC-24245-1

Data Transfer for Multiple Sensor Networks Over a Broad Temperature Range

Unique codes may be generated to distinguish among the signals from sensors coming in via a common medium.

John H. Glenn Research Center, Cleveland, Ohio

At extreme temperatures, cryogenic and over 300 °C, few electronic components are available to support intelligent data transfer over a common, linear combining medium. This innovation allows many sensors to operate on the same wire bus (or on the same airwaves or optical channel: any linearly combining medium), transmitting simultaneously, but individually re-

coverable at a node in a cooler part of the test area.

This innovation has been demonstrated using room-temperature silicon microcircuits as proxy. The microcircuits have analog functionality comparable to componentry designed using silicon carbide. Given a common, linearly combining medium, multiple sending units may transmit information simultaneously. A

listening node, using various techniques, can pick out the signal from a single sender, if it has unique qualities, e.g. a "voice." The problem being solved is commonly referred to as the cocktail party problem. The human brain uses the cocktail party effect when it is able to recognize and follow a single conversation in a party full of talkers and other noise sources.

High-temperature sensors have been used in silicon carbide electronic oscillator circuits. The frequency of the oscillator changes as a function of the changes in the sensed parameter, such as pressure. This change is analogous to changes in the pitch of a person's voice.

The output of this oscillator and many others may be superimposed onto a single medium. This medium may be the power lines supplying current to the sensors, a third wire dedicated to data transmission, the airwaves through radio transmission, an optical medium, etc. However, with nothing to distin-

guish the identities of each source — that is, the source separation — this system is useless.

Using digital electronic functions, unique codes or patterns are created and used to modulate the output of the sensor. By using a dividend of the oscillator frequency to generate the code, a constant a priori number of oscillator cycles will define each bit. At the receiver, a detected frequency will be correlated with stored code patterns to find a match. If detected and verified as coming from a known sender, a frequency will be disassociated from noise and

from other transmitting sensors in that it has a unique modulation pattern or "voice." The length of the detected code, or instantaneously, the frequency detected, is the measure, and intelligent data transfer has been accomplished.

This work was done by Michael Krasowski of Glenn Research Center. Further information is contained in a TSP (see page 1).

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steven Fedor, Mail Stop 4-8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18910-1.

Using Combustion Synthesis to Reinforce Berms and Other Regolith Structures

New structures will require a minimum of maintenance and upkeep.

Lyndon B. Johnson Space Center, Houston, Texas

The Moonraker Excavator and other tools under development for use on the Moon, Mars, and asteroids will be employed to construct a number of civil engineering projects and to mine the soil. Mounds of loose soil will be subject to the local transport mechanisms plus artificial mechanisms such as blast effects from landers and erosion from surface vehicles. Some of these structures will require some permanence, with a minimum of maintenance and upkeep.

Combustion Synthesis (CS) is a family of processes and techniques whereby chemistry is used to transform materials, often creating flame in a hard vacuum. CS can be used to stabilize civil engineering works such as berms, habitat shielding, ramps, pads, roadways, and the like. The method is to unroll thin sheets of CS fabric between layers of regolith and then fire the fabric, creating a

continuous sheet of crusty material to be interposed among layers of loose regolith. The combination of low-energy processes, ISRU (in situ resource utilization) excavator, and CS fabrics, seems compelling as a general method for establishing structures of some permanence and utility, especially in the role of robotic missions as precursors to manned exploration and settlement.

In robotic precursory missions, excavator/mobility ensembles mine the Lunar surface, erect constructions of soil, and dispense sheets of CS fabrics that are covered with layers of soil, fired, and then again covered with layers of soil, iterating until the desired dimensions and forms are achieved. At the base of each berm, for example, is a shallow trench lined with CS fabric, fired and filled, mounded, and then covered and fired, iteratively to provide a footing against lateral shear. A larger

trench is host to a habitat module, back-filled, covered with fabric, covered with soil, and fired.

Covering the applied CS fabric with layers of soil before firing allows the resulting matrix to incorporate soil both above and below the fabric ply into the fused layer, developing a very irregular surface which, like sandpaper, can provide an anchor for loose soil. CS fabrics employ a coarse fiberglass weave that persists as reinforcement for the fired material. The fiberglass softens at a temperature that exceeds the combustion temperature by factors of two to three, and withstands the installation process.

This type of structure should be more resistant to rocket blast effects from Lunar landers.

This work was done by Gary Rodriguez of sysRAND Corporation for Johnson Space Center. Further information is contained in a TSP (see page 1). MSC-24411-1

Visible-Infrared Hyperspectral Image Projector

Goddard Space Flight Center, Greenbelt, Maryland

The VisIR HIP generates spatially-spectrally complex scenes. The generated scenes simulate real-world targets viewed by various remote sensing instruments. The VisIR HIP consists of two subsystems: a spectral engine and a spa-

tial engine. The spectral engine generates spectrally complex uniform illumination that spans the wavelength range between 380 nm and 1,600 nm. The spatial engine generates two-dimensional gray-scale scenes. When combined, the

two engines are capable of producing two-dimensional scenes with a unique spectrum at each pixel. The VisIR HIP can be used to calibrate any spectrally sensitive remote-sensing instrument. Tests were conducted on the Wide-field