Luehr Gas Cleaning Systems
Mercury Control with Optimized Activated Carbon Re-Use

Federal & State limitations on mercury (Hg) emissions will require innovative and proven methods to economically and consistently meet operational and emission performance requirements. It is difficult for the conventional emission system, i.e. electrostatic precipitators (ESP) and flue gas desulphurization (FGD), to meet the new regulations for Hg control. Baghouses have demonstrated that they can meet these requirements - but not all baghouses are the same - most require high levels of activated carbon (AC) to meet the 90% removal standard.

The key components required for efficient and effective Hg control include:

- Physical contact between Hg and the AC
- Retention time for the chemical/ physical reaction between the Hg and AC
- Maximize the usage of the injected AC
- High collection efficiency

The most common method of a dry gas cleaning system for Hg capture injects the AC in the ductwork upstream of the filter, and relies on the chance that the Hg molecule and the AC will come in contact with each other. This most likely occurs on the surface of the filter media, and often requires a significant amount of activated carbon to be injected into the system to increase the chances of the two coming in contact with each other. This method does not allow much time for the Hg and AC reaction to occur. In traditional systems, every time a bag is cleaned the buildup of AC is also removed; without the AC bed in place, the Hg can pass through without coming in contact with any AC and be discharged into the atmosphere.

Filter Cake

An additive particle-particulate layer is formed on the filter bags. This layer is very important for the crude gas cleaning process and obtaining extremely low emission levels.

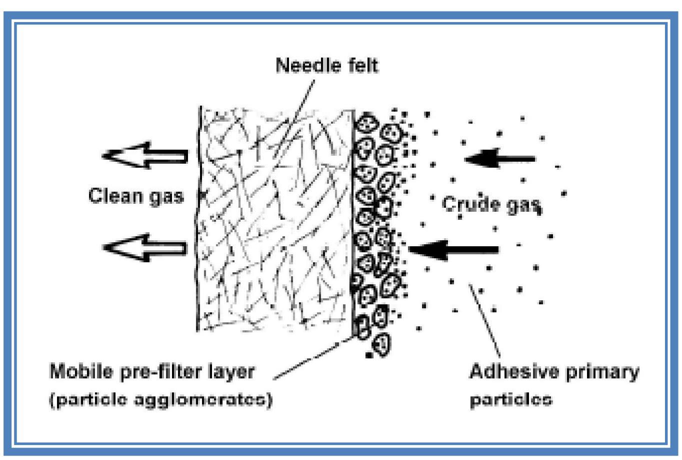


Illustration: Mobile pre-filter layer for the separation of fine, adhesive particles

Luehr Gas Cleaning Systems
Mercury Control with Optimized Activated Carbon Re-Use

Condensable particulates, like organics, metallic fume, and acid gases, are controlled by chemical or physical adsorption in the exterior layers of the filter cake. The filter cake provides a bed for the sorbents to react and form chemical bonds with the additives. The bed structure creates a depth of physical contact sites for the particulate to impact, removing them from the gaseous exhaust stream.

The Luehr Filter system has unique design benefits to maintain this filter cake depth and removal efficiencies:

- Horizontal flat bags
- Compact design
- Cage design
- Downward crude gas flow
- Cleaning cycle
- Conditioning rotor / reaction chamber
- Additive / dust recirculation system

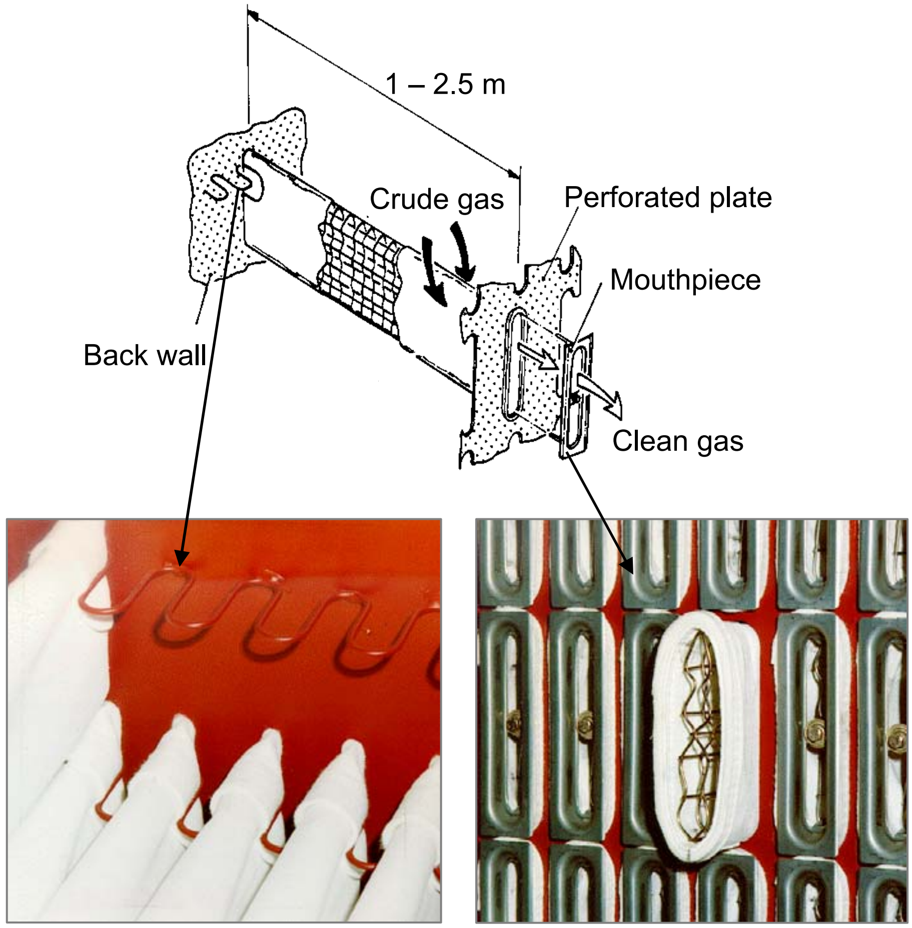
Horizontally Mounted Flat Bags

The bags and cages are less than 10 feet long and are supported on both ends, eliminating the chance of adjacent bags coming in contact with one another during the cleaning cycle. The fixed structure allows a calm zone for particulates to fall without being re-entrained in the filter media.

The bags are easily removed while standing on an access platform. The operator does not need to enter the filter for bag replacement.

Luehr Gas Cleaning Systems
Mercury Control with Optimized Activated Carbon Re-Use

Flat Bag Element

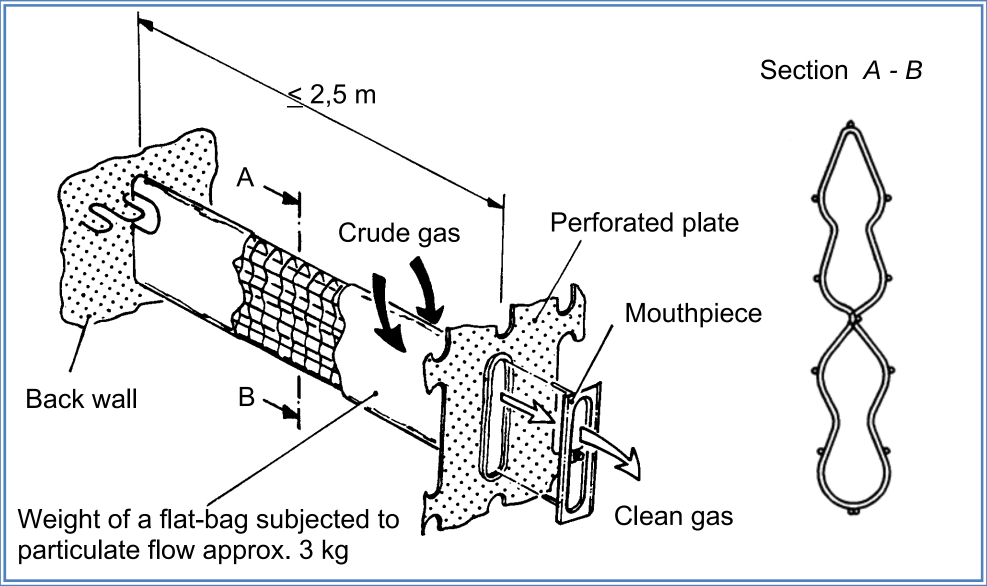


Holder at Back Wall

Mouthpieces and Perforated Wall

Concave Cage

The concave design of the cage reduces the mechanical stress applied to the bag during the cleaning cycle, as the bag does not expand beyond its original shape. The cages are manufactured with spacing between the wire mesh of about 1 inch, further reducing the mechanical stress on the filter media.



Compact Design

The horizontal bags and configuration of the filter modules allows for a small footprint.

Specific cloth area (SCA) is higher with the Luehr design.

Luehr SCA ~ 5.8 ft^2 / ft^3

Traditional SCA ~ 3.4 – 3.7 ft^2 / ft^3

Downward Gas Flow

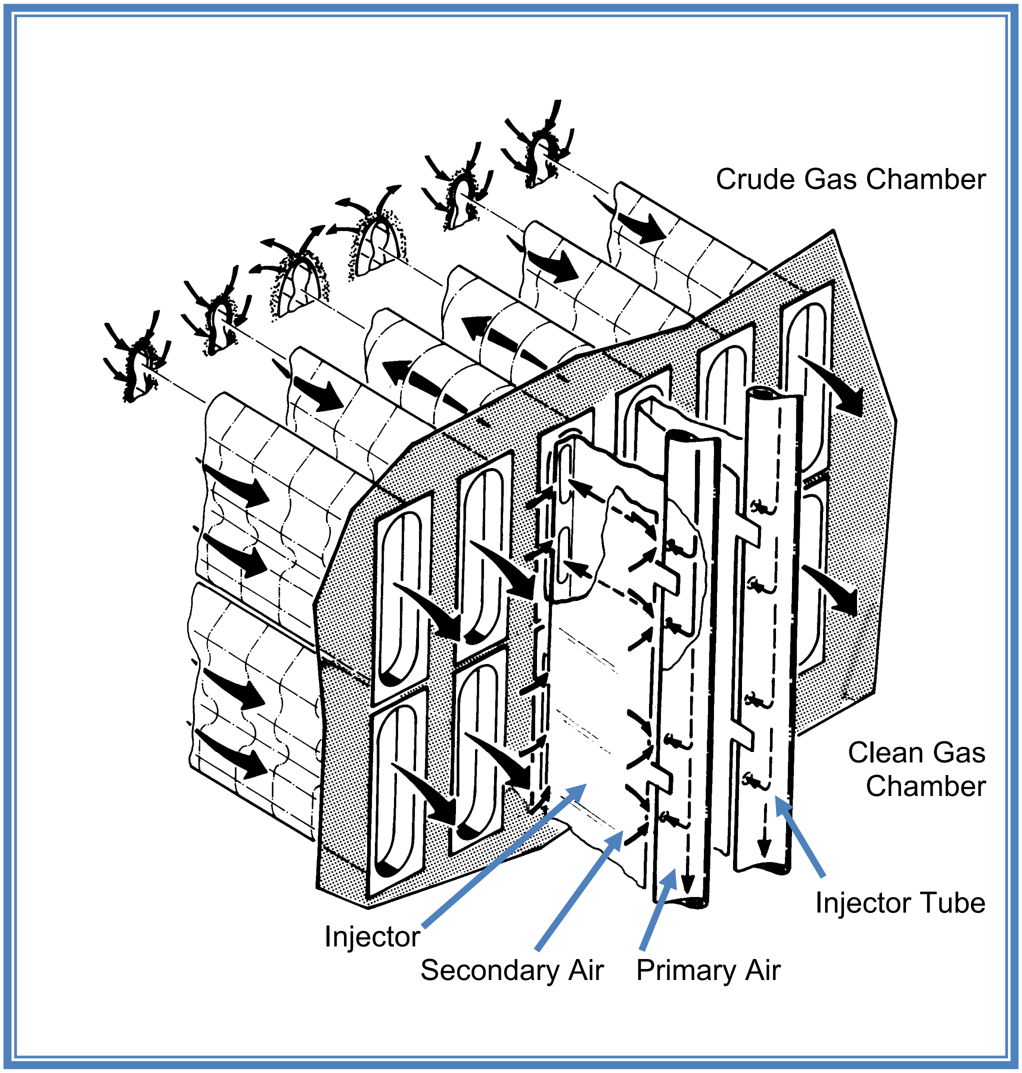
The crude gas flows downward in the same direction as the released dirt, basically eliminating any concerns about "can velocity". There is minimal chance of the dirt particles becoming suspended in the gas stream. This feature allows for smaller spacing between the bags.

Cleaning Mechanism

The cleaning cycle is typically done by a preset time cycle. This reduces the delta pressure across the filter media which also helps in maintaining a filter cake on the bag.

During the cleaning cycle, low pressure air is introduced into the clean side of the bags which releases portion of the particulate on the dirty side of the bag which falls into the bottom of the hopper.

Only a few vertical rows of bags are cleaned at a time. This is a very small percentage of the total filter cloth area which minimizes the particulate carryover typically seen after a cleaning cycle.



Conditioning Rotor and Reaction Chamber

The injected activated carbon is introduced before the reaction chamber and is homogeneously mixed with the crude gas stream in the conditioning rotor. This enables the sorption sites to initiate contact between the additives and interact with the gaseous pollutants.

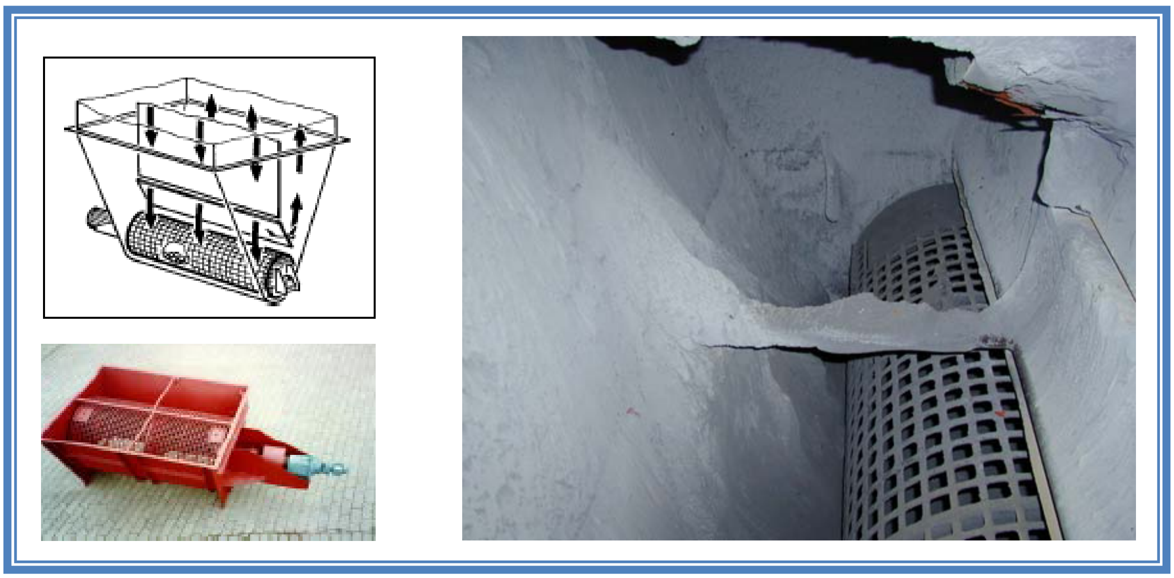
The Conditioning Rotor increases ***reaction effectiveness*** by increasing the opportunity of the additives to contact and react with the acid gas components.

The conditioning rotor is located at the bottom of the two-pass reaction chamber elbow and mixes the crude gas stream with the activated carbon.

The Reaction Chamber increases ***residence time*** in the system for the additives to react with the crude acid gas.

The vertical reactor shaft and crude gas inlet area allows intimate contact in the reaction area for the physical and chemical conversions to occur between the crude gas stream and the particulate additive powders.

The reaction chamber extends the residence time (1 – 2 seconds) of the crude gas and injected additive, increasing the opportunity of the gas and powder to physically contact, allowing the reaction to occur.



The reaction chamber and conditioning rotor optimize the effectiveness of the reaction chemistry. Without the presence of the reaction chamber and conditioning rotor, feed rates would need to be increased because the neutralization reaction could only occur on the filter cake.

Fine particle sizes are agglomerated so the overall particle size of the crude gas entering the filter is larger. Larger particles are easier to collect in the filter bed than small.

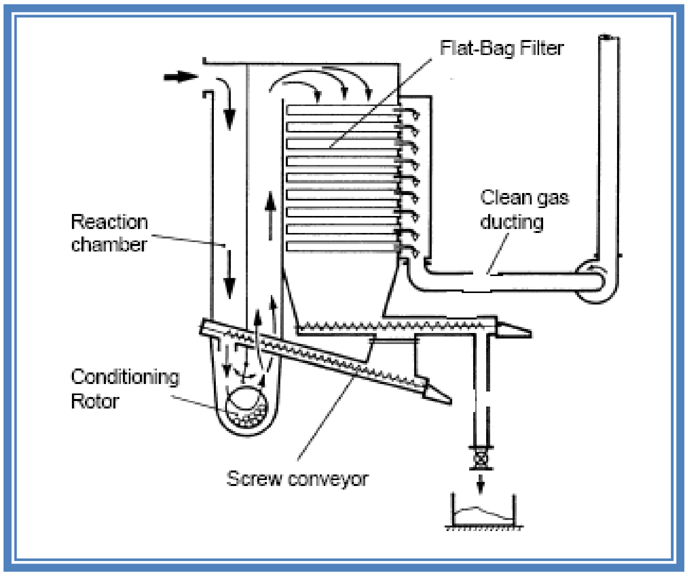
Additive/ Dust Recycle System

The collected baghouse dust includes activated carbon that has remaining charge sites which are still available to adsorb Hg. Re-circulating this dust optimizes its effectiveness and minimizes the raw material demand of new activated carbon.

When this dust is recycled back into the dirty air stream and mixed in the conditioning rotor, the available sorbent sites can be contacted, and the pollutants are adsorbed and removed from the exhaust gas.

Residuals collected at the filter inlet chamber and the filter hoppers are transported via screw conveyors or drag link conveyors into intermediate hoppers for re-use or for disposal.

The particle recycle process assures that there is continuous new formation of the layer on the filter surfaces.



Bag Life

Operating costs are minimized when bags don't need to be changed.

Factors that extend bag life include:

- Low differential pressure drop
- Reducing cleaning frequency
- Minimizing blinding of bags
- Cage design

Luehr Gas Cleaning Systems
Mercury Control with Optimized Activated Carbon Re-Use

Performance Results

Atlantic States Cast Iron Pipe Co. Phillipsburg, NJ

In 2006, Atlantic States Cast Iron Pipe became the first foundry in North America to apply control technology to substantially limit Hg emissions. Representing an investment of more than $9.3 million, the new technology installed by Atlantic States has allowed it to surpass compliance with emission standards set by the U.S. Environmental Protection Agency under the federal Clean Air Act, and preemptively meet in New Jersey Department of Environmental Protection (NJDEP) Hg regulations far ahead of its compliance date of January 3, 2010.

The NJDEP Hg regulations require foundries to achieve an emission rate of 35 mg Hg per ton of pipe manufactured or at least 75% removal. During a certified stack test conducted on December 5, 2006, Atlantic States achieved Hg emissions of less than 1.0 μg/Nm^3 and exceeded 99% removal. As a result, three years ahead of NJDEP's schedule, Atlantic States has voluntarily put systems in place that removed over 50 lbs of Hg from its emissions in 2006 and will remove over 200 lbs of Hg from its emissions before the new regulations become effective. The new system has also dramatically reduced lead emissions. During the stack test, Atlantic States achieved lead emissions of 0.00039 lb/hr or 99.9% removal.

Airflow....................................55,110 dscfm

Upstream Temp. ....280-290°F

6,020 flat bags ....~ 59,772 ft^2

Air to cloth ratio .... 3.2:1 to 3.3:1

Dust recirc rate (KUV) ....up to 10:1

AC design loading ....12 lb/hr

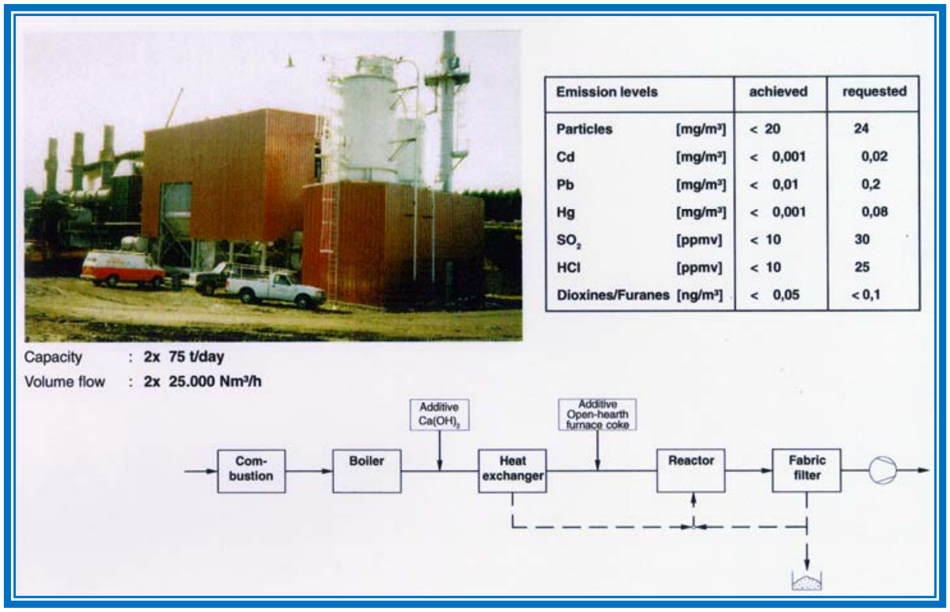
Sodium bicarbonate for SO_2 control

Enviroblend for heavy metals control

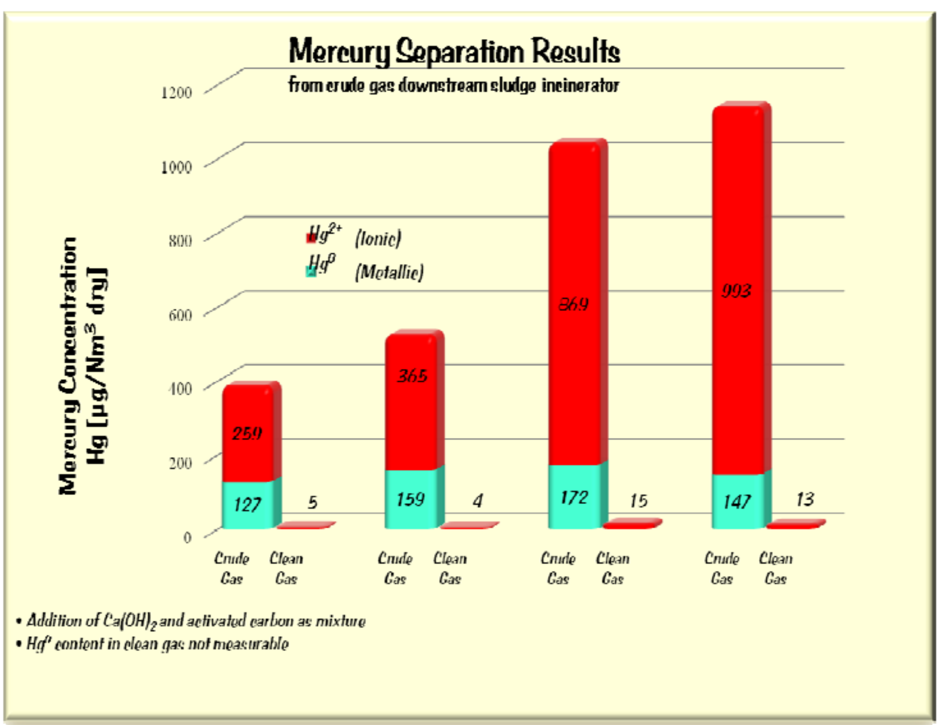
Pre 2006 Installation		Guarantee	After Installation
Hg:	289 μg/Nm^3, total	15 μg/Nm^3	0.94 μg/Nm^3
P.M.:	N/A	0.002 gr/dscf	0.0008 gr/dscf
SO_2:	50-75 ppm	N/A	8 ppm

Luehr Gas Cleaning Systems
Mercury Control with Optimized Activated Carbon Re-Use

Luehr Flat-bag filter with Conditioning Rotor – Recycle Process downstream of a domestic waste incinerator documented high removal efficiencies for Hg, acid gas components, and metallic hazardous air pollutants (HAPs).



Emission levels		achieved	requested
Particles	[mg/m³]	< 20	24
Cd	[mg/m³]	< 0,001	0,02
Pb	[mg/m³]	< 0,01	0,2
Hg	[mg/m³]	< 0,001	0,08
SO_2	[ppmv]	< 10	30
HCl	[ppmv]	< 10	25
Dioxines/Furanes	[ng/m³]	< 0,05	< 0,1



Hg concentrations were measured in both ionic and metallic forms at the inlet and outlet of the domestic waste incinerator crude gas cleaning system.

Hydrated lime and activated carbon were injected upstream of the Luehr fabric filter.

Collected lime and activated carbon are recycled and re-introduced into the crude gas ductwork upstream of the conditioning rotor.

Design & Operational Benefits of Luehr Gas Cleaning Systems

- High control efficiencies
- Absorption of acid crude gas
- Unique down flow design
- Large filtration “surface area to volume” cloth ratio
- Small footprint
- Long bag life (iron foundry 6+ yrs)
- Simple mounting/dismounting of filter bags
- Bag replacement during plant operation
- Recycle system minimizes activated carbon consumption

Keywords:
Mercury – Activated Carbon – Emissions – Activated Carbon Recycle – Flue Gas Treatment