Ash from Energy-from-Waste

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WHITE PAPER

Nearly all downstream waste process (e.g. recycling, energy recovery) generates some amount of waste—meaning there is a residue of material that cannot be further processed. Energy-from-waste (EfW) facilities generate an ash residue composed of the noncombustible material in wastes and, to a lesser extent, materials added for air pollution control, such as activated carbon and lime. Most of the ash generated is termed "bottom ash" and refers to the heavier fractions of non-combusted materials. This ash is removed from the bottom of the combustor itself, through a piece of equipment called the ash discharger. The remaining ash generated is called "fly ash" and is captured from the remaining parts of the process, including the air pollution control equipment. In the U.S., these two ash streams are generally managed together, as "combined ash".

Is EfW Ash Hazardous?

The combined ash is tested routinely to confirm that it is non-hazardous per U.S. EPA regulations. No ash from Covanta's U.S. EfW facilities has ever been determined to be a hazardous waste.

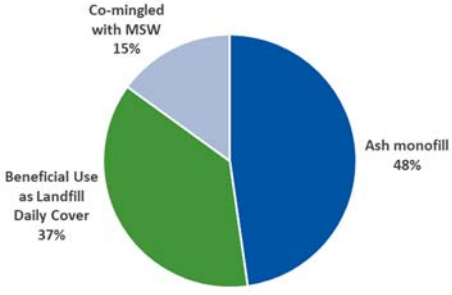
To comply with U.S. EPA regulations, ash is regularly tested for toxicity through the toxicity characteristic leaching procedure (TCLP).[2] The TCLP test is intended to simulate a worst-case condition for any solid waste in a landfill for many years.

U.S. EPA on Toxicity

"Toxic wastes are harmful or fatal when ingested or absorbed (e.g., containing mercury, lead, etc.). When toxic wastes are land disposed, contaminated liquid may leach from the waste and pollute ground water. Toxicity is defined through a laboratory procedure called the Toxicity Characteristic Leaching Procedure (TCLP) (Method 1311). The TCLP helps identify wastes likely to leach concentrations of contaminants that may be harmful to human health or the environment."[1]

In practice, ash has been demonstrated to be more stable and resistant to leaching than regular municipal solid waste (MSW). Chemical reactions that occur in the ash, similar to those that occur in cement, act to sequester heavy metals. A well-documented study involving both the U.S. EPA and Marion County, Oregon monitored leachate characteristics from an Oregon ash monofill over a four-year period and found average contaminant levels in leachate less than 8% of the TCLP limits.[3] A comparison of the Marion leachate results with typical values for MSW landfill leachate[4] reveal much lower levels of organics and metals for the ash monofill leachate. Furthermore, ash does not biodegrade in a landfill the way that MSW does. [5,6]

Where Does Ash Go?



In the United States, roughly half of the ash is managed in traditional MSW landfills (Subtitle D landfills) either beneficially as daily cover or co-mingled with MSW. Approximately one-third of the ash generated at Covanta's EfW facilities is beneficially used as daily cover in traditional MSW landfills, which reduces the need for virgin soils and saves landfill space. The remaining ash not placed in MSW landfills is placed in ash monofills (a non-hazardous waste landfill that only contains ash). Once in the MSW landfill or ash monofill landfill, the ash begins to exhibit concrete-like properties that cause it to harden once set in place.

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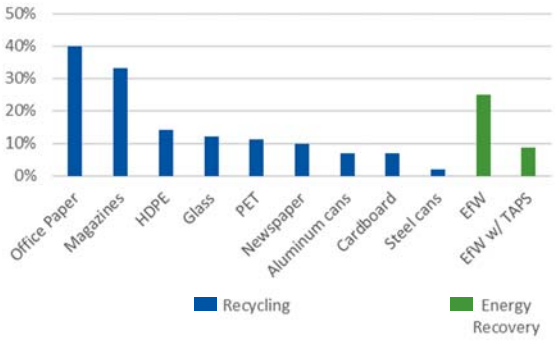
How Much Ash is Generated?

Nearly all downstream processes for waste generate a residue which requires further treatment or disposal, including recycling and energy recovery. For example, up to 40% of recycled office paper is discarded. Based on current operations, the ash from EfW facilities is about 10% of the volume of the initial waste. From a different perspective, the volume of waste that requires landfilling is reduced by approximately 90%. On a weight basis, the ash residue is 25% of the initial waste. Efforts already underway to recycle materials from ash promise to reduce residues even further.

Residue / Discard Rate - Recycling and Energy Recovery Options[7]



Can Ash be Reused or Recycled?

Yes! The first step is pulling metal out of the ash for recycling. We use advanced magnets and eddy current separators to remove ferrous and non-ferrous metal from the ash for recycling. Since 2012, we have increased our overall metals recycling by over 30% and our non-ferrous metal recycling by over 180%. Today, we recycle the equivalent of 6 Golden Gate bridges of ferrous metal and 3 billion soda cans of non-ferrous metal every year.

Finding additional uses for ash remains a key objective of the industry and Covanta. Promising opportunities are developing for reuse of ash as both aggregate and a raw material for cement manufacturing. In 2019, we commenced construction of our first Total Ash Processing System ("TAPS"). Located in Fairless Hills, Pennsylvania, adjacent to Covanta's existing metals processing facility, our first TAPS plant is designed to process over 400,000 tons of ash from several of our EfW facilities. TAPS is a unique technology that separates the combined ash from EfW facilities into its component parts. This enables increased recycling of small metal fractions and the recycling of aggregate for reuse as construction material, reducing the volume of ash requiring landfill disposal by as much as 65 percent.

References

[1] U.S. EPA (2009) *Hazardous Waste Characteristics: A User-Friendly Reference Document* https://www.epa.gov/sites/production/files/2016-01/documents/hw-char.pdf

[2] 40 CFR §261.24

[3] Roffman Associates, Inc. (2002) *Municipal Waste Combustion Ash, Soil, and Leachate Characterization Monofill – Cell No. III, 12th and 13th Years Study*. p1-2 provides references for the previous studies and reports.

[4] Kjeldsen, P. *et al.* (2002) Present and Long-Term Composition of MSW Landfill Leachate: A Review, *Critical Reviews in Environmental Science and Technology*, 32 (4): 297-336. https://cues.rutgers.edu/bioreactor-landfill/pdfs/15-Kjeldsenetall2002CritRevEnvSciLandfillLeachat.pdf

[5] See Section 5-1 of U.S. EPA (2018) *Documentation for Greenhouse Gas Emission and Energy Factors Used in the Waste Reduction Model (WARM): Management Practices Chapters*. https://www.epa.gov/sites/production/files/2016-03/documents/warm_v14_management_practices.pdf

[6] Rendek, E., Ducom, P. Germain, Carbon dioxide sequestration in municipal solid waste incinerator (MSWI) bottom ash, Journal of Hazardous Materials, **128**: 1, 73-79 https://doi.org/10.1016/j.jhazmat.2005.07.033

[7] See Exhibit 2-1 of U.S. EPA (2018)

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