BIOMASS ASH HANDLING: SIMPLIFYING THE CHALLENGES

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SYNOPSIS

Ash handling is one of the most challenging aspects of boiler systems. Ash is incredibly corrosive on its own and frequently has debris such as sand mixed in with it. Because of this, it has the capacity to damage equipment, incurring costly repairs and unanticipated downtimes. This article outlines the primary risk factors associated with ash handling and discusses the proper ways to construct bottom ash removal systems, fly ash removal systems, and fly ash storage and unloading equipment to address common and costly ash handling pitfalls.
Biomass ash handling: Simplifying the challenges

By Cliff Moss

Ash handling systems endure some of the most punishing environmental impacts of any equipment in the fuel handling chain. Under intense temperature and abrasive conditions, many systems fail to operate reliably, leaving plant managers at a loss for how to efficiently convey, store and recycling residual biomass ash debris. This article will explore common principles and pitfalls in ash handling systems and provide insight on simple solutions that can improve reliability, reduce downtime and minimize maintenance costs.

Ash system types – pneumatic vs. mechanical

While pneumatic fly ash systems have some benefits for use on other fuels, using pneumatic fly ash systems with biomass fuels can present high maintenance problems, as well as safety concerns. In a pneumatic fly ash system, the entrained particles in biomass, like sand that survived the boiler, enter the pneumatic system and turn it into a virtual sandblasting environment. This constant battering creates erosion that quickly deteriorates the internal equipment.

Another problem with pneumatic systems is the concern of fires and explosions caused by incomplete combustion of the biomass fuels. Biomass fuels have widely varying moisture levels and heating values. This makes it very difficult for boiler operations to always get complete combustion of the fuel before it enters the ash system. A pneumatic ash system potentially introduces elements that would support further combustion.

For these reasons a mechanical ash collection system is preferred, and by far most commonly used.

Bottom ash and fly ash systems

Some mills have ash systems that collect bottom ash material with their fly ash collection system. Adding the bottom ash to the fly ash collection often requires a cumbersome system to take the bottom ash to the back side of the boiler where the fly ash system is located. Adding these systems together as one system has proven to be very unreliable and difficult to maintain. The ash particle characteristics and properties of bottom ash and fly ash are very different and therefore have different conveying principles. Trying to incorporate both in one conveyor design creates additional cost, complexity and too many trade-offs in design reliability.

The problem these mills encounter with a combined bottom and fly ash system is that the bottom and sifting hopper material (ash, rocks, sand, clinker and wood) does not work well in a fly ash system arrangement. When this material is mixed with the fly ash it requires the conveyors downstream to have a more complicated design, such as dual strand drag chain conveyors vs. single strand drag chain conveyor arrangements. It also causes difficulties in the ash silo and conditioning system designs due to the solid bottom ash particles entrained with the fly ash particles.

The best way to avoid these problems is to treat the bottom and sifting hopper material as bottom ash, and handle it separately from the fly ash. Keeping these systems separate allows for a system that will operate very predictably and reliably for each of these two very different types of materials/ash. Additionally, this will require the least amount of conveyors and minimize the total length of the required conveyors.

Bottom ash removal system

The bottom ash system must be designed to handle solid particles such as rocks, sand, clinker, unburned wood, etc. Therefore the conveyor designs and hopper seal techniques must take this into consideration. Typically this means the drag conveyors must utilize dual strand drag chains and hopper seal techniques that include methods that will easily pass solid (sometimes large) particles while not letting air or boiler gasses pass.
A water filled submerged drag chain conveyor is an excellent method of accomplishing both design requirements of handling scald particles and providing a seal which reliably passes large particles. The drag chain conveyor incorporates a horizontal section that is full of water and the drag chain is submerged below the water level. The inlet chute extends into the water thus providing the air/gas tight seal. When the bottom ash particles pass through the inlet chute they enter water and settle to the bottom of the submerged horizontal section of the conveyor where the drag chain flights convey the material towards the inclined section of the conveyor. At the inclined section, the bottom ash material is conveyed up and out of the water.

These conveyors are normally designed at relatively slow drag chain speeds, so the bottom ash particles will de-water somewhat as the material is slowly conveyed up the inclined section.

At this point the bottom ash is normally dumped into a storage bin, concrete bunker and ready for site removal. Sometimes another transfer conveyor is required to get the ash to the accessible location. Since this ash is still wet, it is ready for site removal without concerns of getting airborne during transportation. Normally bottom ash volumes are small enough where the management of the ash removal bins (or bunkers) can be handled on a once per shift (or day) operation.

One of the design issues on any dual strand drag conveyor is uneven drag chain elongation of the dual strand chains. This will happen on any conveyor, but it must be accounted for in the design or it will severely reduce the operational reliability of the conveyor and will require frequent maintenance. These conveyors should utilize drag chains with hardened pins and bushing. It is also good to minimize the number chain connections, so drag chains with pitch lengths greater than 8 inches is optimum. On longer conveyors the drag chain and flight connection must be allowed to articulate so the flights do not impose side stresses on the drag when the chain gets out of alignment from the two varying lengths of drag chain.

A submerged drag conveyor is an affordable and reliable solution to Bottom Ash Collection and removal. It also provides an excellent hopper seal arrangement that will allow large particles to pass through.

The bottom ash conveyor can also be accompanied by Submerged Shatties Hoppers Collection Screws. While shifting hopper ash is volumetrically much less than bottom ash, it still has the same material characteristics as

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Fly ash truck being loaded by ash conditioning conveyor.

bottom ash with less possibility for extremely large pieces. Sifting ash should be treated as part of the bottom ash system. Sifting ash hopper removal can be handled very economically with specially designed submerged screws that work in combination and connection with the submerged drag conveyor. Even if an operation already has an existing submerged drag chain conveyor, adding the sifting hopper collection screws might be a good option to minimize the required equipment and manpower requirements. Many boiler operations still utilize manual ash removal from the sitting hoppers, which can be labor intensive and dangerous. The sifting hopper outlet chutes operate in the same manner as the bottom ash chute. There is not any need for a mechanical seal in this area.

For mills that handle sitting ash manually, dumping the hoppers requires considerable effort and is potentially dangerous, since the hoppers are under a positive pressure and the gas temperature inside is >300°F. For these mills, a submerged bottom ash conveyor with accompanying submerged shaftless screws is an affordable alternative that eliminates the need for hopper seal valves at the hopper discharge. The slow moving screws (<3 rpm) are made of standard carbon steel and require minimal maintenance and upkeep.

Fly ash removal systems

Fly ash is normally defined as the ash that has passed up through the boiler furnace and steam generating bank sections. This ash is collected in the downstream hoppers under equipment such as the economizer, air heater, dust collector, precipitator, baghouse, etc. Generally this ash has particles less than 100 microns in size and has very unique material and flow characteristics. In addition to ash particles, there also are sand and dirt particles that were brought into the boiler process with the biomass. The sand and dirt particles can be a very large percentage of the ash volume in biomass operations that utilize bark, forest debris, or storm damage debris as part of the biomass portfolio. The fly ash system must take this highly erosive potential into consideration in the design of the system.

Since there are not large solid particles that can create high forces on the chain/flight arrangement, fly ash drag conveyors can be designed to operate on a single strand drag chain design with cantilevered flights arrangements. This conveyor design utilizes “en masse” conveying principles, which is a very efficient method of conveying. This method allows the conveyors to be smaller in size and have slower chain speeds for a given volumetric output.

With single strand drag chain, uneven drag chain elongation is no longer a problem or concern in the conveyor.
design and operation. Single strand drag conveyors will have some chain elongation, but it is easily managed in the conveyor take-up mechanism.

By keeping the bottom and sitting ash out of the fly ash system, we have basically eliminated the concern of large solid particles in the ash. This allows for a fly ash drag conveyor design to be smaller and simpler in design complexity, while having better conveying efficiency and reliability with less maintenance and repairs in the future.

**Fly ash storage and unloading**

Once the fly ash has been collected, it must be stored until it can be loaded into a truck for subsequent transport to a landfill area. Since the fly ash is very small and easily airborne, it is important that the storage silos be kept dust tight until the loading process takes place. If the method of transportation uses open top type trucks, it will be necessary to “condition” the ash with water to give it more density and less fluidity, so that it can be loaded and transported without becoming airborne.

The conditioning of the fly ash during truck loading is very important with today’s requirements of eliminating airborne particulates in mill operations. Not to mention the housekeeping problems created by airborne ash particulates. Prudence should be taken here when selecting the ash conditioning and truck unload equipment. The homogenous mixing and absorption of the water in the ash is not done easily when you are trying to load a 20-yard truck in 15 minutes, which makes selecting a proven ash conditioner critical. This equipment should not be purchased based on price alone.

Silo size is determined by the amount of ash the plant can store without bringing in a truck for removal. For example, some plants can transport ash once a shift, and on all days of a week. This would require a small storage silo. Some plants can only transport ash once a day, or might have to store ash over the weekend. This would require a much larger storage silo. The size of the ash silo is, for the most part, a mill decision and can range widely from plant to plant.

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