

INFORMATION SHEET

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Norit Activated Carbons for Mercury Removal from Power Plant Flue Gas

Introduction

Coal fired utility plants have long been viewed as an efficient and cost effective means of safely producing power. Increasing environmental concerns in recent years have resulted in a more complete review of the emissions released in the flue gas. Of all the substances emitted, mercury is one of the major concerns due to the toxicity and persistence in the environment.

Regulatory control of mercury emissions from coal-fired power plants was established by the United States EPA in the Clean Air Mercury Rule (CAMR) issued in March, 2005. This cap-and-trade rule will require reductions in mercury emissions over several years from new and existing coal fired power plants. In addition, several states have also begun to set strict mercury emission limits for coal fired utilities.

Mercury emissions control can be a difficult issue to address since mercury is present in power plant flue gas at very low concentrations, and other components in the flue gas may affect mercury removal efficiency. The good news is that a proven and plant-tested technology exists for mercury removal from flue gas.

The Solution - Norit Powdered Activated Carbons

DARCO[®] Hg and DARCO[®] Hg-LH are lignite based powdered activated carbons (PAC) specially produced for the removal of mercury from flue gas. DARCO Hg-LH is an impregnated lignite based activated carbon that is highly effective for the removal of mercury from flue gas at plants burning low halogen fuels. The technology is simple; inject DARCO Hg or DARCO Hg-LH into the flue gas using an automated feeder. Once in the flue gas stream the carbon adsorbs mercury and is removed by means of the existing Particulate Matter (PM) pollution control device. Mercury removal efficiencies of over 90% have been achieved in actual plant tests.

DARCO Hg and DARCO Hg-LH are highly macroporous, with a high percentage of pores in the 20 to 500 Å range. This large open pore structure facilitates diffusion and mercury removal in the short contact times available in existing flue gas treatment systems. In addition to having a large average pore size, DARCO Hg and DARCO Hg-LH are ground into a very fine powder to ensure good contact between the activated carbon and the flue gas.

Different forms of mercury are known to exist in flue gas from coal combustion. Removal of mercury from the flue gas is believed to be the result of adsorption and chemical reactions with the activated carbon surface. In either case, the mercury is strongly held within the pore structure. Both DARCO Hg and DARCO Hg-LH contain sulfur complexes in the pore structure, which can also react with mercury, binding it within the pores.

[®] DARCO is a registered trademark of Norit Americas Inc

Techniques for Injecting Norit Powdered Activated Carbons

Powdered activated carbon has been successfully used and found to be cost effective for mercury removal from flue gas generated by waste incinerators, industrial combustors, hazardous waste incinerators, metal smelters, and coal fired power plants. Numerous methods have been employed to introduce powdered activated carbons into the various flue gas streams. Some of these are:

- Dry injection directly into
 - the cyclone
 - the spray dryer
 - the economizer
 - the spray dryer outlet
- Carbon/lime slurry fed into the spray dryer (up to 1 lb/gallon of water)

Studies carried out by the EPA to determine the effectiveness of slurry vs. dry injection were inconclusive. Some results suggested that dry injection is somewhat more effective than carbon/lime slurry injection, whereas others found no influence on the injection method. More recent plant tests in the coal fired power industry have shown excellent results with dry injection of activated carbon.

The point of injection of the PAC into the flue gas stream is dependent on the design of the combustion and air pollution control (APC) system as well as several other important factors.

Generally, any injection scheme should be designed to:

1. Maximize the contact time between the PAC and the flue gas, and
2. Ensure sufficient turbulence to allow thorough mixing of the PAC and the flue gas stream.

Dosing Rates of Norit Carbons and Removal Efficiencies

Studies have shown that removal efficiency is highly dependent on the dosing rate of PAC, flue gas chemistry, flue gas temperature, and the type of APC system. For example, facilities equipped with an electrostatic precipitator (ESP) may require more carbon dosing for mercury removal than facilities equipped with a fabric filter (FF). The carbon adsorptive capacity for mercury is also inversely related to flue gas temperature at the point of carbon injection. One study has shown that twice as much carbon is required to achieve the same mercury removal when the flue gas temperature at the point of carbon injection is increased from 270°F to 349°F.

The required carbon-dosing rate needed to achieve the desired mercury removal efficiencies will therefore vary from one installation to the next. Dosing rates as low as 1 lb/MM acf have been found to give 90% mercury removal in some types of coal fired power plants. Actual dosing rates should be determined through plant trials on the flue gas stream under actual plant conditions. For this purpose Norit has developed a portable dosing unit, the PORTA-PAC[®] that could be used for tests at small plants. This self-contained unit, utilizing 900 lb bulk bags, has a dosing rate of 2 to 100 lbs/hr. Large plants may require a Norit silo and feeder for cost effective handling of the powdered activated carbon. A mobile silo system is available from Norit Americas Inc. for test work at large plants.

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Handling of Norit Powdered Activated Carbons

To a great extent, the carbon consumption rate will determine the size and type of handling system required. Small users could take delivery in bulk bags while larger users will probably choose delivery in bulk trucks or by rail.

As the global leader in PAC manufacturing, Norit has over 85 years experience in handling and dosing of PAC. Norit's Activated Carbon System and Services Group has a wide range of essentially dust free dosing units, from permanent silo units to small PORTA-PAC units. All of these units are engineered with simplicity and ease of operation in mind. Norit can offer a standard unit, or custom design system tailored to your needs.



Storage silo



Carbon feeder

The design of storage and dosing systems for injecting PAC into a flue gas stream may be "site specific" depending upon the types of APC equipment in use at the plant. Metering of dry carbon can be done volumetrically by a proportional rate screw feeder or by weight displacement using load cells. Norit has had years of experience with these systems and can assist you in designing the right system for your operation.

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Some customers have expressed concerns about the safety issues involved with injecting a combustible powder into the flue gas stream. However, DARCO Hg and DARCO Hg-LH have been processed at temperatures in excess of 1600°F, and the absence of volatiles in Norit carbons minimizes the risks. Although carbon will burn at elevated temperatures in the presence of oxygen, there have been no reports of fires or explosions when Norit or DARCO PACs are properly dosed into flue gas streams. This includes not only the extensive use of PAC in flue gas streams throughout North America and Europe, but also the use of PAC in many other processes.

Specifications of Norit Carbons

Specifications ¹	DARCO Hg	DARCO Hg-LH
Molasses decolorizing efficiency, min.	80	70
Moisture, % as packed, max.	8	12
Mesh size (U.S. Sieve Series)		
Less than 325 mesh (45 µm), % min.	95	95
Typical Properties		
Iodine number, mg/g	550	500
Total sulfur, %	1.2	1.2
Bulk density, tamped, g/mL	0.51	0.60
lb/ft ³	32	37
Surface area, m ² /g	600	550
Ignition temperature, °C	≥400	≥400

References

Norit has been active on a worldwide basis in the development of flue gas PAC injection for the control of mercury since 1986. Norit powdered activated carbons have been field tested or commercially used for mercury control in more than 60 facilities in North America and more than 80 combustors/incinerators throughout Europe and the Far East.

Norit Americas Inc.

Norit Americas is a wholly owned subsidiary of Norit N.V., which is based in the Netherlands. Norit is one of the largest producers of activated carbon in the world and has led the way in technical development in the application of its products in a number of industries. Norit has been in the business of manufacturing activated carbons for more than 85 years and offers the most complete product line to suit your desired application. For more information please contact your local regional sales manager or:

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¹Subject to change, please refer to the current Product Datasheet.