Pulse-jet Baghouse Optimization in WTE: Meeting the Challenges of the Future

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Abstract
Like many coal-fired power plants today, the waste-to-energy (WTE) industry is faced with a number of challenges including the need to maximize plant output, lower outlet emissions and increase plant efficiencies. Within WTE, there's also been a move from reverse-air baghouses to pulse-jet collectors due to lower initial capital costs and the ability to operate pulse-jet collectors at higher air-to-cloth ratios (3-4:1), allowing for a smaller housing footprint. However, the majority of today's pulse-jet collectors utilize an off-line cleaning mode where modules are taken out of service and pulsed to lower the differential pressure. There are inherent advantages in switching from an off-line cleaning mode to an on-line cleaning mode. This paper discusses the idea of using the fabric filter as a damper and stabilizing draft through the baghouse and boiler. It also outlines the use of pleated filter element (PFE) technology to address increased production concerns, and the need for lower outlet emissions.

Combustion System Operating Parameters
In the operation of a combustion system, the ID (induced draft) fan is normally controlled with a pressure transducer located in the combustion area. The normal draft used to control the combustion process can be as low as .25" w.c. to as much as 3" w.c. The draft at the inlet is used to control the fan damper position, maintaining constant airflow through the system. Since the system has components that create pressure drop, this draft is fairly constant to airflow volume.

Off Line Pulse-jet Cleaning in a Combustion Dust Collection System
Off line cleaning is the typical mode of cleaning in a pulse-jet collector. This method of cleaning often causes fluctuations in pressure drop in the baghouse, which in turn causes an adverse effect on the draft in the combustion system. When a compartment is removed from service for cleaning, the pressure drop across the baghouse increases and the result is a reduction of negative pressure at the pressure transducer. This causes the fan damper to open to balance the flow to the "set" negative pressure in the control area. Once the compartment is cleaned and returned to service, the lower differential of that compartment causes a lower system differential, resulting in a higher negative pressure at the pressure transducer signal. This often causes heat to be removed from the process resulting in higher temperatures and airflows at the baghouse. This change in system pressure causes changes in draft volume until the fan damper reacts to the pressure transducer signal. This fluctuation is a result of the removal of a compartment from service.

Moving to On Line Cleaning
In pulse-jet collectors, the cleaning function rearranges the dustcake and some dust is removed. The result in the rearrangement of the dustcake is a reduction in differential pressure at the most recently cleaned row of filter bags. The displaced dust that falls off the ends of the bags is subject to the internal velocities of the airflow as it approaches the ends of the bags. This is referred to as can velocity, and it affects the dust removal through separation of the finer sub-micron particulate by returning this material back to the filter surface.
The finer sub-micron particulate creates a thin, dense cake structure on the fabric that results in high differential pressure and no change in differential pressure when cleaning.

The pulse sequence plays an important part in minimizing the re-entrainment of material. Pulsing one row of filter bags adjacent to another row (sequential order) can cause the fine, sub-micron material to migrate to the most recently cleaned row. Staggering the order of rows to be pulsed by skipping three rows puts distance between the recently cleaned rows and rows yet to be cleaned, improving the dustcake for optimum filtration. (Figure 1).

Most systems consist of multiple compartments or modules, and a differential change in one compartment or module at one time (when taken down to clean) often unloads a large amount of material to the hopper. Since the material handling system cannot completely remove this material before the compartment or module is returned to service, the lower differential of that compartment or module will produce higher airflow. The increase in airflow will disturb the material in the hopper causing a percentage of it to return to the filter surface. The result is an increase in differential pressure and increased cleaning frequency.

A staggered pulse sequence in all baghouse compartments simultaneously is recommended to control differential pressure across the entire baghouse, preventing the draft of the combustion process from causing pressure differential changes. When a staggered pulse sequence cleaning is implemented in all compartments simultaneously, the differential pressure of the baghouse across all compartments is consistent. This maintains a more constant pressure in the combustion process, preventing a minimum of fluctuation of airflow volume through the system while keeping the fan on a stable point on the curve. The result is a consistent volumetric flow that requires less pulsing and a more stable and uniform air distribution in all modules.

Read DP Across the Entire Fabric Filter
The first step to staggering the pulse sequence in all baghouse compartments simultaneously is to set the cleaning controls to read the differential pressure across the entire baghouse. Pressure taps should be located in the ductwork prior to the baghouse and after the baghouse before the fan. This will provide a reading of the system pressure that the baghouse imposes on the operation. When the pressure taps are connected to a pressure transducer or Photohelic® gauge, the cleaning around a set point on the gauge can be controlled so that the pressure drop across the baghouse doesn't change more than 1/2-inch w.c. and the fan will not realize major system pressure changes. (Figure 2).

The pressure transducer should be wired to all the control boards on all of the baghouse compartments. (Figure 3). When the set point requires the collector to clean, one row in all the compartments will pulse at the same time. Material will be discharged into all the hoppers more evenly, and the resistance across the baghouse will drop uniformly. Since the differential change is distributed across the entire baghouse, airflow will also be distributed uniformly.

If your operation requires changes in the combustion process due to boiler load requirements, it is recommended that a lower differential pressure setting be used to trigger the cleaning cycles. The lower air volume will cause dust buildup and suspension on the filter bags that doesn't increase the differential pressure as dramatically as occurs with higher fan volumes realized at a maximum combustion operation. When the volumes are increased, the result is an immediate higher differential pressure and problems with dust removal. If two set points for triggering differential pressure cannot be programmed, it is recommended to run the baghouse through an entire cleaning cycle prior to operating at maximum production levels. This will remove excess dust and allow for maintaining more consistent differential pressures.
Program must be re-written to instigate the proposed method of cleaning.

Controls are set to maintain a stable draft through the baghouse.

Note: In the event a PLC is used with a control board, the program must be re-written to instigate the proposed method of cleaning.

Results of On Line Cleaning:
In addition to stabilizing the baghouse system, the following benefits may also be realized by implementing on line staggered pulse cleaning in all compartments simultaneously.

- Reduced overall differential pressure across the system
- Increased bag life
- Stabilized combustion loading
- Compressed air savings

Upgrades Through the Years to Fabric Filter Choices.
In the 1980s, most facilities used 16 oz. fiberglass. There was then a drive to use PPS felt, (formerly known as trade name Ryton®). The need to maximize capacity has the WTE industry looking at alternative technologies to help optimize performance of boiler baghouses. In cases where the size of

Figure 2. Controls are set 1/2” - 1” apart to maintain a stable draft through the baghouse.

Figure 3. Recommended wiring for on-line cleaning.
the baghouse is a restriction to the amount of airflow that it
can accept, pleated filters have been used to dramatically
increase the amount of cloth area available for filtration. Until
recently, pleated filters were available only in fibers
withstanding temperatures below 275°F (135°C). However,
in the last several years, pleated filters have become available
in aramid, PPS, and even fiberglass media. These
developments expand the options for producers restricted in
production by the size of the primary dust collection system.

Pleated filter elements provide a simple retrofit for
upgrading existing dust collectors and improving problematic
systems. These elements are one-piece units that are a direct
replacement for traditional filter bags and cages in pulse-jet
units. The media resists surface penetration of particulate,
dramatically increasing efficiencies while operating at
significantly lower differential pressures than felted or woven
materials. The media is pleated and molded into a filter
element, increasing filtration surface area over filter bags by
up to 300%, depending on existing filter bag sizes. Though
shorter in length, filter elements actually increase the available
filtration area on a hole for hole basis.

PFEs as a Problem Solver
Pleated filter elements can also help with other problems
common to pulse-jet cleaning baghouses including bottom bag
abrasion, inlet abrasion, high hopper levels, and heavy grain
loading to the filter elements.

Figure 4. Bottom bag abrasion

Bottom bag abrasion (Figure 4) is very common in pulse-jet
baghouses. It typically occurs opposite the inlet and around
the periphery of the baghouse. As the flue gas enters a
module, typical baffling redirects the gas stream down into the
hopper. Since the hopper is a converging cone and the cross
sectional diameter gets smaller, the gas stream speeds up
causing dust to be re-entrained to the filter bags. Since PFEs
are much shorter in length, they can

in most cases completely eliminate bottom bag abrasion
(Figure 5).

Figure 5. Shorter ThermoPleat elements eliminate
abrasion problems and are less susceptible to high grain
loading.

Meeting new emissions requirements with the addition of
controls such as spray dryer absorbers, carbon injection, and
dry scrubbers can add grain loading to the filters. The
additional grain loading in many cases means the fabric filter
will operate at a much higher differential pressure than its
design allows. It's a common occurrence to find facilities
today that were designed to operate at much lower airflows in
the past that are now needing upgrades to meet today's
increased production. Pleated filter elements can double or
triple the available cloth area to carry the added airflow. Also,
because they're shorter in length there is a much larger drop
out zone underneath them where the flue gas stream can
expand and slow down allowing some of the heavier
particulate to drop out of the gas stream before ever reaching
the PFEs. In many cases a conversion from conventional bags
and cages to pleated filter elements means an additional drop
out zone for particulate entering a baghouse anywhere from 4
to 10 feet.

Additionally the shorter length of PFEs will be an
advantage when high hopper levels are experienced. From
time-to-time all plants experience plugged hoppers that can
literally vaporize the long conventional filters that hang close
to the hopper area of the baghouse. By installing PFEs the
larger drop out zone will add protection to the filters when
high hopper levels are experienced.
ThermoPleat® - for temps up to 450°F

Conclusion
In summary, the future will bring more opportunities for the WTE industry to become more profitable. The ideas provided in this discussion provide the ability to increase profitability by impacting the back end equipment. Advances that may not have been economically feasible in the past can now be optimistically considered.

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