the ENERGY lab

PROJECT FACTS

Carbon Sequestration

Reactor Design for CO_2 Capture Using Sorbents

Background

Carbon Sequestration is rapidly becoming accepted as a viable option to reduce the amount of carbon dioxide (CO_2) emitted from large point sources (for example, power generation plants), while continuing to use our Nation's fossil fuels to produce affordable, clean energy. The capture or separation of carbon dioxide from flue gas represents a significant cost and energy penalty in the overall sequestration process. Solid sorbent technology for CO_2 capture is one option to reduce the penalty associated with capturing flue gas CO_2. In addition to the sorbent development, specific reactor configurations must be developed to manage the flue gas flow, and the sorbent handling and regeneration. The project will facilitate commercial readiness of advanced, cost-effective sorbent-based capture technologies. Technical challenges include identification of candidate reactor designs with sorbents for investigation. Once identified, engineering design criteria must be provided to determine the applicability of the technology in a power generation scheme.

Objective

The project seeks to obtain the optimal design and engineering information for sorbent-based technology. Engineering support and reactor design oversight will be provided for the development of CO_2 removal processes utilizing solid sorbents currently under development by NETL researchers. The sorbent technology will ultimately reach the programmatic goal to be able to remove 90 percent CO_2 while keeping the increase in cost of energy service below 35 percent for post-combustion techniques.

Accomplishments

Based on an external study related to CO_2 sorbent development, the initial performance target for CO_2 capture with sorbents from flue gas is a reduction of 30-50 percent of the energy (regeneration heat duty) required for a wet scrubbing MEA process. Key engineering information (heat of reaction, specific heats, loading capacity, moisture effects, flue gas contaminant effects etc.) will be experimentally obtained for candidate in-house sorbents being developed. This information combined with isotherm studies will be used to update the reactor analysis of this external study.

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Detailed modeling of both the absorber and regenerator will be performed by in-house NETL modelers. The efforts are focusing on management of heat and mass transfer for various reactors configurations, including reactors proposed in an external study. Insertion of chemical kinetics into the modeling effort will also be included. In addition to examining moving and fluid bed concepts and general transport reactor designs, another design under consideration is that of a stationary structured-bed that offers potentially excellent heat transfer characteristics.

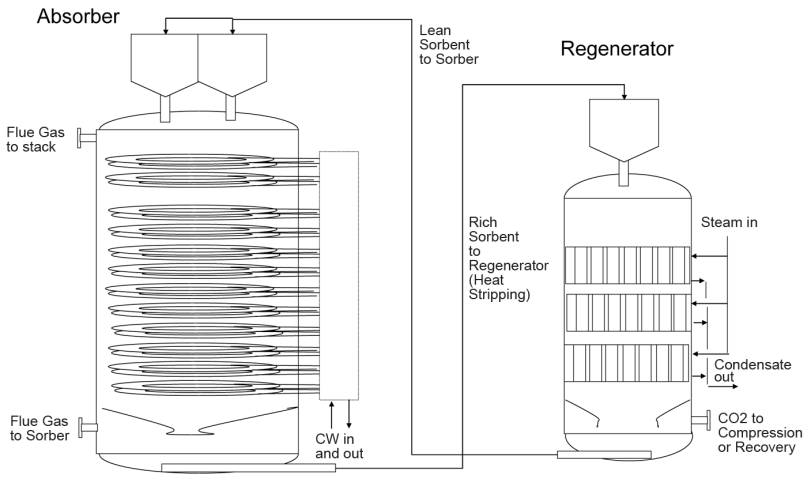
Key Results to Date Include:

- Measured sorbent parameters play a significant role in the type of reactor that is suited to the application, showing tradeoffs in sorbent properties for fixed-bed, moving-bed, or fluid bed concepts.
- Heat management is critical in both the absorption and regeneration process, and will require significant heat transfer surface in contact with the sorbent.
- Moisture may have a significant impact on the sorbent and operational design of the system.
- Down-selection has produced four conceptual reactor designs.

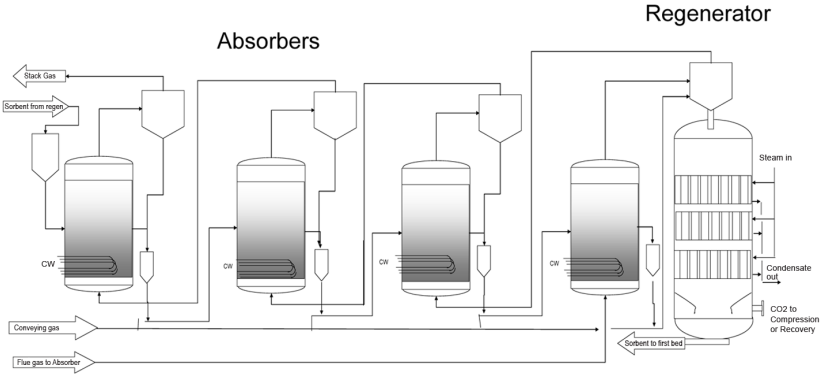
Benefits

Because of the widespread use of coal to produce power, a novel scrubbing technique is needed to further capture CO_2 in flue gas. Sorbent-based scrubbing can produce certain technical and economic advantages as compared to more traditional wet scrubbing processes. However, the use of the sorbent in a particular reactor design is a key and will ultimately determine whether the realization of a sorbent-based technology can indeed be used for CO_2 capture from flue gas.

Moving Bed Reactors



Fluid Bed / Moving Bed Reactors



System shown with 4 countercurrent beds, but the actual number is dependent on sorbent isotherm data.

Compressors are needed but not shown for flue gas and conveying gas

System shown is one of multiple parallel systems required for capacity of plant.