CIBO Fluid Bed XXI Conference

June 2 - 4, 2008
Oak Lawn, Illinois

I. Fluid Bed Applications Workshop – Robert (Bob) Bibb, B&A Inc. - Engineers

Bob discussed the clash of energy and environmental policy and regulations as they affected FBC boiler development for burning lower grade fuels while meeting environmental requirements since the mid-seventies and the initial boiler application developments. Since then, sizes have gone from 50,000 PPH to over 2.5 million PPH; reliability has gone from that of a developing technology to being equal to or better than conventional technologies; and, the range of fuels usable with the technology has been proven beyond that applicable for conventional units.

Over that time period, initial problems associates with refractory, erosion, fuel handling and sizing, limestone sizing and consumption, plugging, bottom ash handling and operating availability have been solved to the extent of being equal to or better than those for conventional boilers. For all practical purposes, the FBC Boiler is a mature technology along with the stoker and pulverized coal boiler. The Fluidized Bed Boiler is now a viable consideration for burning any solid fuel, especially low-grade fuels or a wide variety of very different fuels.

Bob discussed ten things to evaluate when considering a FBC Boiler. These include the kind and characteristics of the fuels to be used, the operating requirements and potential forcogeneration, the stringency of the air permit limits at the plant location, sorbant availability and corporate sensitivity to capital versus operating costs. In today's environment, the FBC Boiler has some significant advantages in many cases. However, it may not be the correct choice in all cases.

Bob introduced Jack Fuller of West Virginia University who reported on an energy workshop intended to look at the problems of high and volatile energy costs on energy intensive industries and proposed research projects that might help alleviate some of the problems. DOE noted that new coal and nuclear plants have been lagging in the marketplace. This has led to a supply problem for low cost electric generation, resulting in an upward pressure on electric prices. Prof. Lave at Carnegie Mellon pointed out that US industry is not the most efficient in the world because, in general, our energy prices have been low

compared to the rest of the world. One of the research groups felt that generation efficiency as well as end use efficiency needed to be improved.

For an individual company, there is energy related planning, energy efficiency projects, and government programs and incentives to be considered. Alternative fuels, cogeneration projects, “green” credits, etc. are all part of energy related planning. Energy efficiency programs from DOE can be utilized including, bench marking, best practices, and energy audits. Internal reward systems can be changed to provide incentives for energy efficiency. EPA has a tool kit that is focused specifically on energy waste. Wider consideration needs to be given to all aspects of operations, including packaging, transportation, outsourcing, etc. European practices were mentioned as having coped with higher energy costs as fuels such as oil have been taxed heavily in Europe leading to higher energy costs. Industries in Europe had to become more efficient to survive. More deployment of cogeneration and combined heat and power can improve overall efficiency. A number of tax policies were put forth to provide incentives for higher energy efficiency across the entire energy sector (i.e. from production to end use). Environmental issues that were suggested included developing NOx reduction technologies that did not require the use of ammonia, developing less energy intensive CO2 capture technologies, and identifying co-location opportunities for coal gasification and other chemical products. A summary report was issued on this workshop. The goal is to get down to a few projects that might be funded to go further.

II. 2007 FBC Survey Results - Jack A. Fuller, West Virginia University

Jack Fuller presented a summary of the results of the 2007 Fluid Bed Operating Survey. A total of 32 boiler units responded, of which 27 were CFB. Most units use coal, although bituminous gob, pet coke, biomass, and tire derived fuels were mentioned. The Ca/S ratios averaged out to be 3.5, but the range was from 0.9 to 10.8. Nearly 70% were utilizing the fly ash and 77% were using the bottom ash. Overall plant availability improved somewhat in the last year. The level had fallen to about 85% in recent surveys and improved to 88% last year. Gob plants seem to have higher availability than the rest. Older units were exhibiting somewhat higher availability as plant owners have garnered more experience with their units. Tube leaks continue to be the major cause of forced outages. The more successful plants monitor the spots where erosion is a problem and fix these at the annual outage. However, problems external to the boiler continue to be the cause of a majority of the forced outages.

III. Owners' Panel Report - Gary L. Merritt, Inter-Power/ AhlCon Partners, L.P

The owners noted that new CO limits are being proposed. Apparently one FB unit was reported to have achieved a very low level of CO. However, no other emissions data were reported. It was also not reported about whether the load was changing or not. Without this additional data, it is very difficult to determine if this level is consistently achievable. Comments from the floor indicated that, in general, it was not. Usually, CO levels go in tandem with other emissions in the opposite direction. Also, load changes influence the CO levels.

Tube leaks were reported as the major cause of forced outages. Erosion of the tubing seems to be the major underlying cause. In many cases, the high wear areas are specific and known. One owner conducts annual outages and repairs these specific areas annually and has avoided forced outages. This is a difficult problem to predict in advance. Once the unit is in operation, tube mapping and monitoring can help to identify areas that are more susceptible. Economic evaluations have to be made to determine whether flame spray, weld overlay, or material hardness is the optimal solution. Panel replacement has also been proposed. One owner stated that welding over a thinned tube was not a good idea. Cutting out the tube and replacing it was deemed to be superior. Operator training practices were discussed.

The use of simulators was questioned. Early simulators were expensive and not particularly representative of CFB operation. Advances in computers and software have occurred, which have reduced the costs to $100 - 200 K, as well as improved the simulation. However, for small units, this is still a sizeable investment.

IV. Suppliers' Panel Report - Robert (Bob) Bibb, B&A Inc. - Engineers

Bob Bibb coordinated the Suppliers' Panel, including Dave Gadai of Metso Power; Jim DeSellem of The Babcock & Wilcox Company' Bill Campbell of ENSR International; and Scott Darling of Alstom Power, Inc. While the service business has been good and some new units have been ordered, the outlook is murky due to increasing commodity prices and increasing environmental intervention. Most new projects are requesting some kind of biomass co- firing. Environmental NGOs have targeted solid fuel plants for intervention. Litigation needs to be planned into the process. Delay tactics can invalidate an existing air permit. PM2.5 regulations are coming. Case-by-case MACT is impacting many projects. For coal-fired projects, CO2 is becoming an issue. Class I areas are major stumbling blocks. PSD requirements need to be considered.

The interest in biomass is at an all time high. Utilities are considering biomass. Fuel supply can be an issue. Paper mills are best situated to utilize biomass. Long term contracts are not always possible. Balancing cost issues is one way to attempt to mitigate the increasing costs of new plant. Construction costs are now more than the equipment costs. Working on reducing the construction time and costs can help reduce the overall cost of the new plant.

V. Climate Change Issues Panel – Moderator - Gary L. Merritt, Inter-Power/ AhlCon Partners, L.P.

The panel consisted of:

Michael Ling, US EPA

David Walden, Winrock International

Tom Gray and Valerie Plachy, Tetra Tech; Inc.

James Ekmann, Leonardo Technologies Inc.

Michael Ling stated Climate Change is a complex issue and cuts across multiple agencies and multiple departments and programs within the EPA. GHG sources are dominated by electric generation at 34% and transportation at 28%. Industry weighs in at 19%. Of the electric generation, 83% of the CO2 comes from coal firing. The Mass. vs EPA decision from the Supreme Court triggered EPA activity. EPA had taken the position that CO2 was not a pollutant. The Supreme Court ruled that the definition of a "pollutant" was wide enough to include CO2 (basically anything man-made that is emitted into the atmosphere).

The Court ordered EPA to prepare an "endangerment" finding for CO2. The Court order was for mobile sources. However, once CO2 becomes a regulated pollutant, the rest of the Clean Air Act is brought into play. Any regulation for mobile sources could automatically result in other regulations for stationary sources, as well as many other mobile sources including air transportation, water transportation, area sources, off road vehicles, and other small combustion sources. The EPA has decided to issue an Advanced Notice of Proposed Rule Making to request comments on this issue. Typically the comment period is 60 - 90 days.

Under Title II of the Clean Air Act, there are at least 4 sections that could be utilized. Under Title I, Stationary Sources, there are at least 6 sections, including the potential for ambient air standards, NSPS, and NSR. Any regulation other than Section 112 (HAP) will trigger Prevention of Significant Deterioration (PSD). Major Sources are 100 tons/yr for some categories and 250 ton/yr for all others.

Title V Operating Permits is also a 100 ton/yr program. These levels are sufficiently low that apartment buildings and office buildings would be brought into the program. There are also Sections for International Air Pollution and other Sections that could be utilized. Thus, interconnections among CAA provisions call for careful evaluation before any final action involving GHGs is taken. There are lots of questions and not a lot of answers.

The GHG reporting rule is required to require reporting of GHG emissions above "appropriate thresholds". The proposed rule is due in Sept. 2008, with a final rule some time in 2009. Legislation is being proposed. Lieberman-Warner is now Boxer-Lieberman-Warner. At the moment, the Senate is the only body taking floor time on a bill.

David Walden reported that the Environmental Resources Trust has initiated the GHG Registry, which is trademarked. The ERT is a group within Winrock International that focuses on voluntary action to reduce GHGs. Part of these activities include: building the infrastructure for trading systems and facilitating the trading of over 2 million tons/yr of GHG reductions. There is not a clear standard for accounting for CO2 reductions. The Registry goals are to encourage early, voluntary reductions in GHG emissions.

Essentials of a registry including the definition of the commodity, with measurement, verification, and ownership issues resolved. The Registry should provide a "gatekeeper" function that screens out projects that do not qualify. The idea is that reductions should be real. The system applies a serial number to each ton of carbon so that it can be tracked. Industrial projects that substitute biomass for coal can create offsets for CO2. Questions include: Who owns it? Is the Title Clear? Can it be measured? Will the reduction be recognized?

By participation in the registry, these questions can be resolved. Baselines are critical and must be established. Third party verification is required. Verification certificates are issued.which are tradeable. Energy efficiency projects would also qualify. In the voluntary programs, emissions credits trade for around $5/ton. The EU ETS currently trades for around $25 - 30/ton.

Tom Gray and Valerie Plachy of Tetra Tech, Inc. reported on Greenhouse Gas Inventories in the foot print process. Verification is critical for a good carbon foot print. There are a number of registries or inventories that are voluntary at the present time. The value of a registry is predicated on it being transparent, verified, underpinned by scientific basis, and project based. EPA and DOE both have voluntary programs. Reporting includes CO2 and/or CO2 equivalents. The Climate Registry was used as an example.

Reporting can be on a facility or a company basis. U.S. or North American operations can be reported. Protocols are set up for calculating the inventory. The World Resources Institute has published a methodology. Direct emissions are usually pretty straight forward. Indirect emissions include purchased electricity, steam, etc. Another level includes transportation, shipping, etc. Employee transportation to work is also included.

Emissions reported must be verifiable. The principles of verification include completeness, consistency, comparability, accuracy, and transparency. Third party verification is used to confirm that the inventory meets the requirements so that reductions can be traded. The goal is less than a 5% difference in comparable assessments. The independent review provides credibility to the process and a degree of certainty that the reductions are real and tradeable. Tetra Tech would be a verification entity and is a member of several exchanges and programs.

James Ekmann pointed out that carbon capture and sequestration will likely be a needed technology to stabilize CO2 in the atmosphere at some reasonable level (either 550 or 650 ppm). Natural processes include trees and micro-organisms. This requires the development of technologies to quantify, with a high degree of precision and reliability, the amount of carbon stored in a given ecosystem. Efforts in the US include carbon uptake on mined lands, no-till farming, and reforestation. Engineered capture and storage can be a applied within a plant boundary or for capture of CO2 from the air. Technologies are already deployed commercially to capture carbon dioxide from gas streams. Natural CO2 reservoirs exist. Most do not leak, but some do. Technology development is centered around characterizing the storage site.

Capture goals include reducing the cost and energy requirements of the capture process. Amine scrubbing, oxygen firing, and gasification with shift reactors and gas cleaning are all potential processes for CO2 capture. There are large point sources and saline formations that are relatively near each other. The NATCARB website has a collection of information on storage options.

The DOE program has shifted emphasis to include more sequestration demonstration projects. On the capture side, a sodium carbonate-bicarbonate solution project has been funded by DOE. The EU is funding a lime-limestone system as a CO2 carrier. The lime is used to capture CO2 to form limestone. The limestone is calcined to release the CO2. Because this process takes place at a relatively high temperature, the heat can be rejected to the steam cycle, thus reducing the energy losses of the system. One company is looking at capturing CO2 from the air (much like a tree). They are proposing to build some of these in the next 5 years. Another company is looking at membrane separation of CO2 for smaller systems.

VI. Meeting Today's and Tomorrow's Challenges with FBC Technology & Manufacturers' Panel - Gary Merritt, Inter-Power/ AhlCon Partners, L.P.

The panel consisted of:

Carl Bozzuto, Alstom Power, Inc.

James DeSellem The Babcock & Wilcox Company

Markku Roppo and Roger Leimbach, Metso Power and Automation

Carl Bozzuto described some of Alstom's activities in developments in fluid bed technology. Current technologies include the New Integrated Desulfurization (NID) system, the moving bed heat exchanger, and the "just in time" limestone system. The NID takes advantage of the excess calcium in the fly ash by taking a portion from the first collection hopper and wetting it through a special mixer. The resulting material is sprayed back into the duct work for additional sulfur capture. This equipment was seen being installed at the East Kentucky plant at last year's meeting. There are now 1200 Mw in operation. The moving bed heat exchanger allows solids to fall over the finned heat transfer surface. This system allows for a reduction in overall heat transfer surface. The first moving bed heat exchanger will be installed this summer. The "just in time" limestone system provides for limestone milling and direct injection into a CFB. This system reduces or eliminates some of the storage bins and particulate filter systems, resulting in a lower cost limestone prep system. This system was also installed at East Kentucky.

Biomass is also being fired at a number of units. Many inquiries request some portion of biomass firing as part of renewables requirements for CO2 reductions. As CO2 capture and sequestration is becoming a big issue, Alstom has been developing several technologies for capture. Field test units are now installed at the WE Energies plant at Pleasant Prairie Power Station and the Vattenfall Plant at Schwarze Pumpe. The US plant is a small slip stream utilizing the chilled ammonia process. This system aims to reduce the overall energy requirement for capture and compression by using an ammonium carbonate-bicarbonate loop for capture and regeneration. The bicarbonate solution can be pumped up to a high pressure for regeneration to reduce the compression work. The dissociation energy for the bicarbonate is less than for an amine. The Vattenfall plant is a 30 MW test unit for oxygen firing. This unit will start up this summer. Amine systems are on 2 existing plants in the US, Warrior Run and Shady Point. These plants treat about 10% of the flue gas to recover CO2 for food grade uses. A number of other demonstrations are underway.

Jim DeSellem of B&W reported on biomass activities for bubbling bed units. Jim noted that B&W has been emphasizing the smaller units for BFB applications

under 50 Mw. In a bubbling bed, the air flow is enough to lift the particles off the grate. At lower velocities, the bed is fixed and the particles don't really move. At much higher velocities, the particles are lifted and carried out of the bed. When they are captured and recirculated, they become a circulating fluid bed, or CFB. In between, the additional air flow over that needed to lift the particles, goes into making air bubbles. As this is the typical operating velocity, these units are generally referred to as bubbling beds.

At the present time, most of the B&W BFB units are burning mixtures of biomass. They are starting to see lower moisture biomass materials as candidate fuel. Tree stumps are becoming a common alternate fuel. The shredded pieces still have long strands of material. These have to be mixed with another biomass fuel to less than 50% in order to be handled. Sludge is also burned. This is a good mixing material. Tire derived fuel is now less economical than it used to be. The wire in the TDF has to be considered. Although most biomass is relatively low in ash, there are instances where high ash material is encountered. In this case, bed material has to be purged. For biomass, as the material decays, the nitrogen in the fuel becomes more available to convert to NOx. Material that looks like mulch will cause a spike in NOx formation.

Fine fuels are a problem for BFBs, as this fuel is carried out of the bed. It has to be blended in large part with other fuels in order to maintain operations. Digester knots (rejects) are fibrous materials that are high in alkalis (and sulfur). This material can cause plugging of the bed and the nozzles. Construction and demolition wastes are becoming more common as an alternate fuel. Variability is the biggest problem. Some types of material are not allowed to be burned (creosote ties, for example). Agricultural fuels are also showing up as alternate fuels. The U.S. variety is different from the European variety due to the differences in fertilizer and pesticide usage. B&W has set up a biomass database with more than 1000 different biomass fuels. Ash characterization has been undertaken for these fuels with the University of Akron. In operations, it is critical to avoid hot spots.

Controls are important. BFBs are very responsive. Attention to detail such that control elements don't work against each other is key to improved operation. Continuous operation of the bed drain system to get rid of rocks is now possible. A bed material reclaim system has been developed. The system consists of vibrating conveyors and a bucket elevator. Chemistry is becoming more important. There is a lot of chemistry that is possible. Ash characterization is one area that can benefit from a study of the chemistry. Relating eutectic temperatures with chemistry compositions has been pursued with university studies. Flue gas recirculation is used to prevent flames in fuel chutes, as well as to disperse the fuel in an overbed feed system. B&W has a verified, CFD model of a bubbling bed system. Cellulosic ethanol waste is being tested as a BFB fuel. B&W is working with developers and the DOE on this part of the process. Pelletized, biomass fuel is being promoted as comparable to coal.

Grasses are not a particularly good fuel for a fluid bed. With pelletization, it is much easier to handle and feed these types of fuels.

Markku Roppo of Metso reported on Metso activities in fluid bed boilers. Metso purchased Kvaerner, which also had technology from Tampella and Gotaverken. The CFB technologies can handle fuels ranging from coals and pet coke down to low heating value fuels such as biomass. With biomass firing, emissions, including CO2 are reduced. The potential for fouling and slagging increases due to the alkalis and chlorides in the fuel. When co-firing biomass with coal, there is a non-linear reduction in limestone usage as the alkali in the biomass assists in sulfur removal. Thus, with a 50/50 mixture, the limestone usage is only 40% of the case with 100% coal. Even in the case of NOx, the mixture of coal and biomass has lower NOx than either pure biomass or pure coal.

Alkali chlorides can be responsible for high temperature SH corrosion. With 100% biomass, this corrosion occurs at temperatures above 850 F. With the mixture of coal and biomass, the alkali is tied up with the sulfur as alkali sulfates with a higher melting temperature than alkali chlorides. High alkali concentrations can lead to the potential for bed agglomeration. Bed temperature control is typically used to keep the bed below the specific temperature limit. Fuel and biomass require separate feeding systems. A number of units have been in operation in Europe for over 15 years. A large unit (900 kpph) in the US (LA) burning pet coke, bark, and sludge has been in operation for about 1 year.

Roger Leimbach of Metso talked about controls and control optimization for biomass units. Metso has over 100 units (mostly in Europe). Metso does control optimization on all makes of fluid bed units. They are currently working on the controls for the first supercritical CFB for the Lagizsa plant in Poland. The controls need to control the output of the plant. In order to do this, the input needs to be controlled, which, in turn, requires good measurements. Multi-variable control systems are needed. At a Stora-Enso plant in Finland, a number of boilers operate, including a BFB, burning peat and sludge. Testing and measurements were done for several days to characterize the plant. Control systems, with fuzzy logic software, provided reductions in CO, NOx, and O2, along with a considerable reduction in variability.

VII. Mobotec Technology Update - Dave Judy, NALCO Mobotec

In the last year, NALCO has purchase a major share of Mobotec. Patents have also been issued on the ROFA/ROTAMIX technology. ROFA stands for rotating over-fire air. Mobotec does theirown modeling for the application of the technology. They also make their own nozzles. They will provide a complete installation, but prefer that the owner handle the bulk of the installation with their preferred vendors. The bulk of the equipment can be installed prior to the boiler penetrations. The actual boiler penetrations and close up takes from 3 to 8

days. Data from two units was shown giving the variation of gas compositions at the cyclone inlet. Oxygen, NOx, CO, and SO2 were found to have considerable variation across the cyclone inlet. Similar data was taken for particulates. The highest particle densities were noted in the corners. Model studies were used to predict improvements in mixing and gas concentrations. The result is a more uniform concentration of all components, leading to lower overall emissions. Mobotec also has a mercury control product. By modeling, the amount of additive can be reduced to meet the required compliance level. The unit can be tuned after installation through the use of testing and modeling. The results include reduced emissions, reduced limestone consumption, reduced chemical consumption, and potential efficiency gains. Controls are also important.

VIII. Alternative Fuels for CFBs - Charles Wagner, Burns & Roe Enterprises, Inc.

Many states have renewable portfolio standards or in the process of setting them. While wind and solar are renewable, they are intermittent and often expensive. Steam temperatures need to be considered for the variety of fuels to be burned. Lower temperatures may be required for fuels with chlorides and alkalies. The quantity, quality, and price of biomass, including detailed chemical analyses, are a necessity. The typical volumetric quantity of biomass is 10 times that of coal. Biomass combustion increases the flue gas flow, due to the higher moisture level. Gasification can be used to generate a clean fuel gas that can be fired into an existing boiler. An existing PC unit is not capable of 100% firing. Turkey litter is not a good combustion fuel. The material is low density with low heating value. It is very difficult to handle. Corrosion potential is very high.

IX. Limestone Sizing and Preparation - Howard Fitzgerald, Chemical Lime Company

Howard pointed out that Chemical Lime and Franklin Industrial Minerals are both owned by the Lhoist Company. Chemical Lime is primarily in the Southeast and West Coast. Franklin is in the Southwest and Southern states. Limestone, Lime, and Hydrated Lime are not the same mineral. Limestone is heated in a kiln to drive off CO2, making lime (or quick lime). The lime when mixed with water makes calcium hydroxide, or hydrated lime. The lime, or hydrated lime, can be reacted with CO2 over time to reform limestone.

Limestone production in the US is about 1.1 billion tons/yr, about the same as coal. Applications include agricultural and construction uses, as well as emissions controls. There are also uses in manufacturing for a wide variety of applications. Limestones vary in quality due to impurities and sizing (as well as specific surface area). Aggregate use can tolerate limestones with less than 80% calcium carbonate. Portland cement can use 80% limestone with 20%

silica. Wet FGD can use 92% calcium carbonate, unless wallboard is the intended by-product. In that case, as well as for CFBs, a 95% purity is required. For fillers, such as fine papers and some manufacturing processes, greater than 97% purity is required. Value increases as the purity increases.

Size requirements typically are between 30 mesh and 200 mesh. The specific gravity should be consistent and with 2.7 - 2.9. Mechanical properties such as porosity, hardness, flowability, etc. are important considerations. Sizing and classifying includes primary and secondary crushing, followed by air classification and screening. It is often advantageous to purchase the limestone from a supplier that has multiple uses, so that the rejects from the screening can be used by the supplier for other purposes.

Downstream trim methods for sulfur control can be used to optimize the cost. Opportunity absorbents can include lime kiln dust and limestone fines. This material could be mixed with the coal feed or as bed make up. The lime kiln dust can be used to improve the SO2 removal with an overall reduction in the $/ton of SO2.

X. FBC Parts and After Market Services - Robert S. Morrow, Detroit Stoker Company

FBC technology is not a big part of the stoker business. However, coal distributors, refuse distributors, feeders, and service work are part of the product line. The over-bed feed systems typically use an overthrow feeder to throw the coal over the bed. Radiation and mixing issues caused some damage to these feeders. Wear issues also surfaced. The next generation of distributors incorporated a smaller throat and either air or gas cooling for the parts exposed to radiation. Air swept distributors are similar to the distributors for waste incineration units. These are applicable to free flowing fuels. The RDF and MSW fuels need more air assistance with no horizontal sections. Metering devices are similar to the RDF metering devices. Rotary seal feeders are used for limestone feeding. These can be used to feed against a higher pressure (up to 6 psi). These rotary valve systems can also be used for ash systems. Detroit Stoker also does castings. Nozzles, tuyeres, and directional nozzles can all be cast. Materials can be varied, depending upon the application.

XI. Bag Selection and PM Control – Thomas W. Anderson, Midwesco Filter Resources, Inc.

The ever changing EPA has maintained 2 programs consistently. EPA's focus will include PM 2.5 collection efficiency and the verification of filter media efficiencies. On the EPA website, there are 6 filter media that have been certified. There are two pleatable materials and 4 membrane materials that are certified. The program is administered out of EPA RTI. An environmental testing

firm in Roanoke, VA, carried out the tests. With these results, the E-NGOs have gone to the states on the west coast to promote the use of membrane materials. The California SCAQMD issued Rule 1156, which reduced the testing requirements for those firms which use these types of bag filter media. There are 32 states that are looking at enacting similar laws. The National Parks have their own environmental rules. Anything that might cause “haze” in a national park will be required to get the best particulate removal.

The membrane coating requires fewer pulses and less pressure drop than the traditional felted material. However, the best media and filter in the world will be worthless without proper operation and preventive maintenance. With these materials, the maintenance will have to be exceptional. Clean, dry air is needed. The diaphragm needs to be changed regularly. The reservoir and supply line need to be adequately sized. The hoppers have to be evacuated. The pulse sequence needs to be staggered.

The collection of PM2.5 will need to compare costs of the bag material against the cost of energy needed to operate the baghouse as well as the cost of maintenance. With an existing bag filter, if the gas velocity is high, the membrane will be ripped off rather quickly. The membrane also does not build up much of a filter cake. This means that those projects that are using the bag filter for SO2 collection will suffer. These lab filter tests have not been field tested. Never the less, this media could be mandated for PM2.5.

XII. Plant Tours - Tom Wasilowski, Corn Products – Argo

Tom gave a description of the Argo Plant’s new CFB, which replaced 3 gas-fired boilers for main production and 3 older coal-fired boilers, which are no longer in use. The older coal boilers are being torn down. Two of the 3 gas-fired boilers are kept on hot standby. The FW CFB is a 1.1 million lb/hr unit with steam conditions of 650 psig and 700 F. The steam goes through 2 let down turbines for about 50 MW of cogeneration prior to being utilized in the processing plant. Most of the plant requirements are for 150 psi steam or less. The 150 psi steam is taken as extraction steam. The turbine exhaust is 5 psi. The plant demand determines the steam load. A substation provides grid connection for any additional electric demand. Illinois coal is used at the site. The higher chloride content of the Illinois coal required the use of lime addition after the CFB for HCl control in the baghouse. The plant has a 20 day coal pile and a 7 day limestone pile. There are 4 coal silos with Stock feeders. There are 2 front wall and 2 rear wall feed points. The feeders are gravimetric feeders. A drag chain moves the coal toward the gravity feed chutes. The first opening is half the width of the conveyor. The second opening is the full width, effectively splitting the coal stream.

The coal is delivered by 25 rail cars, which is roughly a day and a half supply. Limestone is injected into the boiler separately. Although the limestone is milled on the site, a storage system is used to get the limestone to the boiler. The unit has a tubular air heater. The unit was at half load during the visit. The total coal flow was about 35 ton/hr. The limestone flow was about 8.7 ton/hr, which would correspond to a Ca/S ratio in the neighborhood of 3. With the low load, the excess air level was fairly high at 7.1% oxygen. The unit was running completely automatic at that load. Criteria emissions were kept within limits at the low load operation.

We also visited the NALCO R&D facilities for water treatment. NALCO was purchased by venture capital and then spun off again. They have recently purchased Mobotec. The R&D labs cover all varieties of water treatment activities including boiler water, pulp and paper, cooling towers, HVAC, and others. Water chemistry and materials are the mainstays of the work. NALCO attempts to work closely with clients to understand their water chemistry requirements in order to try to provide solutions, rather than just to do post mortem analysis of problems to identify the type of corrosion or operational problem.