Lehigh receives grant to reduce cost of carbon capture at coal-fired power plants

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Lehigh University's Energy Research Center (ERC) has been awarded a grant from the U.S. Department of Energy (DOE) to develop methods of recovering and reusing the heat that would be generated by the carbon-dioxide (CO_2) compression process in a carbon capture system. The goal of the research project is to facilitate carbon capture and sequestration, or storage (CCS), and thus limit the amount of CO_2, a greenhouse gas, emitted into the atmosphere by coal-fired power plants.

Unlike other modeling studies of carbon capture systems, which focus on specific components in the carbon capture system, Lehigh researchers will look at the entire power plant.

"Because the carbon capture system, boiler, steam turbine cycle and CO_2 compressor are so closely interconnected, we believe that considering these as a coupled system can be helpful in identifying opportunities for energy and cost savings," said Edward Levy, ERC's director.

The 30-month grant is being awarded through DOE's National Energy Technology Laboratory (NETL). The funding was provided by the American Recovery and Reinvestment Act of 2009, the economic stimulus package passed by Congress in February. The ERC will use the DOE grant to train graduate students to develop computational models of the methods that are used to capture and compress CO_2 and to estimate the increases in power plant efficiency that will result from each method.

In the past year 35 years, the ERC has developed a variety of technologies and solutions that improve the operating efficiency of power plants while reducing emissions of toxic substances and greenhouse gases.

One ERC technology has achieved a 70-percent reduction in mercury emissions from coal-fired power plants by modifying the physical conditions of boilers. A second promotes the capture of toxic acids, and the capture and reuse of water, by condensing water and acid vapors in separate heat exchangers. A third limits costly slagging on boiler tubes by integrating optical technologies and artificial intelligence. Boiler OP, a combustion optimization technology developed at the ERC in the mid-1990s, has been implemented at more than two dozen U.S. power plants, a coal-powered plant in China, and an oil-fired plant in Mexico.

The benefits of reusing captured heat

Coal-fired power plants produce half the electricity in the U.S. and account for about 75 percent of total power generation in China, which leads the world in coal consumption. At a coal-fired plant, finely ground coal is mixed with air and burned in a boiler, or furnace, where it heats water in the boiler pipes into steam that spins turbines to generate electric current. Meanwhile, carbon from the coal reacts with oxygen in the air to form CO_2, which exits the power plant with the flue gas and enters the atmosphere.

Carbon-capture technologies separate CO_2 from the flue gas and the CO_2 is then compressed to high pressure. Compressed CO_2 can be transported by pipeline and is currently used to help extract oil from underground reservoirs in a process known as enhanced oil recovery. Scientists are also evaluating the feasibility of injecting compressed CO_2 one or two miles below the earth's surface into saline aquifers whose geological features would sequester the CO_2 underground.

The goal of the current ERC project, says Levy, is to recover heat that is generated when CO_2 is compressed and to use that heat to improve the efficiency of the power plant's operation.

"It requires a tremendous amount of pressure, about 2,200 pounds per square inch or close to 150 atmospheres, to compress CO_2 to a supercritical state," says Levy. "In the compression process, CO_2 heats up, creating the potential for heat to be recovered and used beneficially within the power plant.

"All carbon capture schemes reduce power plant efficiency and increase the cost of generating electricity. We're trying to mitigate this. We're looking at different types of compressors to see how much heat can be recovered and what we can do with this heat to improve power plant efficiency and reduce carbon capture costs."

Source: Lehigh University

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