

CASE STUDY



Pneumatic Conveyor for Biomass Plant Electrical & Steam Facility

Customer Overview

The customer provides electrical work and services, producing 33 mega-watts in combined heat and power using biofuels. They needed to partner with a design/build company that had the capability to design and manufacture a complete pneumatic material transfer system for their bio-fuel facility in Reading, PA. They needed to effectively serve the compounding operation with a reliable supply of fly ash without carting the residue to a landfill using 40 semi-trailer loads per day at a cost of over \$1M per year.

SERVICES PROVIDED: Engineering & Installation
METHODS & TOOLS: Pneumatic Transfer System
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Pneumatic material transport system.



Project Overview

Interstate Resources, Inc., is a group of manufacturing facilities, headquartered in Arlington, Virginia, that employs over 1,500 people in Georgia, Maryland, Massachusetts, New Jersey, North Carolina, Pennsylvania, South Carolina, Tennessee, and Virginia. Its subsidiary, [the customer], was founded in 2006 and is based in Reading, Pennsylvania. It provides electrical work and services and can produce 33 mega-watts in a combined heat and power facility utilizing bio-fuels.

The biomass plant's electricity and steam output supported the manufacture of 350,000 tons of kraft liner-board per year, and 180,000 tons of recycled corrugated medium per year. Fundamentally, the power plant was comprised of a boiler with a steam turbine and generator. The circulating fluidized bed boiler produces 330,000 lbs. of steam at 1,200 psi with a thermal efficiency of 87%. The steam from the boiler is directed to an extraction, condensing steam turbine.

The three turbine extractions allow precise control of the paper mill and plant parasitic loads. The turbine condenser maximizes the amount of electricity produced from the excess steam. The generator is rated for 33 MW, much larger than the attached plant and mill electric loads. In situations when it is economically favorable, the customer generates excess electricity and opportunistically sells power back to the grid.

The Challenge

The facility's biofuels, or wood burning, created two types of ash by-products - bottom and fly ash. Bottom ash is a non-combustible residue that falls through the bottom of the boiler. Fly ash is driven through the boiler and escapes with the flue gas where it is separated, transferred, and stored in a 2000-ton silo.

The company formed a compounding operation to convert the landfill product (fly ash) into sustainable and recyclable wood filler. The new product, named BioFill™, reduces virgin plastics usage and replaces natural minerals used to convert plastic products. Now that there was a use for the fly ash, there was only one problem. The compounding facility was over 800 feet away from the fly ash storage silo. Trucking the material from the storage silo to a day silo was cost-prohibitive and too slow. Numerous firms could deliver all the necessary parts for a four TPH ash transfer system - in the typical 20-to-22-week delivery period - but only Air Dynamics could also deliver a full design/build solution.

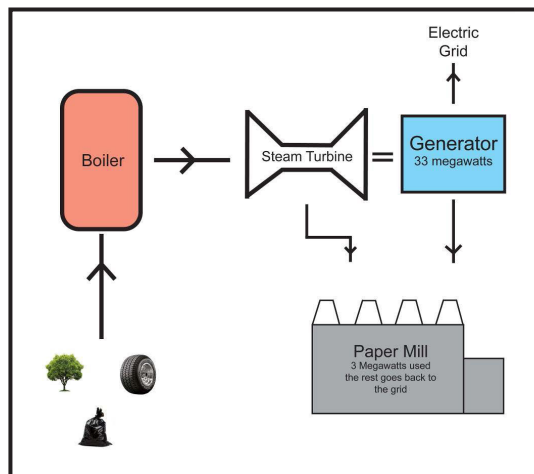
“At our power plant we take construction materials such as wood, tires, and small bits of plastic. We take that material and we burn that in a boiler to create power for both this facility and to provide to the public. Before the compounding facility was built, we were moving between many tractor-trailer loads of both bottom and fly ash to the landfill. We take a waste product and transform it into a usable consumer product.”

— Lee Samuelson, Engineer

The fly ash transfer system had to move the material at a rate of four tons per hour (4 TPH) with a bulk density of 55 lbs. per cubic foot. The fly ash was introduced into a piping system at the base of the 2000-ton storage silo to a day silo located 550 feet horizontally and 65 feet vertically away. The horizontal pipe followed a unique path incorporating ten different, non-standard piping bends and two elevation changes so as not to interfere with raw material receiving.

Upon reaching the ash air/material separator, the product falls through a double-dump type true airlock. The device is unique compared to a rotary-type valve such that there is little to no leakage as the material dispenses from the pneumatic receiver into the day bin even when there is a pressure differential of 12+ inches of mercury.

In addition to the pneumatic transfer system, the customer needed a bin vent to facilitate venting of the air displaced as fly ash filled the day silo. The bin vent filtration had to comply with the strict environmental limits within the city of Reading, PA.



Graphic representation of process.

The Solution

System Operation – The pneumatic transfer system design incorporated a vacuum-type versus a pressure-type conveying system. Since the material is abrasive and contains about 20% silica, the vacuum system lends itself well to any leaks (inward) that may develop due to abrasion.

Material is entrained at the main storage silo where fly ash is metered or fed into the 5-inch convey line. The pick-up velocity is approximately 3600 feet per minute. Motive air is produced by a constant volume variable pressure

pump. Pumps like this have mechanical clearances of .004 or four-thousandths of an inch. This makes them ideal for long piping runs and troublesome materials. As the material resists, the pump persists – the pressure rises to overcome clogs, large irregular pieces of ash etc.

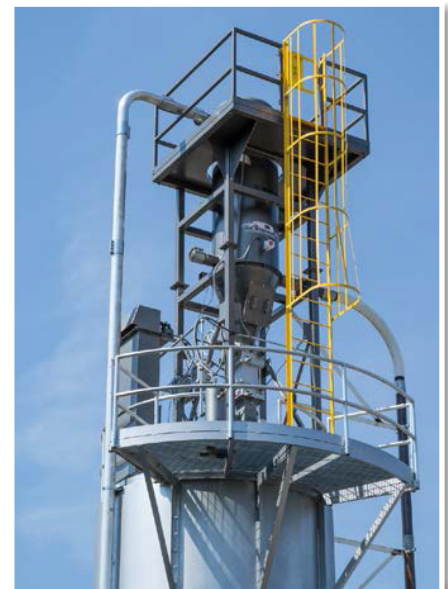
As the material moves through the pipeline, the rarefied air expands and accelerates as it moves toward the positive displacement pump. Material enters the air/material separator radially via a silo inlet to reduce wear on internal mechanical components.

Since the customer site had very stringent environmental criteria for exhausting process air, PTFE membrane media was necessary to meet environmental regulations. Prior to air entering the pump, a safety filter serves to prevent damage in the event of a primary filter failure.

A challenge for any type of vacuum conveying system arises at the point where the conveyed product dispenses into a receiver or hopper that is at atmospheric pressure. A rotary-type valve presents challenges due to clearances at the rotor housing. Therefore, the designer must take adequate precautions to prevent leakage and wear at this point in the system.



Front view of installed unit.



Ladder view of installed unit.



Safety ladder for maintenance access.

Flap-type valves are good choices for vacuum-consented abrasive material. The fly ash is dispensed into a silo at atmospheric pressure. A bin vent on the silo served to filter air displaced because of the 145 cubic feet of fly ash conveyed per hour.

Energy Requirements – The energy required to move 80,000 pounds of fly ash per hour over the project distance (615 feet) is relatively insignificant.

The fly ash transfer system required one horsepower for every 350 pounds of material moved per hour. The fly ash system moves the equivalent of seven, fifty-pound bags of material over a distance of 550 feet horizontally and 65 feet vertically for each horsepower or 23 brake horsepower per 8000 pounds of ash conveyed per hour.

“Working with Air Dynamics was an incredibly enjoyable experience for our engineering firm. They brought expertise to the table that we did not necessarily have in-house, and they conveyed it in a way that was easy for us, our shareholders, and our executives to understand.”

– Lee Samuelson.

The selection of the piping size for any project is a balance of pickup velocity and terminal velocity. If the pickup velocity is too low, there is a risk of material dropout within the pipe system. If the velocity is too high at pickup, the terminal velocity may erode the system components prematurely.

Automation can increase the efficiency of almost every function at a power plant. Pneumatic conveying lends itself well to automation - through instrumentation. If too much material enters the line for example because the material size varies, the feed rate can be slowed to compensate for the product size and density. Costs for these types of additions are minuscule compared to the overall benefit.

Air/Material Separation – Separating air from a product conveyed to a receiver via vacuum or pressure requires an understanding of the material characteris-

tics as well as taking advantage of filter manufacturer's media specifications, experience, mathematical calculations, and performance data.

The customer required a warranty that the filter/receiver and the bin vent exhaust effluent will not exceed an average of 0.02 gr/DSCF (Dry Standard Cubic Foot) after being properly installed and maintained.



Compressed Air and Dew Point Considerations for Outdoor Equipment – It is vitally important to consider the application of instrument-quality air to certain key aspects of a pneumatic transfer system. This system was no exception. Instrument air serves a special purpose when equipment resides outdoors.

Diaphragms and solenoid valves require dry air to function properly under conditions at or below the dew point temperature.

On-time delivery – The pneumatic conveying system was delivered on time and exceeded the four TPH design specifications by 2000 lbs. /hr. Air Dynamics differentiated itself with our in-house ability to take a project from concept all the way through to delivery, startup, and commissioning. This capability was something that Evergreen Power was able to quickly identify in the offeror's proposal.

The Results

Air Dynamics is proud to have been part of this successful, impactful complete turn-key solution, reducing freight costs by over \$1M annually. The design and installation spanned a distance of 550 ft. horizontally, and 65 ft vertically and optimized the movement of fly ash to their compounding operation. The design was engineered to not interfere with the material conveyance for the facility.