Clay-Liquid CO_2 Removal Sorbent

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NETL and its collaborators developed and tested a low-cost solid-state sorbent designed to remove carbon dioxide (CO_2) from flue gas and other gas streams. The new sorbent concept incorporates amines or other polar liquids in a clay matrix using naturally occurring, low-cost materials with lower specific heat capacities than water. The liquid-impregnated clay sorbent is capable of capturing CO2 at 30–60 °C, in the presence of water vapor, and can be regenerated at temperatures around 80–100°C, greatly reducing the energy requirements for regeneration as compared with existing sorbents and significantly reducing operating costs. NETL conducted the initial research and developed the technology. Sud Chemie Inc and ADA Environmental Solutions participated in scaling up of the lab scale material preparation to commercial level preparations and conducting testing of the process, respectively. The new sorbent has won a 2009 R&D 100 Award.

The product responds to an anticipated national need for lower cost technology to capture CO_2 from power plants as part of a CO_2 sequestration program. This need is contingent on probable future regulations that will reduce carbon emissions and will provide a lower cost CO_2 capture-and-sequestration option to cap-and-trade. Commercial CO_2 capture technologies that are in use in the natural gas industry are expensive and energy intensive. The most common is the liquid amine process which requires significant energy for sorbent regeneration. When retrofitted to an existing power plant, the liquid amine process is projected to increase the cost of electricity more than 85%, while penalizing power plant efficiency by 30%. Much of this is due to the energy intensive regeneration of the aqueous amine solution. To make capture-and-sequestration a more desirable option, lower cost technologies must be developed with a minimum of risk to investors.

In this new process, a low-cost, readily-available CO_2 sorbent with a much lower specific heat capacity will eliminate the energy-intensive aqueous solutions and significantly reduce costs. The collaborative effort resulted in a sorbent material that exhibits acceptable performance for commercial applications and a process for sorbent production that is ready for scaleup to commercial scale, as well as design options for the overall capture process using the sorbent. The new, liquid-impregnated-clay solid sorbent is able to remove CO_2 while at the same time meeting operational and system requirements at a reduced cost. In addition to those noted above, the sorbent has other advantages, as follows:

- Available in forms suitable for moving bed operation and fluidized bed reactor operations.
- Low cost materials and preparation procedure. The estimated price of the pelletized sorbent is $8 per lb and the fluidizable, spray-dried material is $11 per lb.
- Stable toward deactivation during 25 sorption/regeneration cycles in the presence of 20 ppm SO_2
- Presence of moisture does not affect the sorbent performance
- Enhanced CO_2 capture capacity on a w/w basis

NETL estimates show potential cost savings of $15 million per year for this technology in a base case [550MW] coal-fueled power plant which would amount to $450 million over the 30 year lifespan of the plant. Estimates indicate that the solid sorbent results in a 45% lower net loss of electric power produced with CO_2 capture, compared to the current commercial liquid amine process. These calculations are conservative and take into consideration the recent advances in energy management of the base case liquid amine process. With a nameplate capacity for U. S. coal-based power plants of over 300,000 MW, annual savings on a nationwide level would approach $8 billion dollars if all plants were required to be fitted with capture units.

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