Abstract
Air pollution control (APC) systems in waste-to-energy (WTE) plants are facing many of the same challenges that independent power facilities (IPP) have dealt with for years. The most prevalent problems being corrosion and emissions. An IPP plant in the southeastern U.S. illustrates the cause and effect that corrosion played in the plant’s operation, as well as the engineered solution designed to address the issue. The result has performed beyond expectations and lends itself well to the same issues in the WTE plants. The paper also provides information regarding the conversion of the electrostatic precipitator (ESP) to a fabric filter baghouse. By utilizing the existing housing of an ESP, a higher particulate collection efficiency can be achieved at a fraction of the capital cost. Finally, the paper discusses filter changeout to filter bags laminated with highly efficient expanded polytetrafluoroethylene (ePTFE) membrane. This media change addresses the demanding environmental regulations the industry faces, as well as providing benefits to the WTE APC system such as superior clean down, increased airflow, and extended filter life. The ultimate results of these three technologies can help decrease maintenance time and cost and increase WTE facility production.

Introduction
Waste-to-energy (WTE) presents air pollution control (APC) challenges unique to this industry. Operationally, the WTE industry is facing numerous changes in the coming years. Fortunately, WTE plant personnel are among the most informed in any industry as to their process and equipment understanding. This knowledge is invaluable as it will help them overcome common problems and ensure they continue to increase their output and profitability.

Corrosion: The Sneaky Thief
Municipal solid waste (MSW) is a difficult fuel. The variable Btu value of MSW can cause these plants to experience swinging boiler loads, varying levels of moisture, inconsistent incineration characteristics, etc. Each of these challenges present this industry with damaging and difficult to manage corrosion. Many times, the corrosion is not a linear progression, it can be affected by a single upset condition, or by many upset conditions. Unnecessary startups and shutdowns cause excursions through the dewpoint resulting in high acid conditions and accelerated corrosion. Corrosion is common to all WTE APC systems but there are engineered solutions available which can help you battle this tireless enemy.

Independent power plants (IPP) that have been built in the past 8-10 years have been designed to burn coal efficiently. They achieve the maximum Btu values from the coals that they burn, and produce the finest ash of any coal burners. These systems were expertly designed to meet very stringent environmental regulations, however, there is an unanticipated
Corrosion is to blame for this thimble hole. The result is pesky emissions and damaged filters.

Figure 1. Corrosion is to blame for this thimble hole. The result is pesky emissions and damaged filters.

problem with these systems: advanced and progressive corrosion in the APC equipment following initial startup. The design of these air pollution control devices, as well as the scrubbing that takes place prior to the baghouse, lowers the inlet temperature anywhere from 150°F to 180°F (65.5°C - 82°C). This has provided a unique condition in independent power production that creates massive, advanced corrosion within the first three to five years of operation. The acid attack that is prevalent in this moisture-laden atmosphere is similar to what waste-to-energy plants go through on startup and shutdown. A byproduct of this troublesome corrosion is the toll it takes on the components of the dust collector (See Figure 1), which generally leads to excessive emissions, restricted airflows, increased frequency of unscheduled shutdowns, costly maintenance, and time consuming filter changeouts.

IPP baghouses were designed much like baghouses in the waste-to-energy industry with similarly sized air-to-cloth ratios, the same types of fabrics, the same thickness of metal, etc. It is for this reason that recently developed engineering solutions for the independent power industry lend themselves perfectly to the dust collection challenges of the WTE dust collection system.

The Thimble to Snapband Conversion.

A major independent power producer in the southeast suffered extreme corrosion problems beginning just three years after initial startup.

The problems in this 12-compartment reverse air baghouse surfaced when the caps of the reverse air filter bags began to fold and bend. The 10 oz. fiberglass filter bags began to fail and other components began to break, including springs critical to filter tensioning. But the most damaging problem was corrosion on the thimbles at the edges. Five years after initial start-up, holes began to form in the thimbles. Thimbles soon began to separate from the tubesheet, hurling them into filter bags, destroying neighboring filters and causing uncontrollable emissions and subsequent unplanned shutdowns for repair and replacement. To make matters worse, these filters had all been replaced with costlier corrosive resistant filter media. Emission spikes occurred regularly caused by the thimble corrosion. The resulting leaks allowed emissions into the clean air plenum, forcing the utility to reduce gas flow and power output while maintenance was performed repeatedly on each of the twelve compartments. These emissions affected not only the power output, but also put the plant at risk of incurring expensive fines.

Large amounts of dust accumulated higher than the thimbles necessitated unscheduled cleanups, as well as higher emissions whenever thimble breakage occurred (See Figure 2). Piles of fugitive dust frequently needed to be vacuumed or shoveled down the 12" tall thimbles, thus resulting in time-consuming maintenance, downtime, and reduced power production, each with increasing monetary cost.

No More Thimbles, No More Clamps.

In response to this plant’s problems, BHA engineered a solution to eliminate the thimbles from the tubesheet. The conversion utilized stainless steel tubesheets with laser-cut holes to accommodate snapband filters engineered to withstand the reverse air action during cleaning and operation. The installa-
tion crew went to work on the system one compartment at a time so that the plant could continue output over the 17-week period required to complete all 12 compartments (See Figure 3). The old tubesheets with thimbles were removed and replaced with the new flat stainless steel snapband style. Compartmental interior surfaces were coated to help the system resist future corrosion. This was referred to as the "bath-tub." The floor was coated 12” up from the new tubesheet all around the walls of the baghouse. The hoppers were repaired with stainless steel patches. Fiberglass filters were installed without the need for clamps cutting maintenance time by half. The snapband design saves hours of installation time (See Figure 4), and the filters are easily and precisely tensioned utilizing a BHA AC Tensioning Tool®.

The entire project was completed ahead of schedule and is a complete success. Plant management is happy with the outcome, and the reduction of maintenance downtime and emissions will benefit their operation for years to come.

Corrosion in WTE Plants on the Rise
In the waste-to-energy industry, the corrosion in most of the facilities is just beginning to reach an advanced stage. Many plants have already re-clad their hoppers, however, they have not taken a hard look at how they are going to replace the tubesheets and when that upgrade should occur. Additionally, many facilities have replaced doors and door seal in response to the corrosion, and have re-clad around the inleakage of old doors that were rusting out. The tubesheet issues need to be addressed. Several plants are considering the Thimble to Snapband Conversion as a replacement within the next two to three years. It’s a retrofit solution that has proven that it is more economical, short and long term, than replacing the components in-kind.

Need Higher Efficiencies From Your APC System?
The Electrostatic Precipitator to Baghouse Conversion
The dust collection workhorse at many WTE plants is the electrostatic precipitator (ESP). While the technology is still reliable in dozens of industries, many WTE plants are facing the need for costly overhauls of aging equipment and increased efficiencies due to tougher environmental regs. One option to consider before reinvigorating a tired ESP dust collector is to convert it into a baghouse.

The successful retrofit of the ESP was engineered to address the costly scenario involved with demolishing the old ESP, while minimizing the lengthy downtime usually required for
such an undertaking. By utilizing the existing structure of the unit to house an efficient pulse-jet cleaning system, the results have proven successful (See Figures 5A & 5B).

**Why Convert To a Baghouse?**

Today, most environmental engineers would agree that advances in fabric filtration technology have surpassed advances in electrostatic precipitation technology. Thus, a majority of the new APC systems being installed throughout the world are fabric filter collectors (baghouses). Baghouses offer several advantages over ESPs:

- Higher efficiency (lower emissions)
- Reduced maintenance (parts + labor)
- Online maintenance (when the baghouses are compartmentalized)
- Tolerance of changes in dust load
- Handling of increased gas volume
- Ability to change filter media as conditions in the process change

The primary advantage of a baghouse is the ability to reduce emissions. As air quality regulations continue to tighten around the world, stack emissions are becoming an increasingly important factor when making decisions about the dust collection system. Existing ESPs find it difficult, if not impossible, to meet the more stringent emissions standards and a new ESP would be economically unfeasible when compared to a baghouse. For some applications, an ESP upgrade is very effective in reducing emissions and should be considered as a viable option. Yet even a rebuild cannot overcome the fact that some applications produce dust that is either too fine for an ESP to collect, or is too resistive or too conductive to hold a charge well enough to be collected in an ESP. For these applications, using fabric filtration is a better option.

**The Conversion From Plates To Pulse-Jet**

The concept of converting an ESP into a baghouse is not new. The idea has been around for years and several conversions have been accomplished around the world. But with the need for increasingly higher efficiencies and the problems associated with aging ESPs, this option has seen a renewed interest in recent years. The genius of the ESP to Baghouse conversion is in its simplicity.

In most cases, the existing sidewalls and hoppers from the ESP can be used without modification. Existing ductwork and material handling systems can also be re-used. Usually, the biggest question is whether to create the clean air plenum within the existing footprint of the ESP inner chamber (See Figure 6), or if the clean air plenum will need to be added to the top of the existing structure (see Figure 7). This decision is based on a number of factors, primarily the temperature of the gas stream, the size of the existing ESP, the desired gas flow, and the types of fabric filters to be used.

The typical conversion (on a moderate sized unit) requires five (5) basic steps, as follows:

1. **Removal of the internal components of the existing ESP.** This includes plates, wires, rapping systems, T/R sets, upper and lower frames, perf plates, etc. The working parts of the ESP are removed leaving an empty shell.

2. **Installation of the tubesheet, baffles, and air directional sys-**
tems. Some modifications may be required to inlets and outlets and to the ductwork for the system to work properly. If an external clean air plenum is required it is accomplished at this step.

3. Installation of access doors, walkways, and ladders. The placement of these items is dependent on the location of the clean air plenum and the ductwork.

4. Installation of filters. In many cases, the technology of choice is ePTFE membrane filter bags. The decision concerning filter type is based on gas volume, gas temperature, size of collector, installation requirements and cost. Choosing the right filter is critical to the success of the overall project. Without the proper filter media, the baghouse may not perform any better than the ESP it replaced. Even worse, the wrong filters may wear out faster and require more maintenance than before. Properly designed, sized, and installed filters will provide the efficiencies and reduced maintenance required.

5. Installation of the filter cleaning system. As mentioned above, the plan uses pulse-jet technology as the filter cleaning system. The necessary components of a pulse-jet cleaning system include air lines, pulse valves, air headers, blow-pipes, and electrical connections between the valves and the cleaning control system.

In most cases, it is recommended that pulse-jet baghouses should clean based on changes in differential pressure ($\Delta P$) instead of time intervals. To do this, the pulse valves are connected to a Pulse-On-Demand™ controller which senses the pressure drop across the filter media and fires the valves just enough to return the $\Delta P$ to a preset value. The cleaning "on" and "off" points are set based on the application and can be changed if process conditions change.

As with any major project, the length of time required varies based on each situation. BHA has successfully converted ESPs into pulse-jet baghouses in as little as four (4) weeks. However, a more typical project length is about 8 weeks.

Eliminate WTE Emissions. Increase Airflow and Steam. Nothing Outperforms the Efficiency of ePTFE.

Many WTE plants utilize reverse air baghouses. Woven fiberglass filter bags are the fabric of choice, especially off the boiler when capturing ash. Many times, production is limited due to high differential pressure in the baghouse, restricting airflow and contributing to higher Loss on Ignition (LOI) ash content. Permit requirements generally require ash content be below 10% LOI to stay within compliance.

To evaluate the situation, a system evaluation is conducted to help determine whether moisture in the gas stream is causing the elevated differential pressure. The source of the moisture usually originates from boiler tube leaks, poor combustion seals, and wet refuse. High moisture content in the ash results...
in the formation of an agglomerative dustcake that is difficult to remove during reverse air cleaning. The fine ash particulate also becomes embedded within the depth of the fiberglass fabric, which in time reduces permeability. Additionally, cleaning of the filter bags becomes difficult due to aggressively designed air-to-cloth ratios (≥ 2.5:1 ft./min.)

**System Upgrades Help WTE Plant Make the Grade**

In Summer 2001, this northeastern U.S. WTE plant committed efforts to repair its boiler tube leaks, replace the combustion seals, and install fiberglass filter bags laminated with expanded polytetrafluoroethylene (PTFE) membrane (see Figure 8).

The ePTFE membrane is laminated to the filtration face of the bags in order to provide complete dust removal during each cleaning cycle. This technology has the ability to repel moisture while simultaneously maximizing airflow capability. The microporous structure of the membrane collects submicron particulate on the surface of the membrane, eliminating bleedthrough and blinding of the filter bags. The ePTFE laminated filter bags typically allow the baghouse to operate at a higher air-to-cloth ratio with up to a 50% decrease in operating differential pressure, thus allowing for higher steam production.

Particulate agglomeration is a common problem in the WTE system. Particulate, when exposed to moisture, can adhere to the fibers of the fabric. This agglomeration restricts airflow and causes differential pressure to increase. The ePTFE membrane filter bags are the most economical solution. The smooth surface of the membrane sheds particulate easily. Since the particulate does not remain on the filter for an extended period of time, it is less likely to absorb enough moisture to solidify on the surface.

**The Results Were Beyond Expected**

Repairing the boiler tube leaks and replacing the combustion seals helped eliminate some of the moisture out of the gas stream, however, the solid waste naturally contains a high percentage of moisture and would have caused problems for the baghouse if the ePTFE filter bags had not been installed. This plant now operates at maximum airflow, which has resulted in more efficient incineration and a cleaner burn. More importantly, steam production is now at 100% of design capacity and LOI is at an all time low. The filter media does make the difference and based on these results, strategic system maintenance and the intelligent technology upgrade proved to be more than worth the investment. The ePTFE technology lends itself perfectly to the WTE dust collection system and has proven itself as an ally to realizing optimized air pollution control.

**Taking the WTE APC System to the Next Level**

By utilizing new product technologies and engineered retrofits and conversions, WTE plants have options that can now help them optimize their air pollution control systems to help increase energy output and profitability. A system evaluation is key to determining the need and details when planning such a conversion. The future of Waste-to-Energy is promising as the nation’s need for power (and output of waste) will ensure the industry’s profitability far into the future. Innovative technologies in air pollution control will continue to be created to fuel the industry’s success and ensure the dust collector enhances the system rather than inhibits it.

Robin Linton has been a specialist in Waste to Energy and Independent Power dust collection systems with BHA for more than 10 years. For more information on the retrofit technologies in this paper, please contact her:

email: rlinton@bha.com  
phone: 800-821-2222 ext. 339