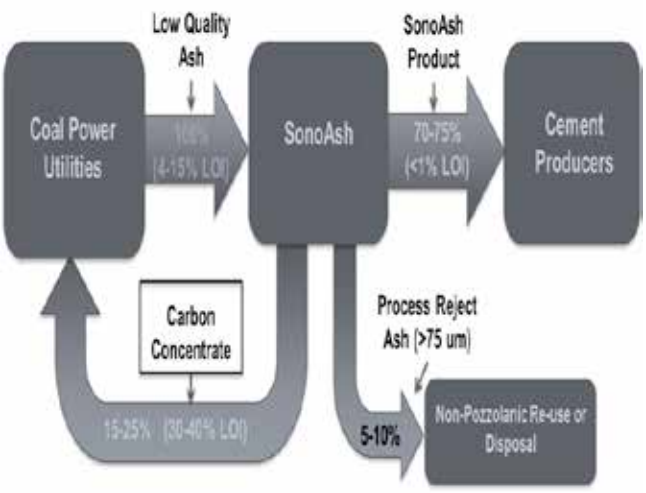
BY CLAUDIO ARATO

Uniform particle size coal ash: Essential for future concrete applications

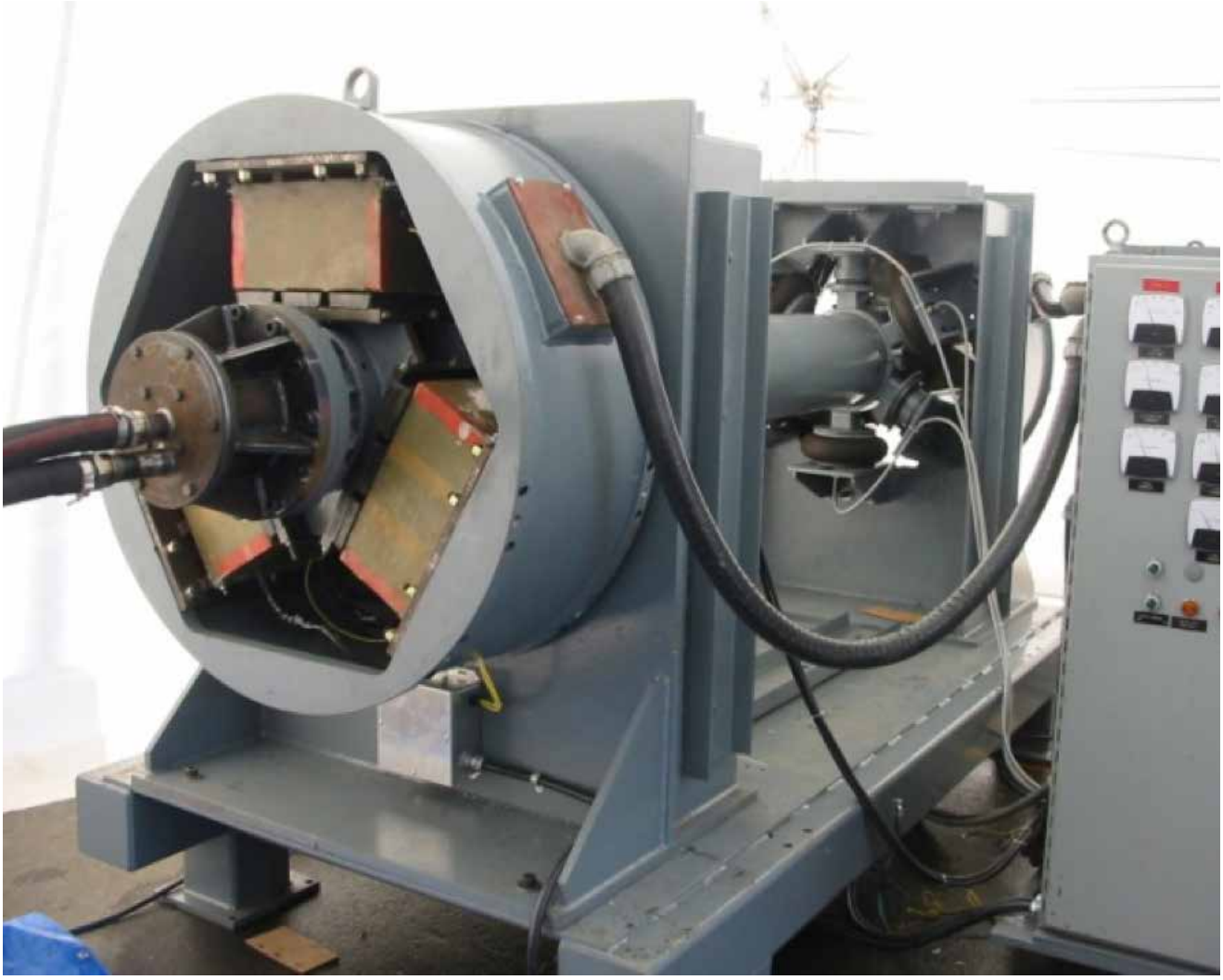
The decline in coal for energy has reduced available fly ash supply to the concrete industry and generated a significant increase in finished product variability, which has led to a sharp rise in material costs for high profile projects such as One World Trade Center, New York City.

The increase in coal combustion residuals (CCR) variability and decline in production has resulted in a shortfall in excess of 100 million tons of high quality coal ash stock.[3] Anecdotal stories abound about CCR imported from Asia to meet U.S. market demands over the last year. The American Coal Ash Association (ACAA) is now taking steps to quantify U.S. coal ash imports by commissioning an industry-wide survey with the results due this September. Why is there a need for CCR imports when there are nearly two billion tons in storage plus annual production?[4] The answer, simply, is consistency.

Over the last several decades, there has been a consistent increase in the demand to beneficiate ash generated from coal-fired power plants. Simultaneously, there has been a steep decline in global coal-derived energy, from greater than 50 percent to less than 30 percent.[1] The coal-fired power industry has made excellent progress in quantifying and mitigating the perception of risk associated with CCR, generically "coal ash," as a pozzolanic high quality material for the production of high performance concrete (HPC). This is seen in the dramatic rise in the use of CCR in North America as the product



At the heart of the SonoAsh process is the Sonicator, which enables the extraction and gradation of ASTM C618 fly ash from previously landfill- or impoundment-grade coal combustion residuals.



SonoAsh CCR Strength Activity Index

Percentages versus portland cement control specimen

Portland cement displacement	3 Days	7 Days	28 Days	56 Days	Water requirement
20%	88	87	95	104	94
30%	80	76	88	99	92
40%	72	66	81	95	89
ASTM C618	**--**	**75 (min)**	**75 (min)**	**--**	**105 (max)**

application utilization rate has nearly doubled over the last decade to nearly 45 percent, even as the aforementioned share of coal in the global energy mix has declined.[2]

The decline in coal use has changed the volumes of reliable and uniform, high quality CCR available to the concrete and construction industries, as measured by consistent Loss on Ignition (LOI; reflecting carbon concentration) and impurities (such as sulfur and nuisance heavy metals). Key concrete parameters like workability and ASTM C618-grade material particle size are often assumed to be consistent in the marketplace but are not. Each of these CCR components have highly empirical correlations with one another as it relates to HPC and LEED-eligible applications, where reuse has significant value-add upside.

NEW BENEFICIATION METHOD

A commercial stage process of Vancouver, B.C.-based SonoAsh LLC enables a sustainable, modular and patented solution for production and impounded CCR, and holds potential for an unprecedented expansion of North American ash stores available to meet growing infrastructure market demands. The latter is achieved by creating pathways to make impounded and production CCR streams into a consistent Manufactured Coal Ash to meet regional individual customer specifications.

Every coal powered plant burns, and has burned, different coal supplies from different sources at different times. This results in significant impediments to subsequent beneficiation of storage impoundment-derived raw feeds because of the infinite CCR combinations of coal ash, bottom ash and boiler slag—in addition to any unique regional environmental conditions and power plant control effects.

The SonoAsh Sonicator reactor processes a broad range of coal ash samples, netting a Manufactured Coal Ash that meets ASTM C618 (AASHTO M295) requirements for high value ordinary portland cement (OPC) displacement, typically at < 1 percent LOI with variable CCR sources, to more than 15 percent LOI at definable particle size specifications, typically 25-100 µm. It is important to note that commercialized dry beneficiation technologies cannot readily produce both tunable low LOI and controlled particle size. As a result, these requirements are subsequently not present in ASTM standards, creating a barrier to high value, engineered HPC applications for challenging infrastructure and marine environments.

The SonoAsh outcome is a genuine market opportunity producing a scalable, regional and highly economical OPC supplement with negligible greenhouse gas (GHG) impact. This creates relevance from a risk mitigation and marketing perspective even where GHG discussions are unmeasured, untaxed or not currently recognized. This is significant for a global market demanding major infrastructure expansion with challenging HPC applications.

As coal ash supplies continue to both shrink and diversify, the SonoAsh intellectual property creates opportunities for the cement and concrete industries that cannot be consistently achieved with dry milling and typical dry coal ash beneficiation technologies. The wet SonoAsh process produces no fugitive emissions (airborne emissions or odors) and is readily deployed at coal-fired generating stations or long-term coal ash storage facilities. Despite the apparent suspension of the U.S. Environmental Protection Agency effluent limitation guidelines (ELGs), SonoAsh believes strongly that for broad adoption, it is necessary to have process designs incorporating maximum water reuse and recovery to minimize water consumption. Ultimately, SonoAsh believes it is possible to achieve zero liquid effluent discharge production facilities and is producing scale up designs to process 200,000 to 500,000 tons of diverse CCR annually.

Consistent particle size allows for expanded use of variable CCR to produce a Manufactured Ash product with a high fineness and low carbon content. This creates a reproducible high strength activity index from CCR normally considered to be of negligible or no value.

Consequently, the use of CCR permit concrete to be produced with reduced water demand in comparison to traditional OPC concrete of the same workability.[5] More consistent and low LOI CCR from variable sources allow for regional utility of CCR for low water concrete applications to be used with reduced air entrainment chemicals and water volumes, which in turn reduces concrete bleeding.

The ability to apply low, variable quality CCR for very high value applications by defining particle size, with very low LOI, creates an unprecedented opportunity. There is now a line of sight to take these low value, high environmental risk stores and transform them into a high quality, low energy input material supply chain for 21st century cement and concrete applications.

The author will be discussing the pathway for Coal Ash 2.0 this month at the 2017 The World of Coal Ash Conference in Lexington, Ky. — *SonoAsh LLC, Vancouver, British Columbia, www.sonoash.com*

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Sources

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