# System Components Key To Efficient, Effective Sorbent Dispersal For Activated Carbon Injection

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**Coal-fired power plants have found activated carbon injection (ACI) to be an effective technology for controlling mercury. Handling the sorbent, however, can pose problems. This article discusses how system equipment can help alleviate some of those problems.**

Injecting powdered activated carbon (PAC) as a sorbent to control mercury emissions is a tried and true way to limit mercury emissions in coal-fired power plants. PAC injection is the only control technology proven to reduce mercury emissions in excess of 90 percent, and in the wake of pending national and state mercury emissions regulations, ACI will continue to grow as an emissions technology. PAC demand for mercury removal applications is projected to grow as much as fivefold through 2014.[1]

## An Old Problem

Conveying, storing, and dispersing such a hard-to-handle sorbent poses a variety of problems from compaction to flooding. The problems aren't new. The sporadic and irregular flow tendencies of dry materials have been issues since the materials-handling industry began. Attempts to solve these problems have ranged from laborers with sledgehammers, to rappers to vibrators to blasts of air. No single technique, however, has provided a universally successful solution.

A combination of appropriately designed and operated system components can help. Efficient, effective storage, flow, and metering of PAC are integral to efficient, effective ACI. Large industrial facilities with ACI systems can consume up to 2 million pounds of PAC annually.[1] Uncontrolled flow and inaccurate metering can result in excessive consumption, which means higher operating costs. If not enough PAC is flowing, rates of mercury removal may be out of compliance with emission standards, resulting in fines. Neither outcome is desirable.

## System Basics

A typical, integrated PAC storage and dispersal system is comprised of a carbon steel storage silo and metering system with vent filters, fluidizing bin bottoms or bin activators to maintain consistent PAC density without fluidization, baffles to provide continuous flow without sorbent compaction and arching; a vibrating unit, intermediate storage hoppers/bins, and gravimetric or volumetric screw feeders and rotary airlocks for discharging PAC into a pneumatic conveying system. Equipment suppliers also should provide system controls, valves, instrumentation, and interconnecting piping.

An integrated PAC storage and handling system, from vent filter (top) to gravimetric feeder (bottom).

Silos are engineered to meet flow demand. A typical silo for a two- or three-feed PAC system might measure 14 ft. in diameter and 80 ft. tall. Significant flow compaction can occur in such a vessel. PAC particle size, bulk density, moisture content, compressibility, etc., combine to determine the extent. Rat holing and arching also can further complicate PAC discharge to the downstream feeders.

Bin activators, unlike aeration devices — air pads, slides, buttons, etc. — which affect localized sections of PAC, influence the entire mass of reagent, alleviating bulk density variations and spot flow problems. Delivering a consistent bulk density and continuous flow of PAC is the key to improved accuracy and decreased cost. Often, savings in reduced material can pay for the entire silo system in several years.

Well-designed bin activators have primary and secondary baffles, with cone-shaped sections sloped at the correct angle — about 45 degrees. If cones aren't shaped appropriately — too shallow or too steep — PAC won't flow freely. Material compaction, build-up, or even stoppage can occur.

The optimum cone shape promotes material flow with high efficiency, low energy consumption, and minimal force requirements. Otherwise, large outlet sizes or cycling of the vibrator unit and high-energy-input vibration become necessary to mobilize materials.

The forces required to activate the material in the bin exceed those needed to discharge sorbent from the activator outlet, causing the activated carbon to compact or stop. Primary baffles put full vibration force into the material, allowing consistent, first-in / first-out draw-down of the PAC from the silo. An adjustable secondary baffle, moving at different amplitudes, creates motion to maintain continuous flow.

When discharging material, bin activators should run continuously and not cycle as cycling can cause first-in / last-out sorbent flow.

Bin activators can help lower utility costs so no additional compressed air is necessary for pneumatic gates. Maintenance costs and the chance of generating fugitive dusts also can be avoided.

PAC next goes into the distributor hopper, which helps achieve uniform dispersal from the bin activator. Hoppers direct material into two or more storage bins, where material is ready for on-demand metering via gravimetric or volumetric screw feeders.

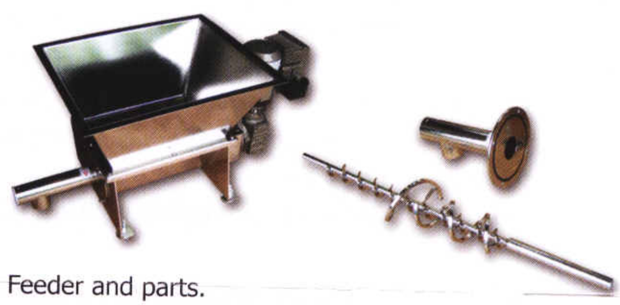
Every hopper outlet is isolated using automatic gate valves. Each outlet leg also is equipped with a bin activator to help with reliable, even, on-demand discharge of the material. Intermediate hoppers that feature dedicated bin activators can help alleviate problem PAC discharge.

## Gravimetric vs. Volumetric

Gravimetric and volumetric feeders meter the activated carbon into a pneumatic conveying system for injection into the flue gas duct.

• Volumetric feeders, typically the simplest and lowest capital cost alternative, discharge a fixed volume of material into the process on a unit-time basis. Using rotary valves (in volumetric feeding) in place of volumetric screw feeders can result in typical accuracies of about 5 to 10 percent on a minute-by-minute basis. If bulk density of a material varies, screw feeders can-

Bin activator.



Feeder and parts.

Gravimetric screw feeder controls.

not recognize density changes and are prone to inaccuracies. Consequently, rotary valves aren't recommended for ACI application due to the variation in PAC bulk density and the relative high cost of the material. Some volumetric feeder designs feature an agitator / conditioner as part of the metering screw. The feature can increase volumetric screw feeder accuracy to plus or minus 1 to 1.5 percent.

• Gravimetric screw feeders are well-suited for metering of powders, flakes, or pellets when precisely controlling feed rates on a loss-of-weight basis is necessary. These feeders also work well when material bulk density can vary or when control of material flow is governed by weight. Systems require platform scales, weight equipment, or load cells, which can add cost compared to volumetric feeders.

The weighing system, however, improves feed accuracy and performances, which also can be documented. Consequently, this type of feeding is beneficial in processes that require multiple feeders to simultaneously dispense materials. Gravimetric metering usually achieves accuracies of plus or minus 0.5 percent. This becomes even more important when metering expensive sorbents such as PAC.

Keep in mind that PAC manufacturers have been changing technology to provide material with increased bulk density. Equipment that can adjust to density and capacity increases can help avoid potentially costly retrofits

## Conclusion

When choosing a system, consider material properties such as slide angle, angle of repose, loose bulk density, packed bulk density, compressibility, mean particle diameter, particle size distribution, and moisture content to get the most efficient performance. All can affect operating conditions for an ACI system. **APC**

## References

1. *Activated Carbon; U.S. Industry Study with Forecasts for 2014 & 2019*, The Freedonia Group.

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