As part of the process of reporting emissions of NO\textsubscript{x} and SO\textsubscript{2} to the regulators, utilities are required to measure the flow rate of stack gas. Over the past few years, numerous utilities have reported evidence that the procedures specified in the EPA regulations for certifying the accuracies of flow monitors result in measured gas flow rates which are higher than the actual values. The financial consequences of errors in flow rate measurement can be quite sizeable, particularly for those utilities which have large coal fired capacities. In response to the need for solutions to this problem, the ERC is conducting an investigation which will result in improved measurement accuracies for utilities. The investigation is bench-marking the measurement accuracies of manually operated probes used by utilities to measure stack gas flow rate. In addition, it is developing solutions to improving measurement accuracy through modifications to the flow field in the stack. This project, funded by a consortium of utility companies, is under the direction of Edward Levy, Director, Energy Research Center.

According to Levy, “The Center’s involvement in stack flow measurement accuracy issues began several years ago when we were asked to assist a utility that wished to determine the flow measurement errors which would result from using the reverse impact velocity probe, otherwise known as the S-probe, required by EPA Reference Method 2. The results showed that when compared to a 3-D probe, the S-probe averaged anywhere from 10 to 20 percent high. Similar results were reported by other utilities.”

Based on this evidence that the S-probe gives readings which are on the high side, the Energy Research Center carried out an investigation in its flow laboratory to determine the effect of flow patterns on S-probe accuracy. These experiments were performed in a scale model of a power plant stack. As is typically done at a power plant, the S-probe was compared to a 3-D probe purchased from a company called United Sensor, Inc. This study, although limited in scope, showed the S-probe always gave higher velocity readings than the 3-D probe and the difference between the two was greater in flows with large amounts of swirl and high radial velocity components. The swirl and radial components of the flow field interfere with the ability of the S-probe to sense the axial velocity component and result in axial velocity readings which are biased on the high side. Since the velocity in the axial direction is the velocity component needed for determining flue gas flow rate, the end result is a
flow rate reading which is also biased on the high side.

Over the past year, there have been some indications EPA is considering modifying the regulations to permit utilities to use a 3-D probe instead of the S-probe for calibrating flow monitors. EPA already acknowledges and allows use of a 3-D probe to demonstrate absence of cyclonic flow. In this sense, they are familiar with the technology and methodology. As a result of the need for more information on the effect of the flow field configuration on probe accuracy, the ERC is working on a new project funded by a group of utilities to examine probe measurement accuracy issues.

According to Jim Roche, Research Associate with the Center, “This project is determining the effects of the swirl and transverse velocity components on the accuracy of the S-probe and of two 3-D probe designs. If utilities do begin to use the 3-D probe for calibrating their flow monitors, they need to be certain these probes provide the expected flow measurement accuracies. The project is also looking at other factors that have the potential to affect the mass flow rate readings. These include, for example, probe calibration accuracy, the analysis method used to convert the velocity readings into a mass flow rate, and the effect of the number of measurements made in the stack on accuracy.”

Utilities have also become interested in methods of conditioning the stack flow to modify the velocity field and reduce measurement error. A cost-effective flow conditioning method must improve measurement accuracy without causing an excessive pressure drop. It must be inexpensive to install and be resistant to attack from acid corrosion. In addition, for many applications, it is important that the flow conditioning device be compact enough to fit within a limited vertical distance just above the stack inlet duct. With this in mind, the project is examining different types of flow conditioners in a search for the most cost-effective approaches to modifying the flow field in the stack.

Levy adds, “The financial consequences of inaccurate stack flow readings can be quite high. If the utility company purchases SO\textsubscript{2} allowances and reports SO\textsubscript{2} emissions which are higher than the actual emissions, it will need to purchase more SO\textsubscript{2} allowances than are really needed. Conversely, if the utility has allowances to sell, by reporting rates of emissions which are higher than the true value, it will have fewer SO\textsubscript{2} allowances available to sell to other companies. When we calculated the cost of these penalties for a 600 MW coal-fired plant burning 1.5% sulfur coal, we found a 10 percent error results in a loss of close to one half million dollars per year. In the future, the costs of stack flow measurement errors may also be affected by NO\textsubscript{x} emission allowances. For utilities with large coal-fired capacity, the financial penalties can be severe.

Many utilities are finding their measured stack gas flow rates are higher than they believe they should be and they have become quite concerned about the issue of flow measurement accuracy. We believe the results we are getting from our project will be very helpful to our sponsors in their efforts to reduce the financial penalties associated with inaccurate readings.”

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