

LEHIGH ENERGY UPDATE



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DILUTION EXTRACTIVE PROBE IMPROVEMENTS NOW AVAILABLE COMMERCIALY

Utilities with fossil-fired power plants are required to use continuous emissions monitoring systems (CEMS) to measure quantities such as SO₂ and NO_x emissions. Among its many components, the typical CEM system includes a device referred to as a dilution extractive probe for removing a small sample of flue gas from the stack. Because of its design and the way it operates, the dilution extractive probe can be a source of measurement error that results in overreporting of emissions. The Energy Research Center and PPL Generation, LLC (PPL) have developed modifications to the standard dilution extractive probe system that eliminate a significant part of this sampling error (see Lehigh Energy Update, February 2000). PPL and the Energy Research Center are in the process of commercializing these improvements through a technology referred to as **DRCalc™**.

A typical dilution-extractive CEMS sampling system includes a probe with a critical or sonic orifice designed to extract a sample of flue gas from a stack or duct. The sample is mixed with dilution air in the probe. The diluted sample is then conveyed to analyzers for measurement of the compounds at lower concentrations. The diluted sample concentrations are then corrected back to source level readings by multiplying the analyzer readings by the dilution ratio, the

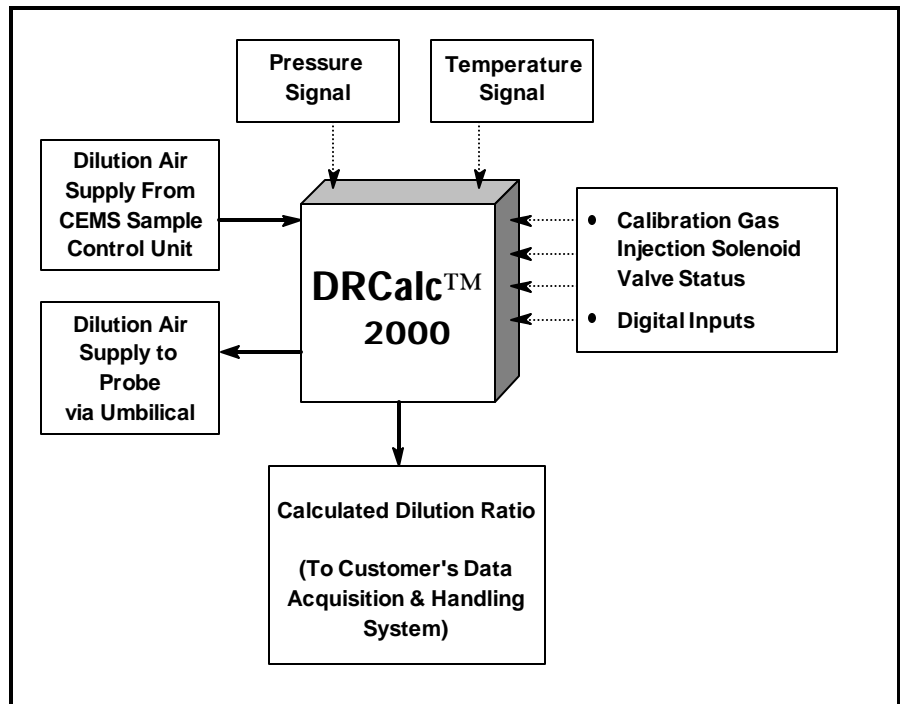


Figure 1: Typical DRCalc™ Arrangement

ratio between dilution air and sample gas flow rates.

During normal operation, a sample of flue gas from the stack is drawn into the probe, mixed with clean, dry air and then sent to the gas analyzers in a diluted form. Dilution ratios of air-to-sample gas flow rates of 50 to 200 are typically used. The relationship between the gas concentration in the stack and the pollutant levels measured at the analyzers is constant if the dilution ratio does not change over time. In practice, however, the dilution ratio does change; and thus the dilution ratio determined at calibration

conditions will differ from the value when the dilution probe is sampling flue gas. There are many factors that affect dilution air flow rate and sample gas flow rate. These include, for example, stack temperature and absolute pressure, flue gas molecular weight and dilution air supply pressure. As a consequence, the dilution ratio varies with stack conditions and probe operating conditions, resulting in errors in concentration measurements as large as 10% in some situations.

Previous attempts to correct for stack pressure and temperature

variation do not adequately account for all the factors which affect the dilution ratio. Indeed, a PPL analysis of its own CEMS data indicated that the original correction algorithm used in the PPL CEM systems was inducing a significant positive measurement bias error. To resolve the discrepancy, PPL and the ERC worked together to develop the new dilution ratio calculation system and successfully implemented it on PPL stack CEM systems in 1999.

The Dilution Ratio Calculation System (**DRCalc™**) provides equipment and software for reducing the measurement bias error, correcting for variations in:

- ! Dilution air supply pressure,
- ! Dilution air supply temperature,
- ! Stack or duct pressure,
- ! Stack or duct temperature,
- ! Sampled gas molecular weight,
- ! Calibration gas molecular weight.

The **DRCalc™** unit consists of a computing device, which is connected to the CEMS and to the plant data acquisition system. In addition, the dilution air supply from the CEMS sample control unit is routed through **DRCalc™** to the dilution probe. Using this information, **DRCalc™** determines the dilution ratio in real-time. The calculated dilution ratio is then multiplied by the analyzer-measured pollutant gas concentrations of the diluted sample to continuously compute the concentration of the pollutants in the stack gas. A patent is pending for the method used to calculate the dilution ratio.

DRCalc™ can be readily implemented in the design of new CEM systems and can also be easily adapted to an existing CEM installation. In the latter case, the dilution air supply from the sample control unit of the CEMS to the probe is routed through the

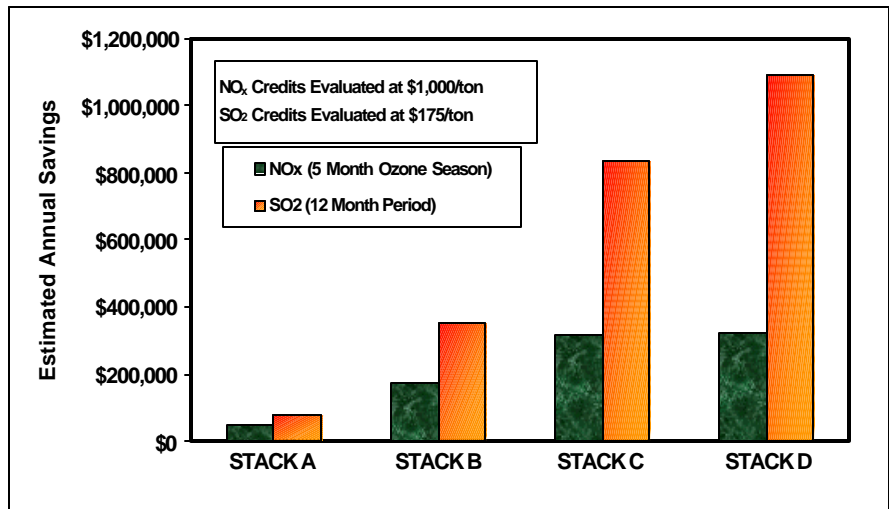


Figure 2: Economic Benefit for Four PPL Stacks

DRCalc™ unit, and wiring connections for various signals are made to the customer's CEMS. For an unheated EPM probe used in a 40 CFR 75 CEMS application, the stack pressure and temperature signals used to correct stack flow rate to standard conditions are wired into the **DRCalc™** unit.

Once all the connections are made, the Data Acquisition & Handling System (DAHS) is re-programmed to substitute the use of the **DRCalc™** output in lieu of a constant dilution ratio or an existing dilution ratio correction algorithm. The dilution ratio calculated by the **DRCalc™** unit is wired into the DAHS via a new or spare analog input. The monitoring systems are re-calibrated based on the new dilution ratio. Calibration and Linearity Error Tests are then conducted to verify the monitoring systems meet the EPA quality assurance requirements.

DRCalc™ can be rack or wall-mounted for ease of installation and with minimal programming changes to the Data Acquisition and Handling System (DAHS). A typical **DRCalc™** implementation is illustrated in Figure 1. Equivalent arrangements are available for probes equipped with temperature controlled heaters.

SAVINGS

PPL has implemented **DRCalc™** on all of its fossil-fired units, taking the steps necessary to ensure the modifications met the quality assurance requirements of the CEMS regulations. Evaluation of the results showed a 3.4% to 9.2% reduction in tons of NO_x and SO₂, compared to those that would be reported assuming a constant dilution ratio. The economic benefits for four PPL stacks are shown in Figure 2. The estimated annual savings are based on reduction in reported NO_x over the five month ozone season and on reduction in reported SO₂ over 12 months. These units range in capacity from 300 MW (Stack A) to 750 MW (Stack D). Total annual savings for the four stacks are \$3.2 million for the conditions specified in the figure. •

For more information on **DRCalc™**, please contact:

John W. Sale
Energy Research Center

Telephone: (610) 758-4545
E-mail: jws3@lehigh.edu