UNITED CONVEYOR CORPORATION

EPA Regulations Accelerate Industry Shift from Wet-to-Dry Bottom Ash Solutions

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Energy efficient and environmentally responsive dry bottom ash technologies are becoming the logical progression for companies looking to improve compliance and gain business value.

In May 2010, the EPA unveiled long-awaited proposed regulations on ash handling. Under the first proposed option, coal ash would be categorized as a special waste regulated by RCRA (Resource Conservation and Recovery Act) Subtitle C hazardous waste provisions. If adopted, this option would create federally enforceable requirements for ash management, including waste generation, transportation and disposal.

Under the second proposed option, coal ash disposal would be regulated under the RCRA's Subtitle D non-hazardous waste provisions. In either scenario, EPA regulations will be more stringent with the elimination of wet ash handling and the phasing out of surface impoundments (ponds) for all coal-fired power plants.

Many utility companies are already investigating a conversion to dry bottom ash systems. There are various proven ash conveying options available to companies seeking to eliminate the storage of bottom ash in ponds. Those companies' still using ponds to store ash by-product have important choices to make as they look to replace wet systems with dry solutions.

Evolution of Ash Handling

Thirty years ago, all ash from coal-fired power plants was typically conveyed as slurry and collected in ash ponds. Many of these ponds are still in use today. In the late 1970's, dry fly ash collection systems began accelerating in popularity especially for new coal-fired installations. Over the past two decades, existing plants have been steadily phasing out environmentally controversial and high maintenance pond-based systems for fly ash disposal.

Dry fly ash conveying is more common than dry bottom ash. Many utilities converted wet fly ash to dry systems in conjunction with the Powder River Basin fuel switching initiatives. Others converted to dry as local markets emerged, enabling the reuse and sale of fly ash to concrete suppliers. Yet others have diverted fly ash from capacity strained ponds as a means to extend the pond life for bottom ash storage.

Today, nearly two-thirds of plants with ash ponds have existing dry fly ash systems, while over 90 percent of bottom ash systems remain wet. The objective for most operations is to eliminate the pond, not necessarily eliminate the use of water from the bottom ash conveying process. However, some plants, in addition to eliminating the pond, will also want to eliminate water from the conveying process. These conditions frame the available choices, which range from continued use of water to 100 percent elimination of water.

Elimination of Bottom Ash in Retention Ponds

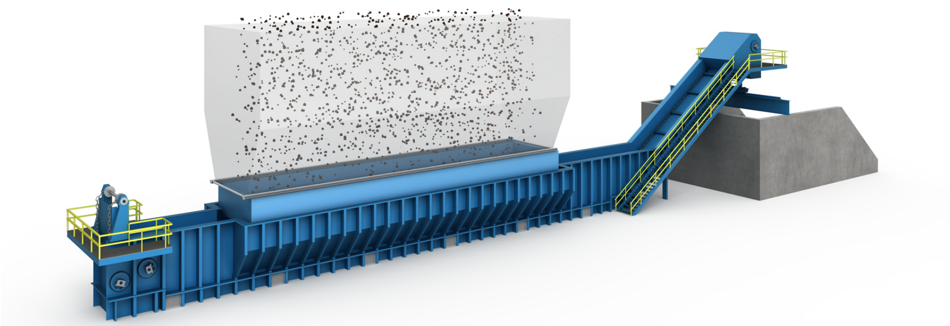
There are different technologies available for eliminating the storage of bottom ash in ponds.

Recirculation Systems

Recirculation systems convert a wet sluice system into a dry ash system with the shortest amount of outage time required. Recirculation systems use separating tanks to clarify ash sluice water usually sent to the ponds with the ash. The first tank, called the Dewatering Bin, collects and dewaters bottom ash solids to approximately 15-18 percent moisture. The clarified water is stored in a surge tank and reused during the conveying cycle. The ash is then unloaded into trucks. The existing hopper underneath the boiler continues to be used as is.

Submerged Flight Conveyor (SFC™)

SFC systems replace existing bottom ash equipment under the boiler with a submerged mechanical chain and flight conveyor. Ash falls from the boiler and accumulates in the upper trough, which is filled with water to quench and cool the ash. Horizontal flights move the accumulated ash along the trough and up a dewatering ramp. At the top of the ramp, the ash falls through a discharge chute to a truck or bunker. The bottom ash in the bunker is picked up once or twice a day with a front-end loader and put into trucks. SFC systems are designed to run continuously and save on power consumption and water usage.

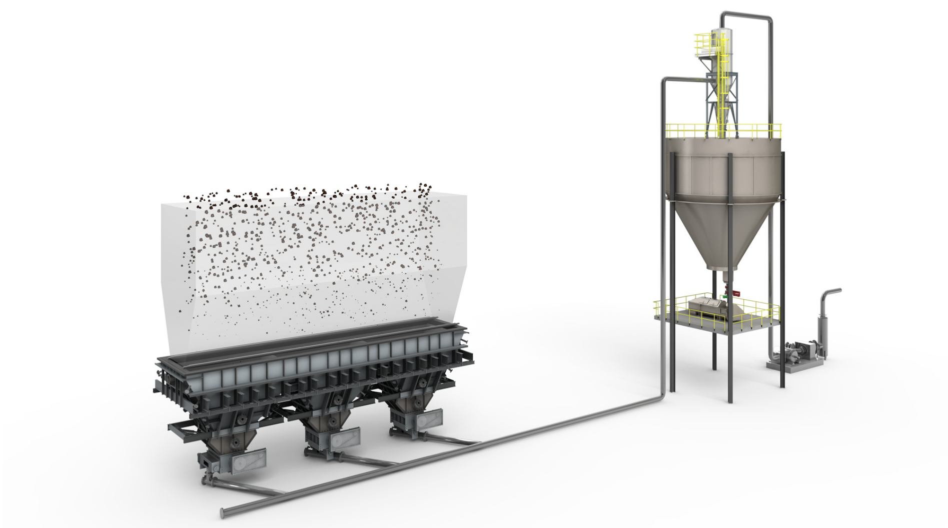


Continuous Dewatering and Recirculation System (CDR™)

The CDR system combines the benefits of a traditional recirculation system with the proven dewatering technology of the Submerged Flight Conveyor (SFC). The CDR system is easily added to existing wet bottom ash systems, requiring no changes to existing hoppers and minimal outage time. The ash dewatering and removal conveyor is located outside of the boiler area. It can service one or more operating units, making it the most cost effective conversion alternative available.

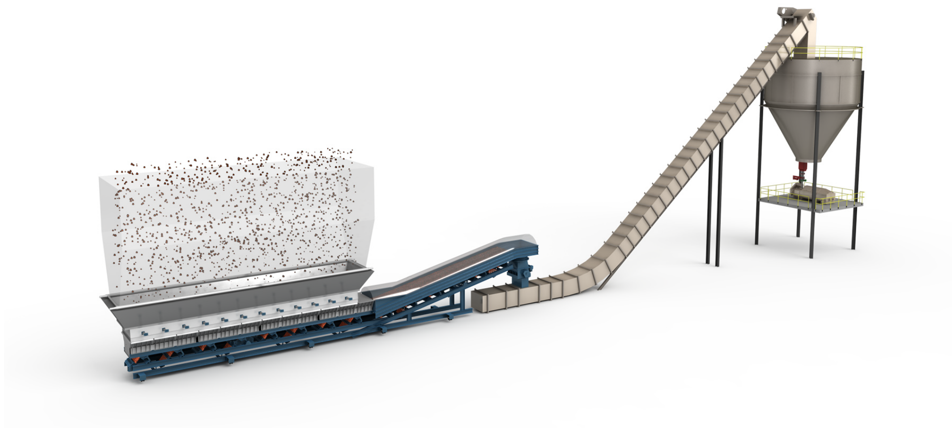
Pneumatic Conveying (PAX™) – 100% dry solution

Pneumatic conveying of dry bottom ash was the very first method used in the 1920s through 1940s. The PAX system utilizes the time-proven vacuum design to convey ash in a dry system; no water needed, resulting in reduced cost and time. Bottom ash is stored dry in a refractory-lined hopper under the boiler. Percolating air cools the ash, helps complete combustion of unburned material, and protects ancillary equipment. Large pieces are crushed small enough to feed into a pneumatic conveying line and conveyed to a dry storage silo. The ash is unloaded through a damp ash conditioner, then belt conveyed or gravity unloaded to a truck.



Vibrating Ash Conveying (VAX™) – 100% dry solution

Vibrating conveying is the newest technology available for bottom ash removal that eliminates the need for a pond. Vibrating conveying provides continuous removal of ash under the boiler, similar to SFC or moving belt systems, except the VAX system has no moving mechanical parts under the boiler. Superior durability, reduced maintenance and enhanced boiler efficiency distinguish the VAX system from related moving stainless steel belt technologies. The gentle catch and throw motion of the vibrating deck moves ash from under the boiler to a crusher, where it is fed to a secondary conveyor. Cooling air is forced up from under the vibrating deck, combusting any unburned bottom ash. The resultant fluidized vibrating bed offers the highest heat transfer back to the boiler of any technology.



<u>**System Selection – One Size Does Not Fit All**</u>

Five technological solutions exist because "one size does not fit all". Each unique plant must evaluate the importance of criteria used in the wet-to-dry decision making. Common criteria used to evaluate technologies and choices are:

- Water Usage/Availability – how much water is available for bottom ash conveying and disposal?
- Physical Space Constraints – what system choices are available based on the space constraints?
- Multiple Unit Synergies – can storage tanks and silos be used for multiple units?
- Time Available for Installation – how long is the outage?
- Design, Material and Installation Costs – what is the budget?
- Costs – what is the 20-year life-cycle cost?
- Operating Costs – what is the average cost of energy used?

For some plants there will be constraints and trade-offs, which will streamline decision making to a single or two possible options. For example, if the ash pond needs to be eliminated in the next 12-24 months and there is no opportunity for a multi-week outage for equipment replacement, the most viable choices become a Continuous Dewatering and Recirculation (CDR) system or Recirculation system. If 100 percent elimination of water is required, then PAX and VAX are two possible options. Physical constraints may eliminate the possibility of finding space for mechanical conveying equipment, leaving PAX as the only 100 percent dry option since it only requires a piping corridor out the boiler house.

Decision Analysis – What is Best For You

Some plants employ decision analysis tool, or grading system, to evaluate the available ash removal options. As shown in Figure 1, each alternative has been scored using a 1 to 5 numerical comparison. A "5" represents the highest match against the criteria. For example, PAX and VAX each score 5 for Water Usage as both technologies use no water. The SFC scores a 3 as it requires one tenth the water of a Recirculation system, but still requires water.

Figure 1: Decision Analysis Tool

	Technology Alternatives										
1 = Worst, 5 = Best	Plant Needs (Scale 1-5)	Re-circ System		CDR		SFC		PAX		VAX	
Criteria for Determining Technology Selection	WT	SC	Total	SC	Total	SC	Total	SC	Total	SC	Total
Water Usage/Availability	Plant Specific Input	2		2		3		5		5	
Outage Time Available		5		5		4		2		3	
Total Installed Cost		1		4		5		3		3	
Operation & Maintenance Cost		2		4		5		3		4	
Power Consumption		1		2		4		2		5	
Boiler House Corridor Availability		5		5		3		5		3	
Multiple Unit Synergies		5		5		2		4		2	
Weighted Total Score											

Fig. 2: Minimize Outage Time

If the primary need of a plant is to minimize outage time, the decision analysis shows the CDR and recirculation systems as the highest match overall.

	Technology Alternatives										
1 = Worst, 5 = Best	Plant Needs (Scale 1-5)	**Re-circ System**		**CDR**		SFC		PAX		VAX	
Criteria for Determining Technology Selection	WT	SC	Total	SC	Total	SC	Total	SC	Total	SC	Total
Water Usage/Availability	2	2	4	2	4	3	6	5	10	5	10
Outage Time Available	5	5	25	5	25	4	20	2	10	3	15
Total Installed Cost	2	1	2	4	8	5	10	3	6	3	6
Operation & Maintenance Cost	2	2	4	4	8	5	10	3	6	4	8
Power Consumption	2	1	2	2	4	4	8	2	4	5	10
Boiler House Corridor Availability	5	5	25	5	25	3	15	5	25	3	15
Multiple Unit Synergies	5	5	25	5	25	2	10	4	20	2	10
Weighted Total Score			**87**		**99**		79		81		74

Fig. 3: Minimize Installed Cost

Both SFC and CDR systems offer the lowest total installed cost while reducing water usage.

	Technology Alternatives											
1 = Worst, 5 = Best	Plant Needs (Scale 1-5)	Re-circ System		CDR		SFC		PAX		VAX		
Criteria for Determining Technology Selection	WT	SC	Total	SC	Total	SC	Total	SC	Total	SC	Total	
Water Usage / Availability	4	2	8	2	8	3	12	5	20	5	20	
Outage Time Available	5	5	25	5	25	4	20	2	10	3	15	
Total Installed Cost	4	1	4	4	16	5	20	3	12	3	12	
Operation & Maintenance Cost	3	2	6	4	12	5	15	3	9	4	12	
Power Consumption	2	1	2	2	4	4	8	2	4	5	10	
Boiler House Corridor Availability	1	5	5	5	5	3	3	5	5	3	3	
Multiple Unit Synergies	1	5	5	5	5	2	2	4	4	2	2	
Weighted Total Score			55		75		**80**		64		74	

Fig. 4: Overcome Structural Barriers / No Water Usage

The PAX system would score high for a plant with existing structural barriers in the boiler house corridor.

	Technology Alternatives										
1 = Worst, 5 = Best	Plant Needs (Scale 1-5)	Re-circ System		CDR		SFC		PAX		VAX	
Criteria for Determining Technology Selection	WT	SC	Total	SC	Total	SC	Total	SC	Total	SC	Total
Water Usage / Availability	5	2	10	2	10	3	15	5	25	5	25
Outage Time Available	1	5	5	5	5	4	4	2	2	3	3
Total Installed Cost	3	1	3	4	12	5	15	3	9	3	9
Operation & Maintenance Cost	3	2	6	4	12	5	15	3	9	4	12
Power Consumption	3	1	3	2	6	4	12	2	6	5	15
Boiler House Corridor Availability	5	5	25	5	25	3	15	5	25	3	15
Multiple Unit Synergies	5	5	25	5	25	2	10	4	20	2	10
Weighted Total Score			77		95		86		**96**		89

Fig. 5: Minimizing O&M Costs / No Water Usage

If power consumption is the leading criteria for a utility than the metrics reveal the VAX system is the top system for them.

	Technology Alternatives										
1 = Worst, 5 = Best	Plant Needs (Scale 1-5)	Re-circ System		CDR		SFC		PAX		VAX	
Criteria for Determining Technology Selection	WT	SC	Total	SC	Total	SC	Total	SC	Total	SC	Total
Water Usage / Availability	5	2	10	2	10	3	15	5	25	5	25
Outage Time Available	1	5	5	5	5	4	4	2	2	3	3
Total Installed Cost	3	1	3	4	12	5	15	3	9	3	9
Operation & Maintenance Cost	3	2	6	4	12	5	15	3	9	4	12
Power Consumption	5	1	5	2	10	4	20	2	10	5	25
Boiler House Corridor Availability	2	5	10	5	10	3	6	5	10	3	6
Multiple Unit Synergies	1	5	5	5	5	2	2	4	4	2	2
Weighted Total Score			44		64		77		69		82

Environmental Challenges Are Coming—Will You Be Ready?

Energy efficient and environmentally responsive dry bottom ash technologies are becoming the logical progression for companies looking to comply with new environmental standards while improving the bottom-line beyond the capabilities of traditional wet systems. Fortunately, multiple technologies are available to best match system benefits with specific plant requirements. With the vast majority of existing wet sluice systems likely to convert to dry systems, several utility companies have already begun exploring dry conversion options and collaborating on the optimal solution for their specific plant needs. UCC is ready to support your needs with the most advanced ash handling technology and system conversion options in the industry. As your partner, we'll design and deliver your optimal wet-to-dry solution.