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Granular Filtration in a Fluidized Bed

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C R A D A facts

DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY

FILTRATION
PROJECT

GRANULAR FILTRATION IN A FLUIDIZED BED

Capabilities

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Successful development of advanced coal-fired power conversion systems often requires reliable and efficient cleanup devices that can remove particulate and gaseous pollutants from high-temperature, high-pressure gas streams. A novel filtration concept for particulate cleanup has been developed at the U.S. Department of Energy's Morgantown Energy Technology Center (METC).

The filtration system consists of a fine metal screen filter immersed in a fluidized bed of granular material. As the gas stream passes through the fluidized bed, a layer of the bed granular material is entrained and deposited at the screen surface. This material provides a natural granular filter to separate fine particles from the gas stream passing through the bed. Since the filtering media is the granular material supplied by the fluidized bed, the filter is not subjected to blinding like candle filters. Because only the in-flowing gas, not fine particle cohesive forces, maintains the granular layer at the screen surface, once the thickness and permeability of the granular layer are stabilized, it remains unchanged as long as the in-flowing gas flow rate remains constant. The weight of the particles and the turbulent nature of the fluidized bed limits the thickness of the granular layer on the filter leading to a self-cleaning attribute of the filter.

The granular filtration testing system consisted of a filter, a two-dimensional fluidized bed, a continuous powder feeder, a laser-based, in-line particle counting, sizing, and velocimeter (PCSV), and a continuous solid feeding/bed material withdrawal system. The two-dimensional, transparent fluidized bed allowed clear observation of the general fluidized state of the granular material and the conditions under which fines are captured by the granular layer. A series of experiments was conducted at various ranges of operating conditions with two different bed materials: a 30x270 mesh acrylic powder with a particle density of 1.1 gm/cc, and a 40x270 mesh Millwood sand with a particle density of 2.5 gm/cc. During the experiments, fine sand (less than 100 micrometers) was fed continuously to the bed through the powder feeder at a constant rate of 3.8 gm/min (0.5 lb/hr). Bed material and captured fine particles were withdrawn continuously through an overflow tube. In order to maintain a constant bed level, makeup bed material was also fed continuously through a non-mechanical valve to the bottom of the fluidized bed. Performance of this granular filtration system was measured by the PCSV downstream of the filter.

High filtration performance was measured when low-density bed material (acrylic powder) was used. Collection efficiencies over 99 percent were obtained with this bed material in a continuous flow mode. However, low filtration performance was experienced with high-density bed material (Millwood sand). The low filtration performance with heavy bed material may

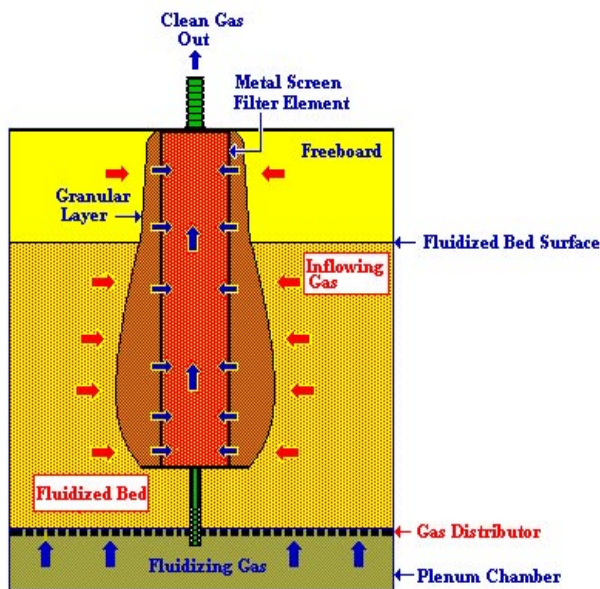
GRANULAR FILTRATION IN A FLUIDIZED BED

be attributed to the failure of maintaining a sufficiently thick granular layer at the screen filter surface. However, a modified filter was designed, fabricated, and tested in the fluidized-bed granular filtration system. Preliminary results of this modified filter showed that high filtration performance was also obtained for heavy bed material. Future activities in the program will concentrate on continuous testing of the modified filter, and adding a solid recycling and separation system to the existing two-dimensional, fluidized-bed granular filtration cold model.

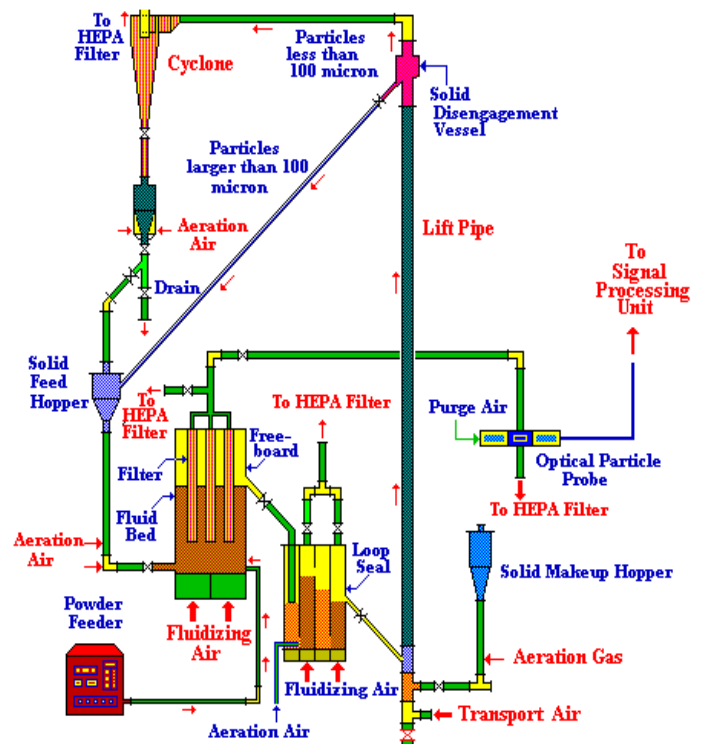
Opportunities

- Apply fluidized-bed granular filtration concept to
 - Particulate cleanup/hot gas desulfurization processes
 - Combustion/flue gas desulfurization/particulate cleanup processes
 - Particulate cleanup/noise attenuation for diesel engines
- Develop concept to pilot scale through three-dimensional cold and hot model testing

The Concept



Granular Filtration in a Fluidized Bed



2-D Fluidized-Bed Granular Filtration Cold Model
with Solid Recycling System
(under construction)