DOING THE DIRTY WORK

BY TOMMY NEWTON

THE SAYING "IT'S A DIRTY JOB BUT SOMEONE HAS TO DO IT" COULD APPLY TO DR. KUNLEI LIU'S CAREER IN CLEAN COAL RESEARCH. "WHY DO I WORK WITH COAL? COAL COMBUSTION IS DIRTY AND IT'S A HEAVY JOB. BUT IT'S FUN."

DR. LIU'S RESEARCH, AS WELL AS THAT OF STUDENTS AND OTHER FACULTY AT WESTERN KENTUCKY UNIVERSITY, HAS THE POTENTIAL TO BENEFIT THE PUBLIC, HELP BUSINESS AND INDUSTRY, CLEAN UP THE ENVIRONMENT, AND PROVIDE A MORE STABLE MARKET FOR KENTUCKY COAL.

Dr. Liu is involved with two major research projects to reduce emissions of mercury and other pollutants (carbon dioxide, nitrogen oxides, sulfur dioxides, organic matter) from coal-burning power plants, which produce fifty-six percent of the electric power in the United States.

By reducing the emission of pollutants, power plants would be able to meet federal regulations and Kentucky's high-sulfur coal would remain economically viable. Without clean coal technology, many power plants would be forced to shut down.

The combustion lab, established in 1992, has been involved with numerous projects to study emissions of nitrogen oxide, sulfur dioxide, organic matter, and mercury during combustion as well as after combustion. The lab's fluidized-bed combustion system has logged more than 8,000 hours of testing since 1995.

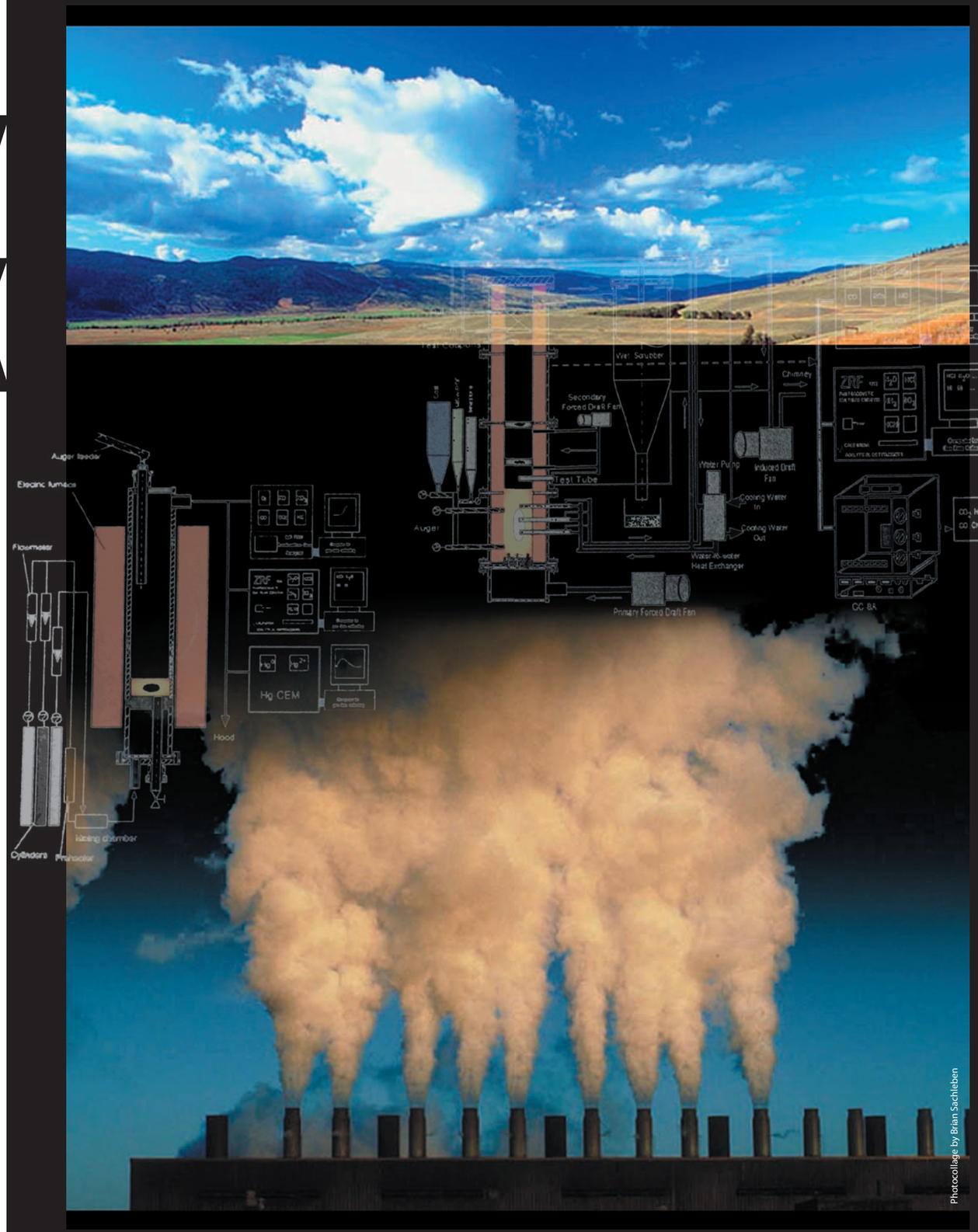
"If we can burn coal much cleaner, it will benefit people, it will benefit the coal industry and it will solve environmental problems," Liu said.

The combustion laboratory is one of the five laboratories in North America capable of conducting Continuous Emission Monitoring (CEM) and the Ontario-Hydro Method (OH method) for mercury emissions in power plants. WKU's mobile mercury monitoring laboratory (a 53-foot semi-trailer) is used at power plants to collect samples from flue gas, fly ash, or ambient air, and then analyze them for mercury.

Dr. Liu's clean coal work is rooted in his native China, where he received his bachelor's degree in power engineering and his master's and doctorate in thermoenergy engineering at Southeast University. From 1993 to 1997, he worked on combustion projects at Southeast University. He was coordinator of the combustion laboratory at WKU from 1997 to 2001. Then in 2001, he left Bowling Green for an engineering position in Knoxville, Tennessee, but he returned to Western in 2002 as an associate professor in the Department of Architectural and Manufacturing Sciences. His duties don't end there. He is supervisor of the Center for Advanced Combustion Engineering in the Institute for Combustion Science and Environmental Technology, and he's a husband and father of two children.

"I like a challenge," he said, "and reducing emissions from coal-fired power plants is a big challenge."

Western's Institute for Combustion Science and Environmental Technology and Materials Characterization



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Continuous Emission Monitoring (CEM): **Machines, which measure, on a continuous basis, pollutants released by a source. The EPA's regulation on mercury emission requires continuous emission monitoring systems for certain large sources.**

Ontario-Hydro Method (OH method): **standard method that was specified by EPA and ASTM to determine mercury concentration and its speciation in flue gas generated from utilities boilers.**

EMISSIONS: Release of pollutants into the air from a source.

MERCURY: A naturally occurring element that is present throughout the environment. Human activity can release some of that mercury into the air, water and soil. In the United States, coal-fired power plants only release 1 percent of overall mercury emission.

CARBON DIOXIDE: A colorless gas that is released into the atmosphere when fossil fuels (oil, natural gas and coal) and wood or wood products are burned. CO_2 is one of the main greenhouse gases.

NITROGEN OXIDES: Gases often formed from fuel nitrogen when fossil fuels, including gasoline and coal, are burned at high temperatures in air to generate electric power and that are a chief component of air pollution that contribute to the formation of smog.

SULFUR OXIDES: SO_x gases are formed when fuel containing sulfur, such as coal and oil, is burned, and when gasoline is extracted from oil, or metals are extracted from ore. Fuel combustion, largely from electricity generation, accounts for most of the total sulfur dioxide (SO_2) emissions, which is a component of acid rain.

Center have developed quite a reputation for clean coal research. The programs, under the direction of Wei-Ping Pan and John T. Riley, have steadily grown and have received millions of dollars in external funding as U.S. power plants are looking for ways to reduce emissions to meet federal regulations.

Mercury pollution has been known to cause neurological and developmental damage in humans. The Environmental Protection Agency and other organizations have supported proposals to measure and reduce mercury emissions.

U.S. power plants emit about forty-eight tons of mercury per year and EPA regulations call for that amount to be reduced thirty percent by 2010 and seventy percent by 2018.

Dr. Liu uses the following to illustrate the challenge of measuring and reducing mercury emissions: The Astrodome would hold thirty billion ping-pong balls with thirty of those representing mercury. To meet EPA requirements, twenty-one of the thirty balls would have to be removed.

In their research, Western faculty and students are looking at several ways to reduce emissions of mercury and other pollutants in the combustion process. Those include injecting materials at various locations in a combustion chamber to capture the mercury, carbon dioxide, nitrogen oxide, and sulfur dioxide.

In the fall of 2003, Western's clean coal research received a $2 million grant from the U.S. Department of Energy for "Establishment of an Environmental Control Technology Laboratory with a Circulating Fluidized Bed Combustion (CFBC) System," and approximately $2 million in grants and contracts from funding agencies and industries for "Mercury Emission Survey and Control."

Construction at Western's Center for Research and Development is expected to begin this summer with completion of the CFBC system by the summer of 2005. The CFBC system is a process for burning chunk coal that is poured in a liquid-like stream with air or gases. The process reduces sulfur dioxide emissions from coal combustion directly. The combustor at the facility will be seventy to eighty feet tall.

The grant award was made through the Combustion Technology University Alliance, a program at the National Energy Technology Laboratory in Pittsburgh that includes about twenty universities and fifteen companies.

The primary objective of the WKU project is to establish an Environmental Control Technology Laboratory (ECTL) using a multifunctional circulating fluidized bed combustion (CFBC) system. The system can be easily configured to make combustion runs with various fuels under varying conditions to analyze and monitor air pollutant emissions, as requested by the lab's industrial partners.

As part of the research to reduce emissions, Dr. Liu and others are investigating methods to capture and store the pollutant of CO_2, a greenhouse gas.

One way of "sequestration," an innovative way of using fossil fuels without releasing the carbon into the air, is by using aqueous ammonia to convert carbon dioxide into ammonium carbonate to create a fertilizer. Western's research will include a small ecosystem to test that method.

Other power sources, such as nuclear, solar, wind, and hydroelectric, offer clean alternatives but they are not developed enough to meet U.S. demands, Dr. Liu said. Therefore, researchers must find ways to clean coal.

It's a dirty job, and Kunlei Liu is having fun while doing it.

Photo by LaDonna Harmon

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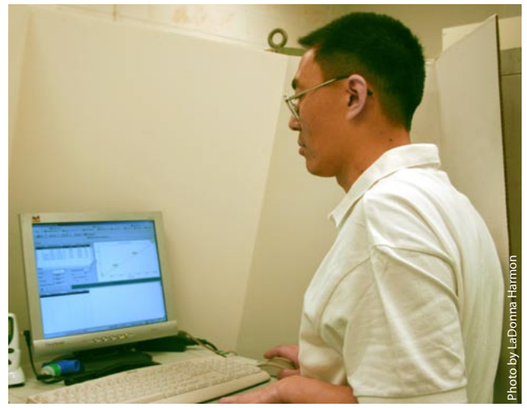
Photo by LaDonna Harmon