Meeting Fly Ash Demand Through Ash Harvesting and Beneficiation

Since approximately 2008, the electric power industry has undergone a major shift away from coal-fired electric power plants in favor of plants using natural gas or passive power production. This change has resulted in a dramatic reduction in coal fly ash production, diminishing from a high of 72.5 million short tons in 2008 to 36.2 million short tons in 2018 (ACAA 2019). Meanwhile, in 2018 the beneficial use of fly ash in concrete accounted for 12.5 million short tons of the material, which represented over 60 percent of its total beneficial use. Although the total tonnage of fly ash used in concrete has not increased significantly in the past 10 years, the concrete industry's demand for fly ash, as a percent of the material's total beneficial use, has increased by nearly 50 percent.

Looking ahead, the utilization of fly ash is expected to increase from 55% in 2018 to 90% in 2039, with the actual volume of fly ash utilized increasing from 20.1 million short tons to 27.8 million short tons at the end of respective periods. The demand boost in North America comes from higher demand from the construction industry, improvement in road construction activities, and building highways however fly ash production will continue to fall over the same time frame. The American Coal Ash Association (ACAA) estimates that the average annual production of fly ash in the U.S. will be 32 million short tons by 2039, with the baseline forecast suggesting that fly ash production will fall from 36.2 million short tons in 2018 to 30.8 million short tons in 2039, decreasing at an annualized rate of 0.8% over the forecast period.

The falling production of fly ash will largely be driven by the decline in the volume of coal-fired electricity generation in the U.S. As a result, there will be a widening gap between demand and supply in the coming years and prices for fly ash are expected to increase as demand outweighs supply. The global fly ash market is expected to grow from $8.5 billion in 2019 to $13.3 billion in 2027, at a CAGR of 5.8%, per Fortune Business.

The growth in demand for fly ash is due to the increasing demand from the construction and infrastructure sectors as Class F is used as a substitute for Portland cement in the production of concrete due to inherit strengths, lower cost and environmental benefits. This demand for fly ash only grows stronger given the Senate recently approved $1 trillion infrastructure bill in an effort to rebuild the nation's crumbling roads and bridges which currently includes $110 billion to be used for the construction of roads and bridges as the final bill is discussed in Congress.

Historically, this fly ash has been obtained directly from coal-fired power plants around the country as it is being produced, but the accelerated rate of decommissioned coal-fired power plants is causing regional gaps in the production, supply, quality, and availability of fly ash around the nation. Fly ash from higher production regions of the nation can be shipped by rail, truck and barge to high-demand regions that do not have supply, but it adds costs and time, and supply is not always reliable. Transporting fly ash large distances significantly increases the cost, and the price point of fly ash in most markets does not support these added transportation costs.

This higher demand has resulted in challenges regarding both the decrease in supply and quality of fly ash in some markets, which in turn has caused providers to consider a new source for the fly ash material that provides the performance attributes needed when used in the production of concrete, harvested fly ash. Harvested fly ash is ash that was not used as it was produced but instead was deposited in landfills or impoundments for disposal. There simply was not sufficient market demand for

the ash to be beneficially used at the time of production. Harvested fly ash is now becoming a principal source of fly ash for producers to meet the increased demand for the concrete industry while providing the same product benefits and will soon make up a significant portion of the total fly ash supply in order to meet demand.

The Benefits Of Ash Harvesting And How It Works

The benefits of ash harvesting are long-reaching and include:

- Capability to meet supply of the growing demand
- Lower costs versus using raw virgin materials
- Lower costs for logistics and delivery to markets
- Environmental as the ash is beneficially used in the production of Portland cement and per the Environmental Protection Agency (EPA) WARM model, every ton used to replace Portland cement, 0.87 tons of CO2 is saved from entering the atmosphere
- Improved product in both the hardened and plastic state of concrete and the beneficial use of fly ash provides higher strength, decreased permeability, increased durability, reduced ASR (Alkali-Silica Reactivity), lower heat of hydration, and increased sulfate resistance
- More reliable supply to concrete producers

Ash harvesting typically falls into two categories:

Ready To Use Ash (Unprocessed Ash) - In many cases, the ash that was previously deposited in landfills or impoundments is good-quality ash. If the ash in these existing impoundments is tested and meets American Society of Testing and Materials (ASTM) C-618 and regulatory specifications, it can be excavated and sold to concrete producers or other manufacturers as is for beneficial use.

Beneficiated Ash (Processed Ash) – Ash contained in some landfills and impoundments does not currently meet ASTM and regulatory specifications to be directly used in concrete production. Reasons can include loss on ignition (LOI) above 6%, minimum concentration of alumina, iron and silica or high moisture and high ammonia content. This ash must first processed or beneficiated to meet specs before it can be beneficially used in the concrete/construction market.

What Makes For a Good Harvesting Site

The condition of the ash and potential for reuse in each case is determined through material sampling, physical testing (microscopy, particle size analysis, carbon content, magnetic content, X-ray fluorescence, atomic absorption), chemical analysis, and analysis of the results.

Based upon these tests and the analysis it can be determined whether the ash previously deposited in landfills or impoundments is good-quality ash that can be sold and reused unprocessed as is, if the ash must first be processed/beneficiated prior to reuse or if the ash is simply not economical for reuse due to its chemical makeup or physical location within the landfill or impoundment. This includes assessing the costs of harvesting the ash to pull it from the landfill or impoundment, the costs for processing/beneficiating, if needed, as well as the logistical costs for transporting the ash to concrete producers via truck, rail or barge.

Charah Solutions EnviroSource™ Fly Ash Beneficiation To Meet Market Demand

In order to meet the growing demand for fly ash it has come apparent that this will require the beneficiation of ash stored in existing landfills and impoundments. This not only meets market demand but also provides the economic measures to meet the concrete producer cost demands while providing the same product and environmental benefits.

The patented Charah Solutions EnviroSource™ fly ash beneficiation technology provides the ash harvesting solution to meet market demand at a significantly lower cost profile and a much more efficient footprint than other beneficiation/processing technologies. EnviroSource technology is a proven thermal process that reduces loss on ignition (LOI), ammonia, activated carbon and moisture in fly. This technology allows the utility the best option for harvesting ash contained in landfills and impoundments which needs to be processed to meet ASTM and regulatory specifications, resulting in a much larger percentage of ash to be sold while meeting the prices demands of concrete producers.

Charah Solutions EnviroSource fly ash beneficiation technology benefits includes:

- Reduces LOI, ammonia, activated carbon, mercury and other contaminants, while increasing supply
- Significantly lower cost profile than competitive technologies
- Efficient footprint with self-contained environmental controls
- Can be deployed in months versus years
- Modular design and scalability allow for production of 40,000 to 200,000 tons per year
- Delivered as a portable or stationary system depending on client requirements
- Separates and isolates heavy metals such as mercury
- Reduces utilities' need for landfills, ponds and other disposal methods
- Cost-effective installation and operation
- Can be installed at operating power plants, non-operating power plants or off-site

With EnviroSource technology, there is no impact on the power plant operation – EnviroSource technology can be fully independent or can be integrated with the operation of the power plant. The EnviroSource process delivers a marketable concrete grade or cement kiln-friendly product from existing coal fly ash streams. EnviroSource technology, is a four-step process:

1. Exposes high LOI fly ash to indirect heat in the thermal desorber
2. Separates off-gassed contaminants from solid in a gas reactor
3. Removes carbon, ammonia, chlorides, and mercury to generate low LOI fly ash
4. Removes metals, ammonia, chlorides, and the products of the combustion from the gas stream using its proprietary gas reactor. This process generates a minimal amount of precipitate (less than 30 tons generated for every 200,000 tons fly ash processed) and the precipitate is returned to the finished product so there is no wastage stream.

EnviroSource Technology Results

Results provide a consistent LOI reduction over a wide range of fly ash inputs, reducing the LOI, ammonia, activated carbon, mercury and other contaminants to meet ASTM and regulatory specifications for sell into the market. The process reduces LOI concentrations by as much as 95% and consistently achieves LOI levels below 1.0% for most ash. The technology can also remove 90% of the ammonia in the ash.

Ash Harvesting Benefits The Entire Industry And The Environment

In order to meet future demand, ash harvesting is certain to become standard practice across the industry as less ash non-harvested is available given the decline in the volume of coal-fired electricity generation in the U.S. The Environmental Protection Agency's issuance in 2015 of the Coal Combustion Residuals (CCR) rule as well as state and local legislation will also help drive demand for ash harvesting and beneficiation as much of this legislation dictates the amount of ash that must be beneficiated in closure projects. Ash harvesting practices will benefit the entire industry in manner that results in a much larger percentage of beneficiated ash to be sold while meeting the price and supply demands of concrete producers across the nation.

Ash harvesting and ash beneficiation also benefits the environment as it conserves our natural resources including water, decreases landfill disposal and reduces greenhouses gases as every ton of ash beneficially used in the production of Portland cement saves 0.87 tons of CO2 from entering the atmosphere. Ash beneficiation plays a vital role at the utility level as utilities work to meet their emissions reduction timeline goals and drive economic and environmental benefits to the local communities.

The future of ash harvesting will benefit the entire industry including utilities, suppliers and concrete producers as well as the environment.

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