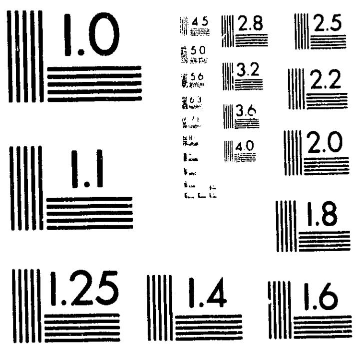
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Fluid-Bed HGD PDU

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Fluid-Bed HGD PDU

Larry A. Bissett
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OBJECTIVE

METC is constructing an on-site, fluid-bed, hot-gas desulfurization (HGD) process development unit (PDU) to support the U.S. Department of Energy's (DOE) Integrated Gasification Combined Cycle power systems program. Once operational, this PDU will be used to develop process scale-up and performance data for a number of configurations and to demonstrate fully coupled sulfidation-regeneration operations. Its size and gas throughput should also enable the PDU to address some of the actual engineering design and control issues associated with fluid-bed, HGD processes.

BACKGROUND

Fluid beds and transport reactors, either alone or in combination, are conceptually attractive for HGD processes for a number of reasons, including:

- Continuous steady-state operation, which simplifies system control strategies,
- Good temperature control, which reduces the potential for sorbent sintering during regeneration, and
- Potentially wide range of regeneration gas SO_2 concentrations, which adds to process flexibility for sulfur recovery options.

The METC Office of Technology Base Development has been providing lab- and bench-scale experimental support to DOE's fluid-bed, HGD development efforts since 1988. This continuous-flow PDU will enable further technology development and testing to proceed at a much larger engineering scale.

The preliminary conceptualization of this PDU was first reported in 1991 (1). Progress has been slower than desired for a number of reasons, including the temporary shutdown of site laboratories and test facilities to address environmental, safety, and health audit findings; NEPA documentation requirements; and project site remediation uncertainties. Progress is now accelerating. Conceptualization has been finalized, an Environmental Assessment has been completed, and project site issues have been resolved. Detailed design and procurement activities are underway.

PROJECT DESCRIPTION

The design has changed somewhat from the preliminary conceptualization first reported in the Eleventh Annual Gasification and Gas Stream Cleanup Systems Contractors Review Meeting (1). Figure 1 is a simplified flow diagram of the present configuration.

The PDU will still have the following features as reported before: a fluid-bed absorber with an 18-inch (46-cm) inside diameter (i.d.) and two-stage capability; a fluid-bed regenerator with a nominal 10-inch (25-cm) i.d.; 1,500 °F (800 °C) temperature capability; and a gas throughput of up to 150,000 scf/hr [4,000 m^3 (NTP)/hr] of simulated coal gasification fuel gas from a natural gas-fired synthesis gas

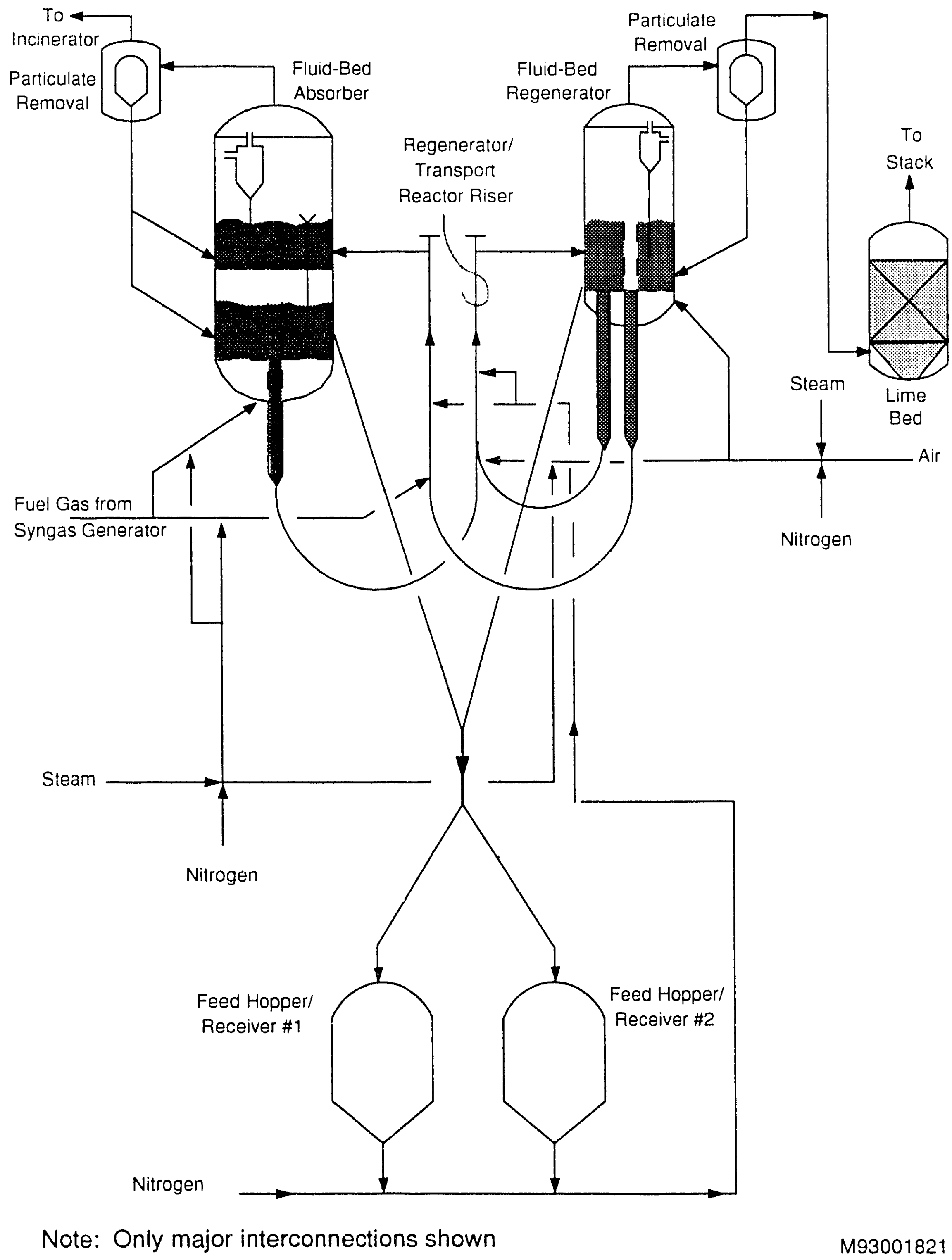

Figure 1. Simplified Flow Diagram of PDU

generator (2). Some major features have been changed:

- Instead of an overhead regenerator with overflow return of sorbent to the absorber, the absorber and regenerator vessels will be adjacent, and sorbent will be transferred through risers and U-bends (as shown in Figure 1) or alternatively Y-bends.

- Instead of using mechanical devices, such as rotary valves, sorbent circulation will be controlled by the absorber-regenerator differential pressure and aeration rates to risers and standpipes.

- Instead of a single sorbent feed hopper and separate sorbent withdrawal lockhoppers from the absorber and regenerator, two feed hopper vessels will be installed that can alternatively serve as receivers for withdrawing sorbent.

- To reduce costs, the design operating pressure was reduced from 600 psia (4.1 MPa) to 400 psia (2.8 MPa), four gas preheaters were consolidated into two, high-temperature candle filters in the major process gas lines were replaced with high-efficiency cyclones, and pressure-balanced metal liners were eliminated from the absorber and regenerator vessel designs.

- To increase capabilities, transport reactor provisions were added to the regenerator side of the system.

- In light of recent sorbent testing results, the PDU is being designed to accommodate both zinc titanate and Z-Sorb, a promoted zinc oxide absorbent from the Phillips Petroleum Company (3).

Since the PDU will likely remain operationally active for a number of years, it optimally should have the capability to handle various sorbents as they are developed and be able to test more than one process concept. Table 1 illustrates some of the desired parameter ranges that are being incorporated into the design for these reasons.

Table 1. Parameter Design Ranges

Sorbent circulation	500 to 5,000 lb/hr (230 to 2,300 kg/hr)
Sorbent particle size	-50 to +270 mesh (50 to 300 μm)
Sorbent particle density	65 to 150 lb/ft^3 (1.0 to 2.4 g/cc)
Absorber bed depth	10 ft maximum (3 m)
Regenerator bed depth	12 ft maximum (4 m)
Transport reactor length	60 ft minimum (18 m)

When operated in a coupled mode, the sulfidation-regeneration sides would be operated together and sorbent would be continuously circulated, utilizing various combinations of underflow and overflow standpipes. In this mode, the PDU will have the capability to test the following systems, with the absorber configured as either a two-stage bubbling bed or as a one-stage turbulent or bubbling bed:

- Fluid-bed sulfidation with near-stoichiometric, undiluted-air transport regeneration.
- Fluid-bed sulfidation with excess-air riser regeneration.

- Fluid-bed sulfidation with diluted-air, fluid-bed regeneration.

The PDU will also have the flexibility to permit the sulfidation-regeneration sides of the system to be decoupled so that various concepts for either side can be tested separately. This is expected to be especially beneficial during initial operations and will likely shorten the overall testing time necessary to develop and verify particular concepts. In addition to the individual processes associated with the coupled systems listed above, the PDU will also be able to test the following concepts in this manner:

- Transport sulfidation, and
- One- or two-stage, fluid-bed regeneration with in-bed heat removal and various regenerants, including near-stoichiometric, undiluted air.

In the decoupled mode of operation, sorbent would be continuously fed from one of the feed hopper/receivers and continuously withdrawn from the process (e.g., the absorber) into the companion feed hopper/receiver. The sorbent would be stored in that particular feed hopper/receiver until the next test, during which the roles of the feed hopper/receivers would be reversed.

The PDU is being located in the main experimental area of METC on the former site of the fixed-bed gasifier, which has now been dismantled. Figure 2 is an aerial photograph of the project site with an artistic rendition of the PDU support structure and important vessels.

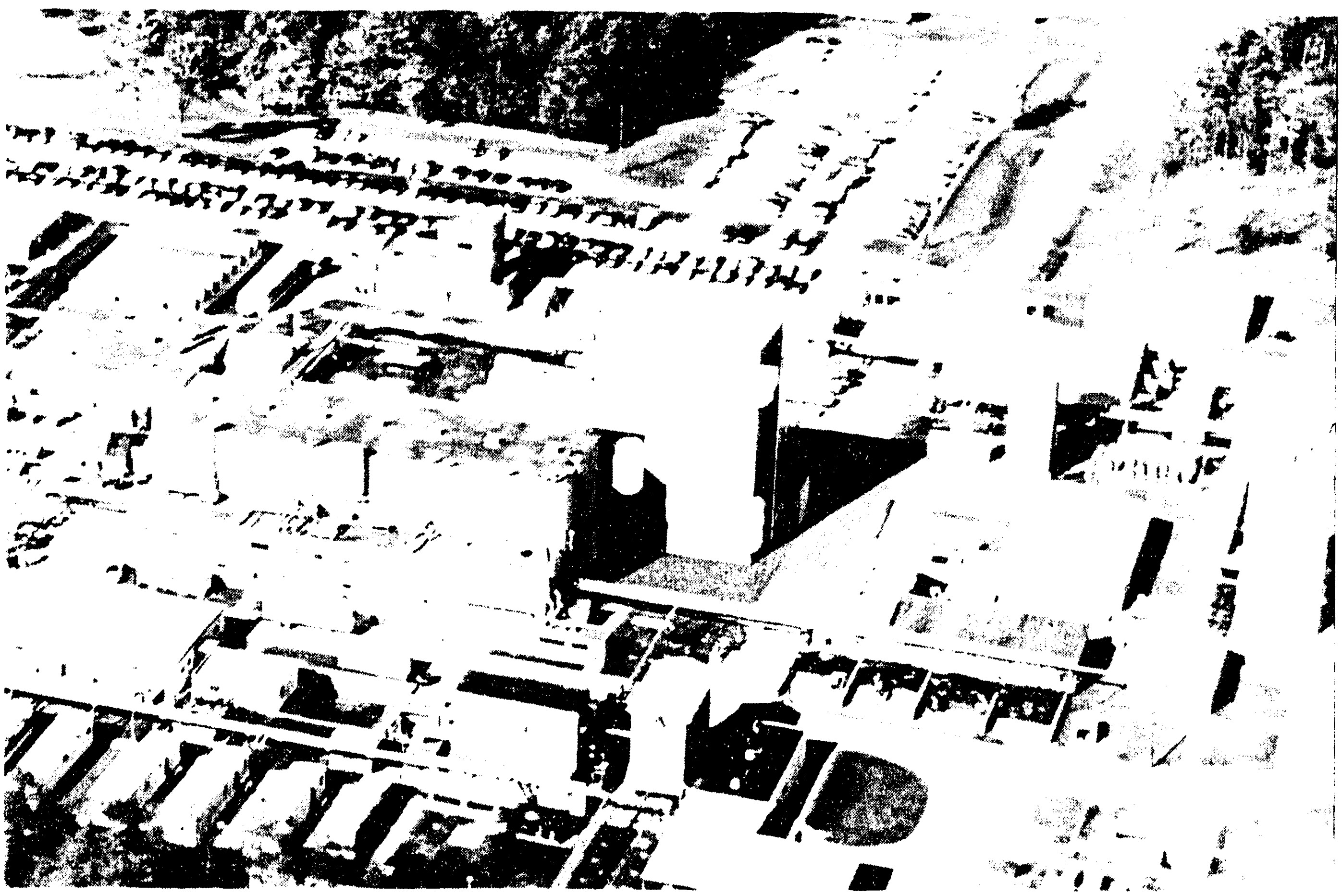

Figure 2. Project Site With Artist Rendition of PDU

FUTURE WORK

The project schedule is shown in Figure 3. As construction proceeds, industrial participation during the test operations phase will be solicited through the Cooperative Research and Development Agreement (CRADA) program. Under the Federal Technology Transfer Act of 1986, the Government may contribute personnel, equipment, and facilities -- but no direct funding -- to the cooperative programs. In turn, the CRADA partners gain the use of a Government facility and protection of proprietary information for 5 years.

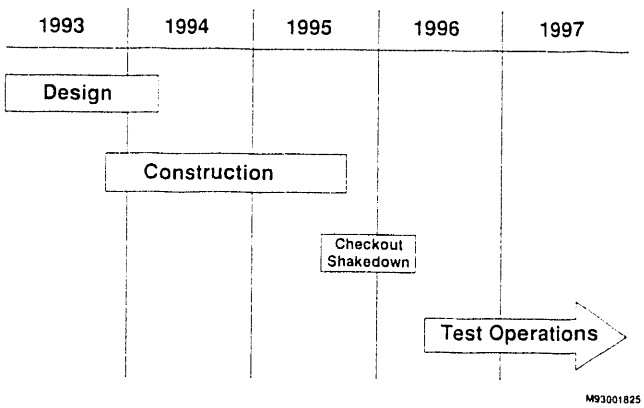

Figure 3. Project Schedule

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