WPCA NEWS

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WORLDWIDE POLLUTION CONTROL ASSOCIATION

As Easy As 1, 2, 3....

Ammonia from Urea Systems are Simple, Safe, Effective

By Norman Foster, Chemithon

Ammonia injection is widely used for reduction of nitrous oxides (DeNOx) in utility boiler stacks. Unfortunately, anhydrous ammonia is a hazardous, toxic, and volatile material that, when spilled, forms a fog which is lethal to humans and animals. Aqueous ammonia is a lesser hazard compared to liquid anhydrous ammonia, but a major spill will result in a very dangerous situation.

SafeDeNOx® completes first successful ozone season at Consumer's Energy Plant Karn

On the other hand, urea is a solid which does not form a toxic cloud, and is essentially non-toxic. Ammonia from urea systems are intended to reduce the potential hazard to the public at large, as well as to plant personnel, by replacing the transportation and storage of anhydrous or aqueous ammonia with the transportation and storage of urea. Urea is a widely available material commonly used for fertilizer and as a feed supplement for cattle.

Urea can be continuously hydrolyzed to produce ammonia as required for DeNOx. Tight control of the injection rate is required for selective catalytic reactor (SCR) and non-selective catalytic reactor (NSCR) applications to prevent under or over dosing of ammonia into the flue gas stream. Excess ammonia dosing will result in ammonia "slip" while not enough ammonia injection will result in inadequate NOx removal.

It is well recognized in the chemical industry that a rapid chemical reaction will have much quicker response to changes in production rate than that of a slower reaction. Since the rapid reaction responds quickly to changes in input of raw materials, rapid reactions are more desirable from a control viewpoint.

continued on page 5

Technology Goes to the Max:

The Max-9, that is, with ESFF Technology

By Bob Taylor, Vice President-Engineering, BHA Group

Recent test results at Alabama Power (Plant Miller) indicate that an electrostatic fabric filter effectively reduced mercury emissions by 50-85% at medium temperatures without using activated carbon. At higher temperatures, with powdered activated carbon (PAC) injection, the electrostatic fabric filter was able to achieve >90% mercury reduction.

For efficient mercury collection, elemental mercury needs to be converted to oxidized form. Preliminary data indicates that the level of oxidized mercury can be increased by adding chlorine at high temperatures or oxidants at medium temperatures. Oxidized mercury is captured when it makes contact with and "binds" to a porous surface (i.e. particulate or activated carbon.) Theoretically, as the contact period increases, the adsorption rate increases (improving collection efficiency.)

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Quick Review about Mercury Collection

Burning coal produces three forms of mercury:

- Particulate bound mercury is trapped in fly ash and is removed as the fly ash is captured in a particulate collector.
- Elemental mercury is vapor at normal operating temperatures and can only be effectively removed by sorbent.
- Ionic (oxidized) mercury is vapor at normal operating temperatures and can be effectively removed by scrubbing and/or sorbent injection.

Inside...

WESP to the Rescue: Meeting the EPA's Mercury Ruling

By Buzz Reynolds, CR Clean Air Technologies

Wet Electrostatic Precipitation (WESP) technology is a well-known technology for removal of sub-micron particulate and acid mist. Less well known is its ability to capture mercury (Hg) from coal flue gas.

In 2001, CR-Clean Air Technologies (CR-CAT) installed at First Energy's Penn Power's Bruce Mansfield Plant (BMP), located in Shippingport, PA, a 316L stainless steel 5,000 acfm metallic pilot WESP (see Figure 1). The pilot WESP uses a slipstream of flue gas from the exhaust of the flue gas desulphurization (FGD) system on BMP Unit No. 2, which has a rated capacity of 835MW and burns 3% sulfur coal. The plant installed the pilot WESP to test for PM2.5 and SO_3 mist removal as a potential control technology to reduce visible emissions. Further mercury testing was performed during 2003 under an award from the U.S. Department of Energy's National Energy Technology Laboratory (see Figure 2).

With release of the U.S. EPA's Mercury Rule calling for phased reduction of mercury emissions, there is great concern among coal-fired utilities about how they will meet these targeted limits, especially if the proposed limits are ratcheted lower. Current available mercury control technology has focused on sorbent injection followed by collection in a fabric filter for elemental mercury control and FGD systems for capture of oxidized mercury.

The original pilot WESP installed by CR-CAT at BMP during 2001 was designed for an industrial customer for 90% removal of PM2.5 at 5,000 acfm in a single field WESP. After testing in September of 2001, the unit was modified to a two-field WESP per a CR-CAT patent within the same collection box.

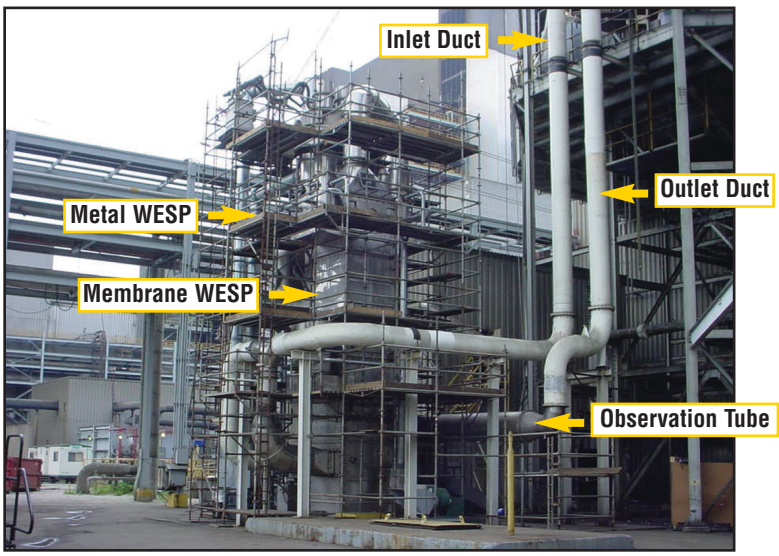

Figure 1
Perspective of Membrane and Metallic WESP at Bruce Mansfield Plant (Metal WESP on the Left, Membrane on the Right)

Mercury Removal in the 316L SS WESP

The table below shows the results of two sets of mercury tests conducted during the fall of 2001 and during the summer of 2003. Mercury testing was performed following Ontario Hydro protocols by the URS Corporation during 2001 and by Ohio University during 2003. Inlet concentrations and removal efficiencies are similar, providing confidence in the performance of the WESP and testing methodology by the two different testing parties.

Mercury	Particulate	Oxidized	Elemental	Particulate	Oxidized	Elemental
Date of Test	Sept -01	Sept -01	Sept -01	July -03	July -03	July -03
Air-Flow	8000	8000	8000	8000	8000	8000
Tested By	URS	URS	URS	Ohio U	Ohio U	Ohio U
# of Fields	1	1	1	2	2	2
Units	ug/dscm	ug/dscm	ug/dscm	ug/dscm	ug/dscm	ug/dscm
Inlet	0.011	0.689	6.245	0.03	1.4	6.2
Outlet	0.004	0.158	3.474	0.01	0.3	4.0
Removal %	64%	77%	44%	67%	79%	36%

Figure 2
Results of two mercury tests at First Energy's Penn Power's Bruce Mansfield Plant (BMP), located in Shippingport, PA,

The majority of mercury at the inlet to the WESP was in the elemental form, 6.2 µg/m³ vs. total mercury inlet of 7.88 µg/m³, or 79%. This was expected since the FGD scrubber installed at BMP should remove most of the oxidized and particulate mercury fraction prior to the WESP inlet.

Elemental mercury collection averaged 40%, with inlet concentrations averaging 6.2 µg/m³ and outlet concentrations at 4.03 µg/m³. Oxidized mercury collection averaged 78%, with inlet concentrations averaging 1.63 µg/m³ and outlet concentrations averaging 0.4µg/m³. Particulate mercury collection averaged 66%, however, inlet levels were so low (0.023 µg/m³) that removal efficiency cannot accurately be determined. Outlet concentrations averaged 0.01 µg/m³.

All testing has been performed at 8,000 acfm, 60% beyond the design air flow. Because a WESP is a volumetric device, it is very sensitive to air flow and velocity. Increase in velocity decreases performance due to less time to collect particles. Conversely, reducing air flow increases performance. If testing had been done at the designed air flow of 5,000 acfm, all test results would be significantly improved from those shown at the 8,000 acfm air flow.

Mercury Species Distribution

Of the 12.94 µg/m³ of mercury coming from the boiler burning 3% sulfur coal to the inlet of the FGD, 46% was oxidized mercury (6.02 µg/m³), 34% was particulate mercury (4.37 µg/m³), and 20% was elemental mercury (2.55 µg/m³) (see Figure 3).

Particulate mercury- The FGD scrubber on boiler #2 at Plant Mansfield is also used as their primary particulate collection device in addition to control of SO_2. There is no fabric filter or dry electrostatic precipitation (ESP.) The FGD system removes 80% of particulate mercury with the WESP achieving an additional 76% removal. Total particulate mercury removal across the two devices was greater than 95%, reducing inlet loading from 4.37 µg/m³ to 0.20 µg/m³.

Oxidized mercury- The scrubber achieves 69% removal of oxidized mercury and the WESP an additional 86% removal. It is significant to note that the WESP achieved higher removal efficiency on oxidized mercury on a lower inlet concentration than the FGD system. Total oxidized mercury removal across the FGD and WESP was greater than 95%.

Elemental mercury- The negative values shown in the table reflect the degassing of oxidized mercury in the FGD scrubber back into elemental mercury. It is hypothesized that the degassing is due to water chemistry and pH control. The WESP achieved only 18% removal of elemental mercury, a lower efficiency than the 36%-44% achieved in the 2001 test. Total elemental mercury across the FGD and WESP was only 6%.

Incremental Mercury Removal across the FGD scrubber and WESP

One of the objectives of this pilot WESP project was to measure the incremental mercury removal efficiency across the existing FGD scrubber and pilot WESP. Figure 3 below shows the respective removal efficiencies of the FGD and WESP for mercury species.

Incremental removal efficiency							
	FGD Inlet		FGD outlet		Wet ESP outlet		Total
	µg/m³	Removal %	µg/m³	FGD Removal %	µg/m³	WESP Removal %	FGD/WESP Removal %
Ash Hg	4.37	0%	0.85	80%	0.20	76%	95%
Hg^{2+}	6.02	0%	1.88	69%	0.26	86%	96%
Hg^{0}	2.55	0%	2.92	-15%	2.39	18%	6%
Total Hg	12.94	0%	4.88	62%	2.85	41%	78%

Figure 3
Mercury Species Distributions

Total Mercury Removal- Total inlet mercury concentration measured at the inlet to the FGD scrubber was 12.94 µg/m³. Total mercury concentration at the outlet of the WESP was 2.85 µg/m³. Total mercury removal achieved was 78%, a removal efficiency that achieves close to what the EPA requirements will be for the year 2018.

Plasma Enhanced ESP for Hg^{o} Control

CR-CAT has patented a WESP improvement called Plasma Enhanced ESP technology that has demonstrated up to 79% oxidation of elemental mercury within a WESP device. The technology has been laboratory tested and is being installed this spring at Southern Company's Plant Miller under an EPRI funded award. The plant burns low sulfur PRB coal, and has a high elemental Hg/oxidized Hg fraction. In this application, a slip-stream WESP field will be installed after a dry ESP field as an alternative approach to reducing mercury emissions to that of injecting activated carbon and capturing the mercury laden carbon in a fabric filter. With the WESP approach, the mercury is removed from the flue gas and put into the water, which is then further concentrated in a wastewater treatment system where the mercury is precipitated out of the water into a smaller, concentrated waste.

PM2.5 & SO_3 Removal

The pilot WESP performance on removing PM2.5 and SO_3 mist were 96% for PM2.5 and 92% for SO_3 at the higher than designed for air flow of 8,000 acfm under the two field configuration. Testing by Ohio University during 2003 showed consistent results to those performed earlier by URS with 89% removal for SO_3 in November of 2002 and 88% in July of 2003. PM2.5 testing in July 2003 reported 93%. Differences can be attributable to test method inaccuracies, test experience, and instrument calibration. The important point was that the metal WESP showed consistent relative high removal efficiency, close to 90%, for both PM2.5 and SO_3 mist.

Conclusion

The tests confirm that WESP technology can collect PM2.5, SO_3 mist as well as mercury at very high levels. Particulate and oxidized mercury species were collected with > 70% efficiency while elemental mercury can be partially oxidized, in the range of 18%-44%. Successful development of the Plasma-ESP technology will allow for high removal efficiency of elemental mercury within the WESP.

With mercury regulations on the horizon, WESP technology should be given consideration as another control technique that also offers collateral benefit of capturing PM2.5, SO_3 with little pressure drop (<1"w.c.), low power consumption (@1kw/1MW), and no additional real estate if mounted on top of the FGD system or retrofitted within a dry ESP.

HOT-SIDE ESP's: Who, What, When, Where, and Why

by Hank Kowalczyk and Bob Hall of EPSCO International Ltd.

Introduction

Pressed by the increased demands for power in the U.S. in the late 60's through mid-70's, and the EPA's drive for lower sulfur dioxide emissions, power plants began to favor the limitless production capacity of the low sulfur coals in the Powder River Basin, Montana, Colorado, New Mexico, and the lignites of Texas and North Dakota.

It was well recognized in the electrostatic precipitator (ESP) industry that these low sulfur fuels would represent a problem with resistivity and collection efficiency due to a diminished mechanism called surface conduction (the absorption of sulfur trioxide (SO_3,) water, and sulfuric acid on the surfaces of the fly ash particles.) This mechanism diminishes with increasing temperature and is also influenced by the presence of alkali metal oxides.

On the other hand, the ESP industry also knew that another mechanism, volume conduction (when current flows through the ash particles), increases with increasing temperatures. The combination of these mechanisms equate with the traditional bell-shaped resistivity vs. temperature curve (see Figure 4).

Rather than suffer the increased ESP size to offset the diminished surface conduction problem, or the increased pressure drop required to operate a fabric filter collector in lieu of an ESP, some utilities opted for the low-resistivity "hot-side" ESP, located ahead of the air pre-heater.

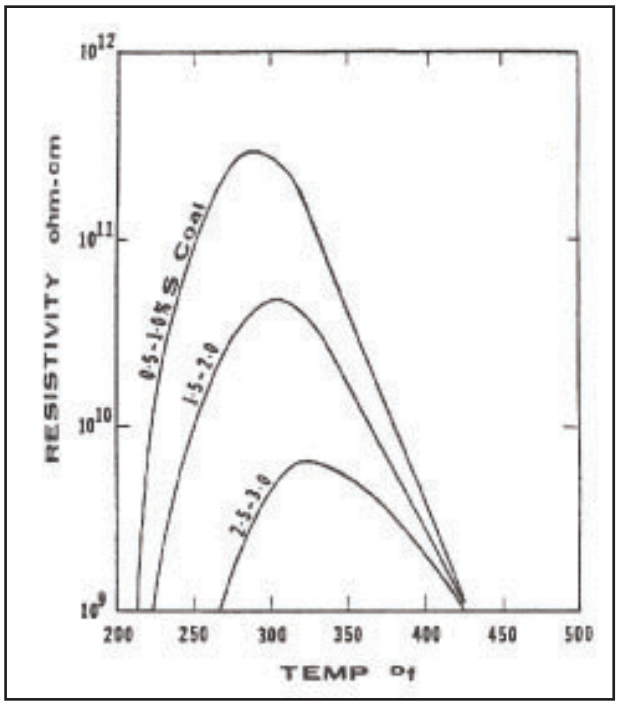

Figure 4: Resistivity Curve

Historical Results of Hot-side ESP's

Early performance results of the hot-side ESP, from the late 60's to the mid-70's, were quite favorable. It was believed to be a panacea for the low sulfur coal ash resistivity problem. In fact, about 150 hot-side ESP's were put into operation. But two-thirds of them were on Eastern low sulfur coals.

The advent of the hot-side ESP on Western fuels introduced more factors, until then unknown, to the matrix of chemical composition of the ash vs. predictable performance efficiency (specifically, silica, alumina, and sodium). The combination of high silica and alumina in the ash could sometimes be mitigated by ammonia conditioning. The nominal presence, or not, of sodium became a major concern, due to a phenomenon today called the "Sodium Depletion Effect." The sodium ion had been identified as the leading contributor to the conductivity of ash at higher temperatures. The reality that there was a finite supply of sodium atoms at the immediate surface of the collecting plate led to various attempts to mitigate the low sodium, high lime ash problem. These attempts included such approaches as:

- sprayed sodium salt solutions or blown dry sodium salt into the gas stream following the economizer,
- blending fuels, or
- adding sodium salt to the coal conveyor.

Problems were experienced with these approaches which ranged from fouling of boiler surfaces to excessive ash buildup in the precipitator, forcing unplanned outages to clean either, or both. In some cases, these outages occurred several times a year.

Further to the dilemma of hot-side ESP development was the matter of the unexpected structural design problems. Some units had no slide plates at the base of the columns, others were designed with the wrong ones. Ruptures were experienced all the way from the roof plates and insulator compartments, down to the hopper crotches, resulting in significant amounts of air and water in-leakage. In some cases, internal structural and bracing components were distorted, causing severe alignment problems. These were the problems that initiated the "hot-to-cold conversion" of many hot-side ESP's.

How We Cooled Them Off

Converting a hot-side ESP to operate successfully on the cold-side was found to be more of a challenge than simply rerouting the gas flow from the ESP inlet to the air pre-heater inlet. It involved the cooperation of the experts who were familiar with all of factors, which influence the electrostatic precipitation process, and the structural and mechanical engineers schooled in the parameters equating with successful ESP design. This implied a thorough and complete investigation of the original design documents, a plant inspection, an understanding of the fuels and sources, ash properties, operating conditions, and performance analyses.

The first benefit to a cold-side ESP is that of the reduced gas volume, and improved SCA, which is typically 30-50% greater after converting to cold-side. But would that increased SCA be adequate for the required performance, given the resultant gas inlet temperature to the ESP? Would that temperature be 300° to 350°F, where SO_3 conditioning could help mitigate a high resistivity condition? And what would be the influence of ash chemistry and gas composition (H_2O, SO_3/H_2SO_4) on the resistivity of the ash? Consider, also, that dust loss factors, as influenced by overall gas distribution, sneakage, velocity, excessive sparking, and rapping re-entrainment, could result in opacity or particulate emissions objectives.

If these elements of analysis appeared favorable to this point, what was the condition of the ESP's internals currently, following, perhaps, years of being subjected to temperatures in excess of 600°F? In particular, the 9" spaced, weighted-wire ESP might be more sensitive to alignment problems than the wider spaced rigid-frame designs. And what about sectionalization and TRs matched for the anticipated current density requirements from the inlet through the outlet fields? Rapping densities should also be checked, for both collecting plates and discharge electrodes. All of these factors would affect ESP performance when converting from hot-side operation to cold-side. They should all be thoroughly investigated.

If some of the above analyses weren't favorable, did the user have options for alternate fuel sources? Could the boiler or air heater be economically modified to produce a more favorable ESP gas inlet temperature? Could fuel blending be considered? If any of these options were possible, the matters of ash content, coal and ash chemistry, resistivity, and particle size distribution would all have to be reconsidered. And perhaps computer modeling for performance estimates would also be wise before executing any of the alternative options available.

Hot-side ESP's were successfully converted over recent years to cold-side operation. But the users who were prone to spend the time and money to investigate all of the above factors were usually the ones likely to meet the emissions performance goals, compliance regulations, and longer term availability and maintenance objectives for the new cold-side ESP.

As Easy As 1, 2, 3.... *continued from page 1*

One well known method to increase the rate of chemical reaction is to use a catalyst. The use of a catalyst to accelerate the hydrolysis of urea is a key element of the ammonia from urea process, as demonstrated in the patented Chemithon SafeDeNOx® Ammonia from Urea process.

The safety features of the SafeDeNOx® process are based on 3 principles:

1. Ammonia is only produced in the quantity needed as it is needed.
2. Ammonia is always in the vapor phase so that it will dissipate quickly in the event of an unintentional discharge.
3. Ammonia is produced as a dilute mixture.

Since the ammonia from urea process continuously produces ammonia as required for DeNOx, ammonia is not stored in any quantity except for that which is in the process equipment and the piping to the point of use. Additionally the ammonia is produced in a form diluted with carbon dioxide and water vapor.

The urea hydrolysis reaction is endothermic (see Figure 5). Urea, water, and heat all have to be present in the correct quantities for the reaction to proceed. The process, such as SafeDeNOx®, may also utilizes a catalyst to significantly increase the speed of the reaction and reduce the ammonia residence time in the reactor.

H_2NCONH_2	+ H_2O	→2 NH_3	+ CO_2
Urea	Water (steam)	Ammonia	Carbon Dioxide

Figure 5: Urea Hydrolysis Reaction

One area of variation in systems is the form of the stored urea. Unlike other processes for generating ammonia, the SafeDeNOx® process stores urea as a granular solid. Dry urea is fed to the system at the rate required to meet the ammonia demand. Excess water is not used to dissolve urea and dissolved urea is not stored.

SafeDeNOx® Plant Overview

The urea storage system feeds dry urea into a melter which melts sufficient urea to fill the molten urea header. The molten urea is pumped into the SafeDeNOx® reactor where urea and water in the form of steam are reacted in the presence of a self-regenerating catalyst to form ammonia and carbon dioxide. The reactor controls will increase or decrease the flow of urea from the urea handling system to match the demand.

Figure 6: Consumer's Energy Plant Karn

As Easy As 1, 2, 3.... *continued from page 5*

The first commercial SafeDeNOx® Ammonia from Urea Process was commissioned at Consumer's Energy Plant Karn (picture 6 on page 5) in May 2003. The SafeDeNOx® process was shut down at the end of the ozone season on October 1, 2003. During this first season of operation, Plant Karn obtained 782.6 tons of NOx credits based on NOx emissions of 0.03 lbs NOx/million BTU.

A key to the successful run was the very fast response time of the process to changes in ammonia demand, as illustrated by the chart in Figure 7 from the Plant Karn control system. Note that the ammonia flow closely tracks the ammonia demand signal during both "ramp up" and "ramp down." This is due to the use of a patented urea conversion catalyst in the process that increases the urea hydrolysis reaction rate up to 20 times relative to non-catalyzed processes.

Further, it is apparent from Figure 7 that the reactor temperature and pressure remain constant during changes in ammonia production rate. The constant temperature and pressure mean that the ammonia concentration in the product gas from the process does not change with changes in ammonia demand. This allows much tighter control of the ammonia flow to the SCR reducing both low conversion of NOx caused by under feeding of ammonia, or ammonia "slip" caused by feeding excess ammonia.

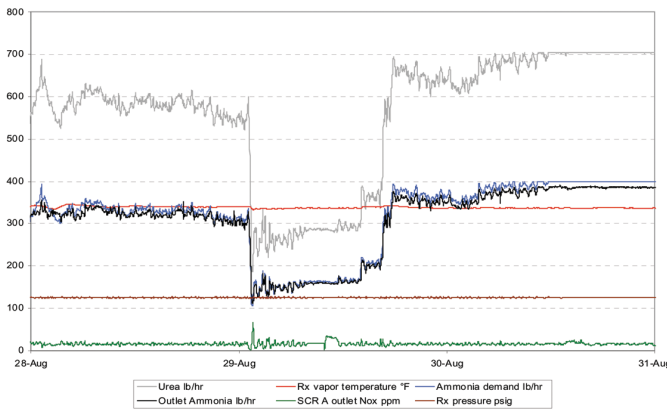

Figure 7: Plant Karn Control System

Critical to the success of the Karn project was the high percentage "on stream factor" (see Figure 8) of the SafeDeNOx® process. The chart to the left shows the availability of the system by month for the first season of operation with an average on stream factor of 98%.

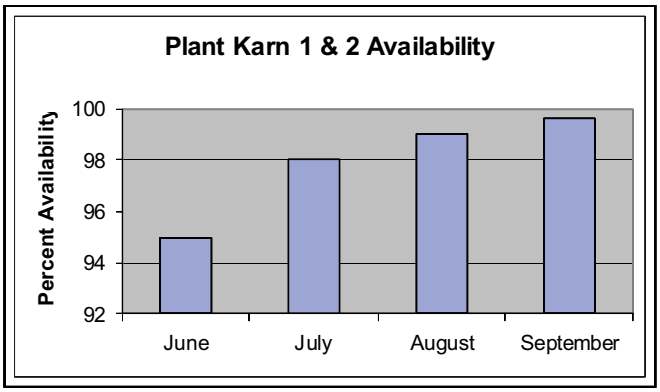

Figure 8: Energy Plant Karn's "On Stream Factor"

Conclusion

Performance of the ammonia from urea process has been commercially demonstrated at Consumer's Energy Plant Karn. The process offers a safe, cost effective alternative to storing ammonia on site. Process advantages of this latest technology include these:

- Responds quickly to changes in ammonia demand.
- Uses a self-regenerating catalyst that significantly reduces the residence time of the ammonia in the system (minutes vs. hours of ammonia production.)
- Produces ammonia at a constant concentration.
- Minimizes energy consumption by using molten urea and direct steam injection.

Technology Goes to the Max: *continued from page 1*

The traditional approach to mercury collection is to inject PAC ahead of a particulate removal device. To achieve 90+% removal, PAC injection rates need to be 1.5 - 10 lb/mmACFM. At current PAC prices, for a typical 750 MW boiler, this would equate to $4.5-$6 million per year (for sorbent alone.) This would likely be in addition to capital costs for installing a new baghouse, scrubber, and/or upgrading an ESP in order to collect the PAC. Plus, activated carbon could create waste disposal problems and void fly ash sales contracts.

ICR data gathered by the EPA indicates that a cold-side ESP in series with flue gas desulphurization (FGD) provides about 74% reduction in mercury on bituminous coal and about 29% reduction in mercury on sub-bituminous coal.

Testing the Max-9

In November 2003, BHA engineers, along with Southern Research Institute (SRI), decided to test the mercury reduction capabilities of BHA's Max-9 electrostatic fabric filter technolo-

gy. The Max-9 technology was originally developed and patented by EPA and licensed to BHA to commercialize. Although the technology has demonstrated extremely high levels of particulate collection (>99.99%), this was the first test specifically measuring mercury reduction at different temperature levels. The testing occurred over a three week period on a 3500acfm (1MW) test system at Southern Company's Plant Miller burning PRB coal (see Figure 10). The average air-to-cloth ratio in the Max-9 collector was 6:1. High permeability PPS felt filters were used in the test. Total mercury and elemental mercury levels were determined at the inlet and outlet of the Max-9 collector. The chart below (Figure 9) shows typical inlet total and elemental mercury values at the inlet and outlet of the Max-9.

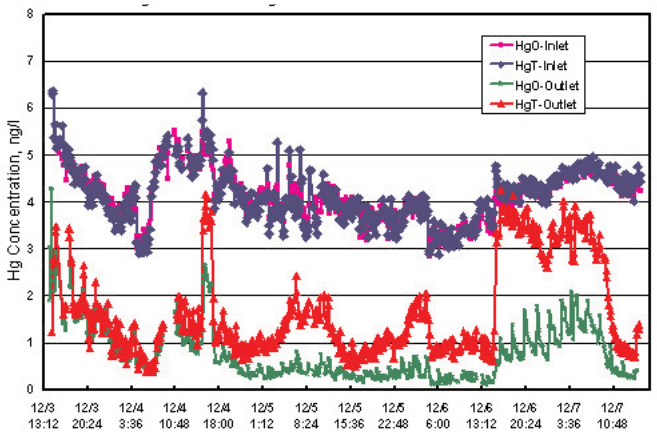

Figure 9: Hg Measurements across ESFF at Plant Miller

At 275°F, the Max-9 achieved 50-85% mercury reduction without activated carbon injection. Mercury removal was highest immediately prior to initiation of a cleaning cycle. This data supports the theory that longer contact time with a porous dustcake and reduced gas temperature improves mercury removal efficiency.

At 325°F and 340°F, the Max-9 without PAC injection achieved minimal mercury reduction. At a PAC injection rate of 2.6 lb/Macf, mercury emissions were reduced >80%. At a PAC injection rate of 3.5 lb/Macf, mercury emissions were reduced >90%. This would indicate that at higher temperatures, PAC is the primary mechanism for mercury collection.

Performance Indicators

Why did the Max-9 at Plant Miller perform so well in regards to mercury collection at lower temperatures? The main reason is believed to be the conversion of a high percentage of elemental mercury to oxidized. In conjunction with the longer contact time between the gas stream and the porous dustcake on the filter bags, mercury removal was increased. The Max-9's use of electrostatic charging enables the unit to maintain high collection efficiency and low pressure drop with infrequent pulse cleaning.

Number of filter bags:	**25 bags in 5 by 5 matrix**
Type of filter media:	**PPS, high permeability felt**
Size of filter bag:	**5.25" by 16'**
Total cloth area:	**~550 ft²**
Number of discharge	**16 electrodes in 4 by 4**
Type of discharge electrode	**Smooth 0.1055" diameter,**
Power supply:	**Single T/R set rated at 45kV**
Gas volume:	**Up to 5,000 ACFM**
Gas temperature:	**225 °F to 370°F**
Coal type:	**Powder River Basin**

Figure 10: Max-9 Test Module at Plant Miller

Thus, the dustcake can stay on the bags for hours (instead of minutes in regular baghouses.) In regular baghouses, extending the cleaning cycle usually results in unacceptable pressure drops.

When PAC was introduced at higher temperatures, the longer contact time again helped boost performance. Because of the Max-9's collection efficiency, utilization rates of sorbent should improve.

These test results seem to indicate that when the gas stream is cooled, an advanced baghouse design such as the Max-9 can effectively reduce mercury emissions without the need for sorbent injection. If the gas stream remains hot, sorbent such as PAC is probably required to meet mercury reduction goals.

During the mercury test period, the Max-9 operated at a system pressure drop approximately one-third that of a conventional baghouse. Figure 11 shows the relative pressure drop of the Max-9 compared to a conventional pulse jet collector operating at the same inlet conditions. The ratio of the specific drag coefficients represents the relative pressure drop of the two systems. Based on the data taken with the high permeability fabric, the Max-9 operated at about one-fourth of the pressure drop of a pulse jet collector.

During the test period, the unit demonstrated >99.99% particulate removal efficiency.

Figure 11: Comparison of Typical System Pressure Drop

	Air to cloth ratio ft/min	Specific drag Coefficient (in. H_2O min ft/lb)
Pulse Jet	5.86	11.42
Max-9	5.9	2.9

The Max-9 technology provides a high efficiency particulate and mercury removal method which seems to provide significant operating economies compared to a conventional pulse-jet fabric filter.

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The WPCA Welcomes its Newest Member: Babcock Power Environmental

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