WPCA NEWS

A Bi-Annual Newsletter Sponsored by the WPCA www.wpca.info ISSUE 3 - 2003

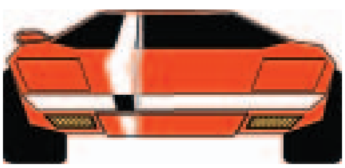
WORLDWIDE POLLUTION CONTROL ASSOCIATION

Meter Evaluation Learn from NASCAR

By Larry Boyer - EPSCO International

No different than a trained NASCAR driver, a well oriented plant engineer, operation engineer, electrical supervisor, or a vendor's field engineer, should be able to check at a glance and determine if all fields are operating up to par.

Traveling at 180 MPH a NASCAR driver has only a momentary opportunity to check feedback from his gauges. To assist in this momentary check, his crew chief has rotated and arranged his gauges so that for acceptable readings, the needles will all point to twelve o'clock. Thus a quick glance gives the driver an indication of underhood conditions. Any variation away from twelve o'clock may mean an indication of potential trouble.



Not necessarily practical, nor convenient to arrange all your panel meters in a similar configuration, but one can develop a picture in your minds eye of what the general position of KV and MA meter needles should be and with a quick walk down the aisle, be able to look for telltale signs of trouble. Even a control room with 256 controls could be scanned in a matter of minutes, allowing a brief picture of the operation.

In the control room layout, having cabinets arranged in ascending field order or arranged by field number can also aid in the viewing of the picture. Regardless of the cabinet arrangement, when the fields are operating properly, there will be a distinct picture.

From an old analog guy's perspective, the use of digital metering can be great, but you will not be able to glance at the digital and determine what may be occurring. Any installation having only digital metering may be well suited for an adaptor to allow the plug in of an analog metering module, thus during periods of troubleshooting an additional aid is present. Meter needle activity has long been a valuable aid in troubleshooting erratic behavior of a control, transformer rectifier, and electrical section.

EPSCO

INSIDE HIGHLIGHTS

Improving Accuracy of Plant Emission Monitors

by Rob Mudry - Airflow Sciences

Major industrial facilities are required to continuously monitor plant emissions to the atmosphere. The continuous emissions monitoring systems (CEMs) in use today are highly sensitive to flow conditions in the vicinity of the monitor probes. If turbulent, swirling flow exists, measurement accuracy is degraded. For optimal accuracy, the flow passing the monitor should be unidirectional and uniform in profile.

At Gainesville Regional Utilities (GRU) Deerhaven Station, Gainesville, Florida, cyclonic flow in the chimney was an occassional issue under certain operating conditions. During these times, the plant had to modify their operating conditions to minimize this flow-related problem. GRU contracted Airflow Sciences Corporation of Livonia, Michigan to determine the root cause of the flow problem and develop a cost-effective design solution.

Airflow Sciences engineers utilized a computational fluid dynamics (CFD) flow model of the chimney and duct system in the analysis. This model provided a clear understanding of the flow profiles that set up the cyclonic, non-uniform flow. Model results are shown in Figure 1. At the monitor location, a highly non-uniform velocity distribution was present.

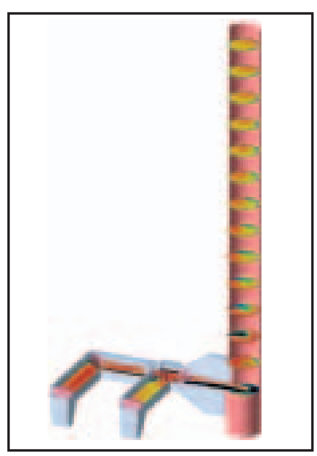


Figure 1 - Baseline Model Results

Continued on page 7

Pilot Hybrid Dry/Wet ESP to be installed at Plant Miller

by Buzz Reynolds - Croll-Reynolds

Of the 1,100 coal-fired power plants in the US, approximately 75% have dry electrostatic precipitators (ESPs) installed and 25% have Flue Gas Desulfurization (FGD) systems. The issue that is now confronting those plants with only dry ESPs installed burning sub-bituminous and lignite coal is these lower sulfur coals typically have higher levels of elemental mercury concentrations, which pass through the dry ESP and out the stack. Based on the EPA's Information Collection Request (ICR) data, elemental mercury emissions are four times higher from sub-bituminous coal than eastern bituminous coal (4.0 lb/Tons/btu vs. 1.0 lb./Tons/btu).

Secondly, where low NOx burners have been installed and there is a high level of unburned carbon in the fly ash, these sub-micron particles are difficult to capture in a dry ESP. Opacity may have increased creating permit and good neighbor issues. Finally, EPA standards for PM2.5 are due out 2005 along with more stringent State regulations for opacity that will require plants to address capturing PM2.5 and acid aerosols, the primary causes of visible emissions.

A proposed solution is to add a wet ESP field after the dry ESP operating above the saturation dew point of the flue gas. A hybrid dry/wet ESP offers the ability to collect multiple pollutants within the same footprint of the existing dry ESP, should the last field of the dry be retrofitted with a wet field.

Previous pilot and demonstration testing of this approach has shown the wet ESP last field can remove PM2.5, sulfur trioxide (SO_3) and toxic metals with high efficiency (>90%), while providing some trim control (20%-50%) of sulfur dioxide (SO_2) and other gases in addition to removal of some mercury. The pilot wet-wall ESP will incorporate CRCAT's patented "Plasma-Enhanced ESP" technology to enhance mercury control without injection of activated carbon, fabric filters or FGD.

EPRI funded a "Hybrid ESP" project at Mirant's Dickerson Station in 2000 with a dry ESP vendor. While opacity was reduced to less than 10%, time constraints prevented mechanical issues associated with the liquid system design from being fixed and the project was terminated. The mechanical issues have since been resolved with a Croll-Reynolds wet-wall design.

The Electric Power Research Institute and Southern Company have agreed to participate in a pilot demonstration of the hybrid dry/wet ESP approach at Alabama Power's Plant Miller with a Croll-Reynolds Clean Air Technologies design. Plant Miller burns PRB coal and has a dry ESP installed. Selective Catalytic Oxidation technology is currently being installed at the plant to reduce NOx emissions. The slip-stream pilot wet ESP unit will be located after the dry ESP. Testing on removal efficiency of PM2.5, SO_3, SO_2, oxidized and elemental mercury will be performed.

CROLL-REYNOLDS Clean Air Technologies

Indigo Technologies Bi-Polar Fine Particulate Agglomerator

by Wallis Harrison - Southern Company Generation
(Member of the WPCA Advisory Board)

A new patented technology for the reduction of fine particulate has recently been introduced to the United States. The technology was invented and developed by Indigo Technologies, Brisbane, Australia. There is currently one full-scale installation in Australia, and the first installation in the US of the Indigo Agglomerator is at a Southern Company plant. The agglomerator is installed in the inlet duct of an electrostatic precipitator (ESP) treating one half of the gas flow from a 250 megawatt coal fired boiler. The ESP has an internal division wall, with separate inlet and outlet duct. There are also opacity monitors located in each outlet duct.

The principal of operation of the Indigo Agglomerator is very simple. Ash entering the agglomerator located in the inlet duct at approximately 50 feet per second, passes though lanes that are alternately charged positive and negative. The positive and negative charged particles are then carefully mixed. The mixing of the alternately charged particulate allows the fine particulate to attach to the larger particulate. The large particulate, with the fines attached, are now easily captured by the ESP.

Baseline testing of the ESP and the Indigo Agglomerator has been completed. Optimization, and testing of the agglomerator will begin soon.

Figure 2
Indigo Agglomeraor
Installation

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MAXimum Efficiency : Max-9™ combines an ESP and Fabric Filter

by Bob Taylor - BHA Group

U.S. Environmental Protection Agency (EPA) has recently named BHA Group, Inc.the exclusive licensee of a new particulate collection technology patented by the EPA. This new technology, called Max-9™, combines high voltage discharge electrodes in the same casing with fabric filters. Initial testing indicates the Max-9 provides collection efficiencies that are higher than those achieved by either the best fabric filters or the best precipitators on the market. Max-9 collection efficiency has been measured at over 99.99+%, with performance increasing over time. The best conventional technologies achieve 99.99%, with decreases in efficiency occurring as the systems age and wear. The high efficiency of the Max-9, particularly with fine particulate, makes it a valuable addition to SOx and Mercury abatement methods, which introduce lime sorbents and/or carbon.

The Max-9 is a combination of an electrostatic precipitator and a fabric filter. Dust laden gas enters the unit from the hopper and travels up through the rows of filters. Weighted-wire high voltage discharge electrodes surround each filter in a grid pattern and positively charge the particles. The particles are then attracted to the grounded filter, which serves the same purpose as a precipitator collecting plate. The similarly charged particles repel each other on the surface of the fabric filter, creating a porous dust layer. This is the secret of the Max-9, and the difference between it and similar devices. In the Max-9, there are no collector plates or grounded steel surfaces to bleed off the charge.

Therefore, the particles retain their charge until being removed, and are continuously repelled from each other, creating a very porous and non-agglomerated dustcake. This is the mechanism that creates the low-pressure drop observed in the Max-9. The factor for measuring the pressure drop of a fabric filter is K2 (specific filtration coefficient, measured in inches/H_2O). Tests have shown that K_2 dropped from a value of 14.5 down to a value of 4 when the discharge electrodes were in operation. With the electric stimulation turned on, pressure drop through the Max-9 is about 25% what it would be in a conventional baghouse operating at the same air-to-cloth ratio.

This electrostatically stimulated fabric filter technology was originally developed and patented by EPA. To test the concept, EPA teamed up with Southern Research Institute (SRI) to build a pilot collector at an SRI test facility. The pilot installation was configured to allow testing with or without discharge electrode energization. With the electronic stimulation turned on, the collection efficiency increased from 99.9% to 99.99+%, almost two orders of magnitude better. Plus, there was an 80% reduction in pressure drop and an 80-90% reduction in sub-micron particle emissions. The reduction in system pressure drop allows the Max-9 to operate at higher air-to-cloth ratios.

To test the Max-9 concept in a real operating environment, SRI and the Southern Company developed a test installation at Alabama Power's Plant Miller. This 5,000 CFM slipstream unit was designed to operate on a variety of fuels, including western coal with extremely fine ash. After more than 4,000 hours of operation, this unit has performed extremely well, confirming all the pilot data. Highlights of the testing include:

- 60-80% reduction in pressure drop
- 80-90% reduction in particulate matter emissions
- 90% reduction in PM 1.0 (sub-micron particulate) emissions

Test engineers operated a Scanning Mobility Particle Sizing (SMPS) system at the Max-9 outlet for several filtering cycles to compare sub-micron emissions with power on to those with power off.

They also ran the SMPS on the Max-9 inlet duct to allow a determination of the fractional collection efficiency for ultrafine particles. The graph shows penetration for particles with diameters in the range between 0.01 and 1 micrometers as determined with this test apparatus at the Plant Miller test site. The penetration reduction with electrostatic augmentation approached an impressive two orders of magnitude over much of the particle size range examined. See the following Figure 3.

The most likely configuration for the Max-9 is as a slipstream unit. The slipstream configuration allows the existing particulate control systems to be retained. Excellent overall efficiency can be achieved by placing the inlet of the Max-9 at the inlet to the existing precipitator or baghouse. The Max-9 inlet can be configured to draw off predominately fine particulate and a portion of the total gas volume, allowing the existing equipment to treat the larger diameter particulate with a reduced gas volume and lower particle concentration.

The Max-9 technology is versatile and can be used as a polishing collector (handling 100% of the gas volume) or installed as a conversion of an existing precipitator, retaining the ESP housing.

. Research is also underway to determine how much SOx, Mercury, and particulate precursors can be collected in the Max-9 alone.

Figure 3 - Max-9 inlet and outlet mass concentration.

Test I.D.	HV on/off	gr/acf	gr/dscf	mg/acm	mg/dscm	lb/106 Btu
Max-9 IN-1	na	1.09712	1.83417	2515.58	4205.59	3.69
Max-9 IN-2	na	1.09165	1.82087	2503.05	4175.09	3.69
Max-9 IN-3	na	1.11335	1.86269	2552.80	4270.97	3.70
Max-9 OUT-2	Off	0.00012	0.0.00019	0.270	0.445	0.0005
Max-9 OUT-3	On	0.00010	0.00017	0.226	0.379	0.0004

An Ounce of Prevention

by Steve Wilson - Hamon Research-Cottrell

Routine inspections of electrostatic precipitators can significantly reduce associated maintenance costs and help insure that emissions remain within allowable limits. A thorough evaluation by an experienced precipitator technician can prevent or delay expensive and/or extensive repairs.

An experienced technician has managed many of the problems that a precipitator might experience. The insight and knowledge of a seasoned technician as gained through the resolution of problems and the observation of problem symptoms experienced on other precipitators in other and related industries is invaluable. Such experience plays an important role in the inspection and troubleshooting of equipment and serves as an additional tool in the solution of the most difficult of both routine and unusual problems.

A complete and thorough inspection is made up of several processes including: a dirty inspection, a clean inspection, an external inspection, electrical checkout and air load test.

Figure 4 Ash buildup on collecting plates and discharge electrodes.

Dirty Inspection

The dirty inspection is performed as soon after process shut down as possible. (Figure 4) It is preferred that the rappers be shutdown as soon as the process is taken off line so that the internals are maintained in as close to "on-line" state as possible. This form of inspection is particularly useful when troubleshooting a known problem. On entering the unit the field specialist is able to observe where ash is building up, where it is not and if there is evidence of high velocity regions. The observations made during the dirty inspection provides qualitative information to the technician that is useful in predicting the effectiveness of the rapping system, the effectiveness of gas distribution devices and the proper functioning of ancillary equipment such as the hopper evacuation systems.

Clean Inspection

The clean inspection would take place after cleaning the unit using a method such as water washing or grit blast cleaning. (Figure 5) It is important that such an inspection be made routinely. The purpose of the clean inspection is to observe the integrity of internal and structural components and to note any evidence of corrosion. Clearances and alignment is also verified during the clean inspection and any failed or missing components should be identified and mapped for replacement during a future outage.

Figure 5 Loose and missing bolts on an emitting system vibrator shaft identified during a clean inspection.

External Inspection

The external inspection can be performed at any time during an outage such as while waiting for the unit to cool following shutdown, while the precipitator internals are being cleaned, etc. The inspection consists of a thorough walk down of the unit exterior. During the walk down, the technician will note the condition of the safety systems such as key interlocks and ground sticks. Additionally, the physical condition of transformer-rectifiers, rappers, heater and vent systems will be observed. Insuring that the equipment is properly grounded is an important safety precaution that can also be performed during the external inspection.

Electrical Inspection

A complete and thorough electrical inspection of all the electrical equipment should be made at each outage opportunity. The efficient and effective operation of an electrostatic precipitator is directly dependent upon the condition of its control systems and ancillary electrical equipment that support precipitator operation. During the electrical inspection, it is recommended that each control be inspected to ascertain that each is in good working order and that each is in readiness for long term operation. Additionally, while it may not be necessary to "ring out" every cable, the condition of cables should be inspected for integrity and their connections verified.

Upon completion of the inspections, the unit should be air load tested before process start and the return of the unit to operation. During the air load, any controls calibration as may be deemed necessary should be performed. Further, air load testing should be used to verify that full operational power is available and that no internal grounds exist. All ancillary equipment should be operated to ascertain proper function.

All inspection results should be thoroughly documented. The experienced technician will generally provide a comprehensive report discussing all of his findings during his inspection. The inspection report will include recommendations for current and future maintenance initiatives.

The latest inspection reports should be reviewed at least three months in advanced of any planned outage. Review of reports will reveal any additional parts that might be required for the planned outage and allow parts to be order with sufficient lead time to ensure their delivery prior to outage start.

Implementing the recommendations of service inspections at the earliest opportunity and having regular follow-up inspection visits scheduled to be performed by a trained technician will maintain the operational integrity of an electrostatic precipitator for many years.

HAMON

Redundancy in Precipitator TR controls Increases Precipitator Availability Cont...

By Peter Aa - Redkoh Industries

In the last WPCA article, experiences with redundancy in ESP automatic voltage controls (AVC) were discussed. This article extends that by discussing other areas where redundancy in an AVC can be invaluable.

In the world of modern microprocessor controls, failure of the main microprocessor can have dire results. Without some other means of being able to continue operating, there are only two (2) options for the ESP transformer rectifier (TR).

1. Either be shutdown until maintenance on the defective AVC card can be performed, or

2. For the control to be switched into a mode of operation where the processor is no longer responsible for firing the silicon controlled rectifier (SCRs) and subseuently getting power to the TR set.

Since shutting down the control/TR may cause unacceptable emissions and result in a system de-rating it is not preferred. The control must continue to maintain power at the TR by using means other than the microprocessor.

The two (2) most common ways of maintaining power during a microprocessor failure are:

1. Have a door-mounted potentiometer linked directly into the AVC firing circuit to directly control the conduction angle of the SCRs. This definitely handles the ability to keep the control/TR in service, but has drawbacks such as the need for a separate firing circuit card, no spark feed-back (thus requiring constant readjustment based on process load), and the degree of protection is impacted since only fuses and breakers are available for current detection.

2. Have a redundant analog controller as part of the AVC. When in manual, the control can be operated between 0 and some predetermined current limit (to protect the SCRs) by adjusting a manual bias potentiometer. This is similar to a simple manual control except for the fact that the redundant analog controller has a spark detector and a built in setback and ramp rate. This allows the AVC to follow the load during manual peration as well as prevent Spark/Arc bursting condi tions that could be detrimental to insulators and internal components, and so the AVC need not be continually attended to. Also, with a redundant analog controller if an over-current condition occurs while the control is in the manual mode, the control will trip, and drive an indicator alerting of the failure, without having to blow fuses or trip breakers.

A further benefit of the redundant controller is that

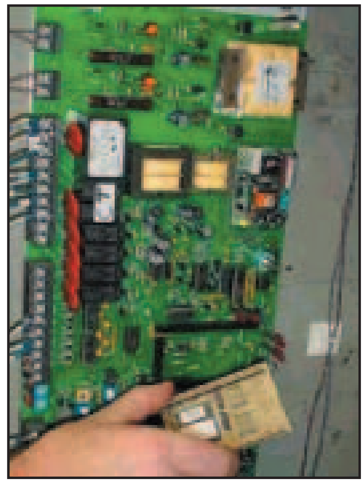

Figure 6 - Redkoh's AVC with microprocessor module removed

it automatically detects a microprocessor failure and will automatically invoke itself should this occur. The control seamlessly switches over to manual and continues operation.

Since the microprocessor has failed, there is no longer a method of determining the electrical levels associated with the control operation. Keeping the old analog meters when upgrading an AVC will take care of this problem.

In the next article, some of the benefits of analog and digital information will be discussed.

REDKOH MEGAnation

Upcoming WPCA Conferences

Low Cost Opacity Reduction Options

by Scott Williams - Duke Energy
(Member of WPCA Advisory Board)

In the process of burning coal to produce electricity, electrostatic precipitators (ESPs) are an essential component in collecting the flyash that results from the combustion process. The challenge of increased air quality regulations and increased equipment performance demand may require the implementation of creative engineering solutions to these challenges.

Many limiting parameters to precipitator performance can be encountered, such as, constantly changing coal supplies, ash that is not easily collected, concerns over lack of operating information, and precipitators designed to 1970 opacity requirements.

A suggested multiphase approach to the problem could be:

- Install supplemental systems to enhance existing precipitator collection capability
- Engineer modifications to existing precipitators
- Install computer-aided diagnostic capabilities

An engineering team should be established to evaluate and provide solutions to these problems.

Possible solutions that may be developed include: installation of flue gas conditioning systems, hot-to-cold precipitator conversions, various mechanical internal precipitator upgrades, controls upgrades, and data acquisition upgrades. These modifications may collectively result in a dramatic decrease in total yearly derates, opacity, and emissions.

There are many factors that should be considered in achieving the goal of opacity reduction. The combustion process problems encountered may include:

(1) high resistivity coal and
(2) sodium depletion in hot-side precipitators.

Operational concerns may primarily be categorized as

(1) lack of precipitator operational data
(2) lack of flexibility in precipitator control. It should be noted that the items presented below are solutions to specific problems and should only be applied when appropriate.

SO_3 and NH_3 Flue Gas Conditioning

For cases where the sulfur percentage has decreased due to requirements for lower sulfur dioxide (SO_2) limits often changing coal quality results in increased ash resistivities, which makes collection difficult.

In order to counteract a high resistivity ash problem the installation of an sulfur trioxide (SO_3) system should be evaluated. SO_3 injection is used to decrease the resistivity of the flyash in the combustion gas stream.

Ammonia (NH_3) can be used in conjunction with SO_3 injection to produce ammonia bisulfate in the flue gas stream, which chemically serves to reduce resistivity and cause the flyash particles to attach to each other and improve collection efficiency. An ammonia system can be used in solo to reduce SO_3 in applications where required. The SO_3 and NH_3 system can be used in combination and are often called a "dual" conditional system.

Results from the use of "dual" conditioning systems can be very favorable under the right circumstances. Often 50% reductions in opacity have been achieved. Of course, these results vary with coal quality.

Sodium Depletion

Sodium depletion is the displacement of sodium ions in the thin ash layer that remains permanently affixed to the precipitator collection plates. This phenomenon is prevalent in "hot side" precipitators. During extended operating periods the sodium ions dissipate and voids are created in the flyash layer. Power can not be properly transferred through these layers, so collection efficiency suffers. There are three methods for dealing with this problem.

Method 1: washing this thin layer of ash off the plates.
Method 2: to install a sodium injection system.
Method 3: to convert a "hot-side precipitator" to a "cold-side precipitator".

In many cases, the washing method is primarily used, particularly on smaller units. Sodium carbonate and sodium sulfate have been injected on the coal conveyor belt, with favorable results. On larger units a Hotside to Coldside conversion may be cost justifiable. The hot-to-cold conversion is basically a ductwork change. The precipitator remains in place, but the relative location in the system changes. The hotside precipitator is located between the boiler and the preheater. The coldside precipitator is located between the preheater and the ID fan. Keep in mind that the SCA of the precipitator increases for the coldside precipitator, in the conversion due to the decrease in gas flow due to lower flue gas temperature.

Mechanical Solutions

Most mechanical concerns inside a precipitator fall in three categories:

(1) Improper clearances between wire and plates, (Proper plate clear ances are necessary in order to generate the maximum possible corona to maximize collection capability.)
(2) Improper cleaning of ash off the plates and wires
(3) inability to remove collected ash from the precipitator hoppers. These circumstances may con tribute to decreased collection efficiency in the precipitator.

There are many examples of mechanical engineering enhancements that can be installed inside the precipitator.

Some of these enhancements are:

(1) lower alignment plate side spacer bars
(2) anti-sway insulators
(3) end plate adjustments
(4) hopper air cannons
(5) vibrator to rapper conversions
(6) plate frame sectionalization
(7) hopper level detectors

The purpose of the lower alignment spacer bars is to improve plate clearances. The anti-sway insulators maintain proper clearances between the plates and wires. The end plate adjustments correct an end plate clearance problem. The hopper air cannons help convey collected ash out of the hoppers and into the ash conveying system. (Buildup of ash reduces current generated and lowers collection efficiency.)

Vibrator packing gland to boot seal conversions eliminate the problem of vibration forces being dissipated in the hot pre-

Airflow Sciences - Continued from page 1

The geometry of the chimney inlet ductwork did not allow the two incoming flow streams to join uniformly. The result was a biased velocity profile which sets up the corkscrewing, cyclonic flow in the chimney. Model results were confirmed via comparison to plant measurements (relative accuracy test audit, or RATA, data), shown in Figure 7.

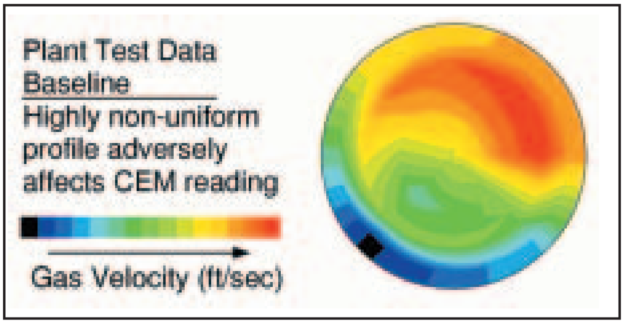

Figure 7. Baseline Velocity Profile at Monitor Location

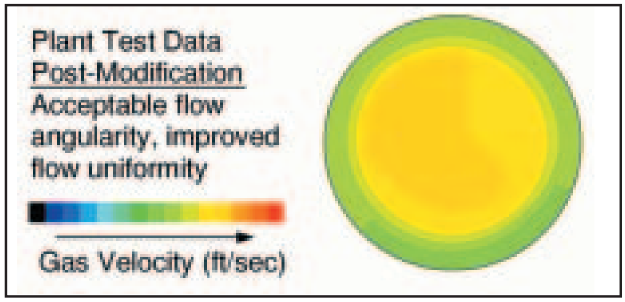

Figure 8. Post Installation Performance - Velocity Profile at Monitor Location

The model was then used to evaluate a number of possible design changes to improve the flow. The final design, after being installed in the plant, reduced the cyclonic flow and significantly improved the velocity profile at the monitor position. Stack test data after installation is shown in Figure 8.

Since the installation, the plant has not experienced any issues with the CEMs accuracy or repeatability due to cyclonic flow under the full range of unit loads.

Airflow Sciences Corporation

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cipitator roof and convey the vibration down to the wire and plate frames where needed to remove ash. The hopper level detectors are a method to determine ash level in hoppers, and prevent hoppers from overfilling and shorting out precipitator sections.

Operations

Operations concerns may include:

(1) lack of availability of precipitator electrical data,

(2) lack of the ability to initiate more than one rapper program.

Data Acquisition systems can be incorporated into precipitator control systems. This system collects voltage, current, and spark rate data provided by new automatic voltage controls. The data can be used to plot graphs and analyze data to more closely track and improve precipitator operation.

New rapper computer based controls can be installed that allow multiple rapper sequence and intensity programs to be programmed, in order to compensate for variable resistivity and load situations.

Conclusion

In conclusion, there are approximately 53 variables that effect the operation of an electrostatic precipitator. Improvement of any of these parameters, or any combination of these parameters, may improve opacity and emissions. It should be noted that all the items listed above are solutions to particular problems, and a careful engineering evaluation is necessary to know when to apply which solution to which problem.

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