

New Applications of the Concrete-Friendly Mercury Sorbent C-PAC™

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ABSTRACT

As reported in a previous World of Coal Ash Conference, the Concrete-Friendly™ mercury sorbent, C-PAC™, can preserve the salability of fly ash in the concrete market after being used for mercury emission control at coal-fired power plants. C-PAC is in commercial production at Albemarle's Twinsburg facility. It is one of Albemarle's powdered activated carbon (PAC) mercury sorbent products. Recently, it has been demonstrated that C-PAC is also able to control the mercury emissions from cement kilns while preserving cement kiln dust properties and avoiding the generation of any waste. The details of these applications are discussed in this paper.

1. BACKGROUND

The fly ash generated from coal combustion is virtually identical in its composition to volcanic ash and is ideal for concrete use. According to the American Coal Ash Association, the US produced 65.6 million metric (MM) tons of fly ash in 2008. Replacing cement in concrete is the primary use of fly ash. About 11.5MM tons of fly ash went to concrete market in 2008¹.

While the U.S. EPA is developing new federal regulations on coal-fired power plant mercury emissions based on Maximum Achievable Control Technology (MACT), twenty states have started controlling the mercury emissions from utilities in their state by 70-90%². For the majority of the coal-fired power plants, the leading technology to comply with the new mercury regulations is activated carbon injection (ACI)³. Power plants inject PAC based mercury sorbents into the flue gas to capture mercury. The carbon sorbent is injected upstream of the plant's existing particulate control device, usually either an electrostatic precipitator (ESP) or fabric filter (FF) baghouse. Currently, 150 ACI systems have been installed by the coal-fired power plants across the country⁴.

The main concern for power plants that sell their fly ash for cement replacement is that PAC based sorbents make the fly ash incompatible with concrete causing the fly ash to be landfilled⁵. To address this challenge Albemarle has successfully developed a Concrete-Friendly™ mercury sorbent, C-PAC™. This sorbent is specially manufactured to preserve fly ash sales for cement replacement by minimizing adsorption of air

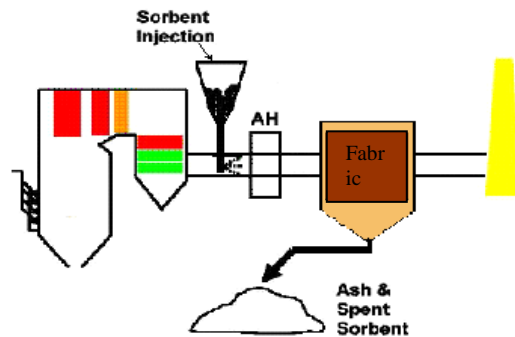
entrainment additives (AEAs) in concrete, while maintaining high mercury adsorption at minimal injection rates⁶.

Recently, it has been demonstrated that C-PAC is also able to capture mercury from cement kilns while preserving cement kiln dust properties and also avoiding the generation of any waste.

In this paper, the recent data from both coal fired power plants and cement plants using the Concrete-Friendly C-PAC to fulfill their respective mercury emission control requirement is presented.

2. COAL-FIRED POWER PLANT MERCURY EMISSION CONTROL USING C-PAC

C-PAC was recently tested at another power plant. The generation capacity of the power plant is > 300MW. The utility burns PRB coals and has a fabric filter for particulate control. Details of the power plant configuration are shown in the figure on the right. C-PAC was injected before the air preheater (APH) at this site.



The plant is able to meet 80% to 85% mercury reduction target with a C-PAC injection rate of only 0.25 lb/MMacf, even at injection temperatures of 430°C to 450°C. The fly ash collected during C-PAC injection was accepted by a fly ash marketer for use in concrete.

C-PAC has been utilized in more than 14 full-scale power plants⁷, and is currently manufactured in Albemarle's Twinsburg, Ohio plant (picture on the right) and shipped to customers daily. The fly ash containing both C-PAC and mercury is being sold into the concrete market as a cement replacement.

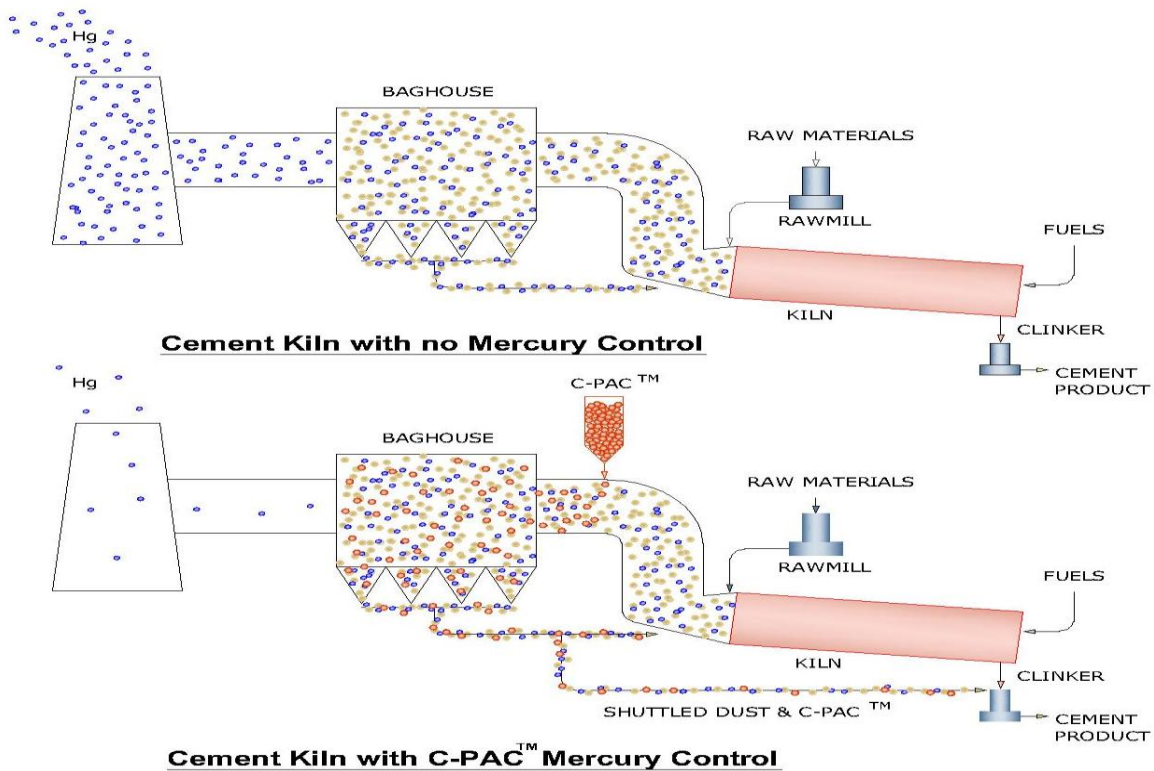


3. CEMENT KILN MERCURY EMISSION CONTROL USING C-PAC

Portland cement kilns are another major mercury emission source, and the U.S. EPA promulgated in 2010 the final MACT standard for cement plants.

It was thought that the only option for the cement plants to meet MACT Hg emission control requirement was to add a polishing baghouse to the kiln at a cost of millions of dollars⁹. Albemarle has proposed, developed and proven via testing a cost-effective solution for the cement industry. The solution is an "In-Process Mercury Control"

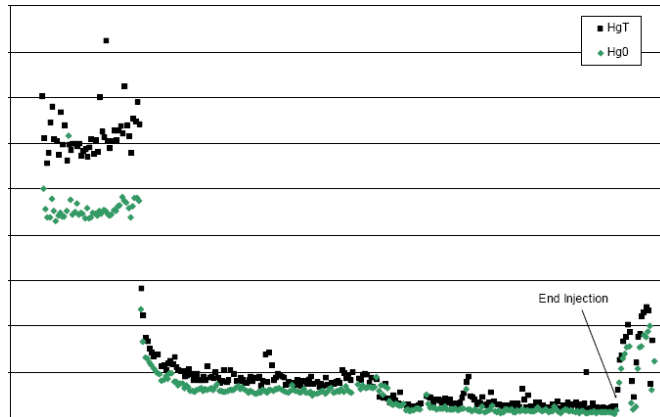
technique using Ablemarle's Concrete-Friendly mercury sorbent, C-PAC, at the existing baghouse, as illustrated in the figures below.



In this technique, Albemarle's C-PAC mercury sorbent, which is both thermally stable and concrete-friendly, is injected as needed upstream of the primary existing particulate control device to reduce and maintain the mercury emission concentration to an acceptable level. Depending on the site, continuous C-PAC injection may be needed or C-PAC injection may only be required when the raw mill is off and Hg is at the highest level.

Then a percentage of the cement kiln dust (CKD) containing mercury laden sorbent is shuttled to the finished mill for use in the final cement product. In this way, no waste disposal or loss of the CKD occurs.

Excellent performance with C-PAC has been observed in several demonstrations, as well as commercial applications. The mercury control results shown in the next figure can be expected.



The advantages of this in-process Hg control technique for the cement kilns include:

1. Requires only a sorbent injection system (low capital cost).
2. Sorbent is the main additional operating cost.
3. The timeframe for equipment design, procurement and installation is short.

The sorbent requirement for this technique is that it must be temperature insensitive, concrete-friendly and have a high Hg capture capability such as C-PAC.

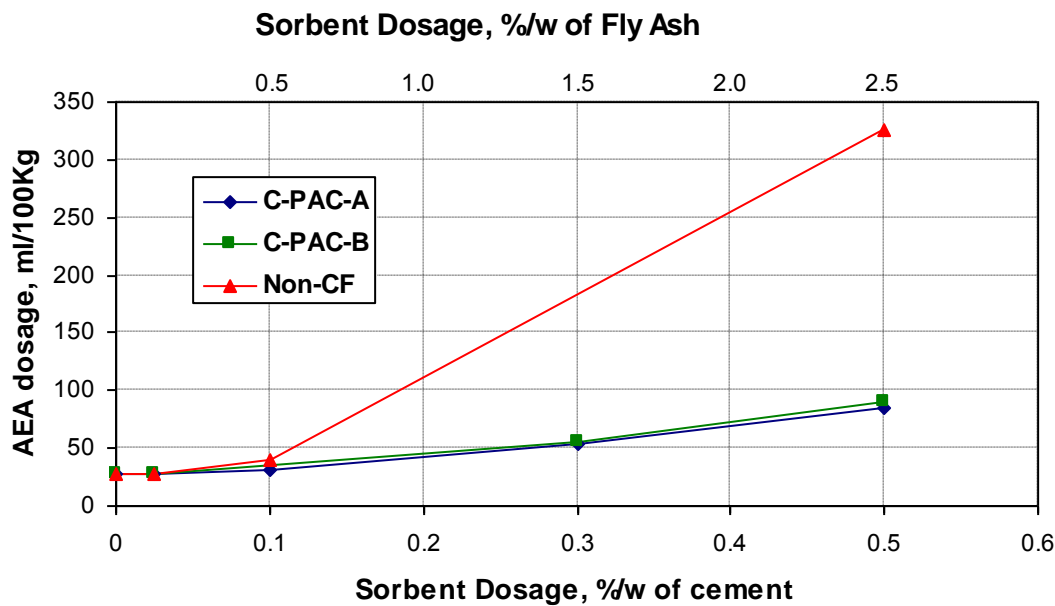
4. ASSESSMENT OF ALBEMARLE'S C-PAC IMPACT ON CONCRETE

Recently, a major fly ash and cement manufacturer assessed the impact of C-PAC on concrete. State-of-the-art equipment and techniques were employed to test the impact of C-PAC on fresh and hardened concrete properties, including:

- Slump
- Air content- of selected mixes, air stability over a 60 minute period
- Set time – of selected mixes
- Strength – of selected mixes
- Hardened air void characteristics – of selected mixes

Significantly less AEA dosage is needed to achieve the same air content in the fresh concrete when the concrete formula contains C-PAC rather than a non concrete-friendly PAC sorbent (see Non-CF in the figure below). With the addition of somewhat higher AEA dosage, the concrete made with C-PAC has the same properties as that without it.

AEA Dosage to Achieve 5-7% Air in Fresh Concrete



The conclusions made by the cement manufacturer include:

- The air retention properties do not appear to be impacted by the carbon based sorbent. Only the air entraining dosage requirement is impacted.
- The hardened air void system do not appear to be impacted by the carbon based sorbents, providing an adequate dosage of air entraining agent is used to reach a 5-7% air in concrete.
- No significant impact was observed on strength development, set time and slump.

5. SUMMARY

Albemarle's Concrete-Friendly mercury sorbents, on which a patent is pending, continue to demonstrate high mercury reduction performance at an expanding number of power plants. The use of C-PAC allows these power plants continue selling their fly ash for use in concrete, generate fly ash sales revenue, avoid fly ash disposal costs, and fill landfill space. C-PAC has also demonstrated the ability to control the mercury emissions from cement plants, generate no disposal cost and no wasting of the CKD. This technique helps cement plant to meet the new MACT Hg emission control requirement without the addition of a costly polishing baghouse.

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