Mercury Emission Controls For Sewage Sludge Incinerators

Chavond-Barry Engineering Corp.

What Is Mercury & Why Should We Remove It Form Our Stacks?

- Liquid Metal – many uses in the 20th Century

  Amalgams (gold), switches, thermometers, manometers, catalyst, felt, production of NaOH & $Cl_{(g)}$

- 113 Pounds/gallon

- Bio accumulates
- Neurotoxin
- Dimethylmercury
  - Extremely Toxic

New Federal Limits

Effective March 21, 2016

2016 Hg EMISSION LIMITS*		
	Existing	**New**
Fluidized Beds:	0.037	0.001
Multiple Hearths:	0.28	0.001
Units:	mg/dscm @ 7% O_2	

*40 CFR 60 – Subparts LLLL (New/Modified) & MMMM (Existing)

Where Does Hg Originate?

- Cinnabar, HgS
- Environmentally Stable
- Roast at 650°F to extract mercury

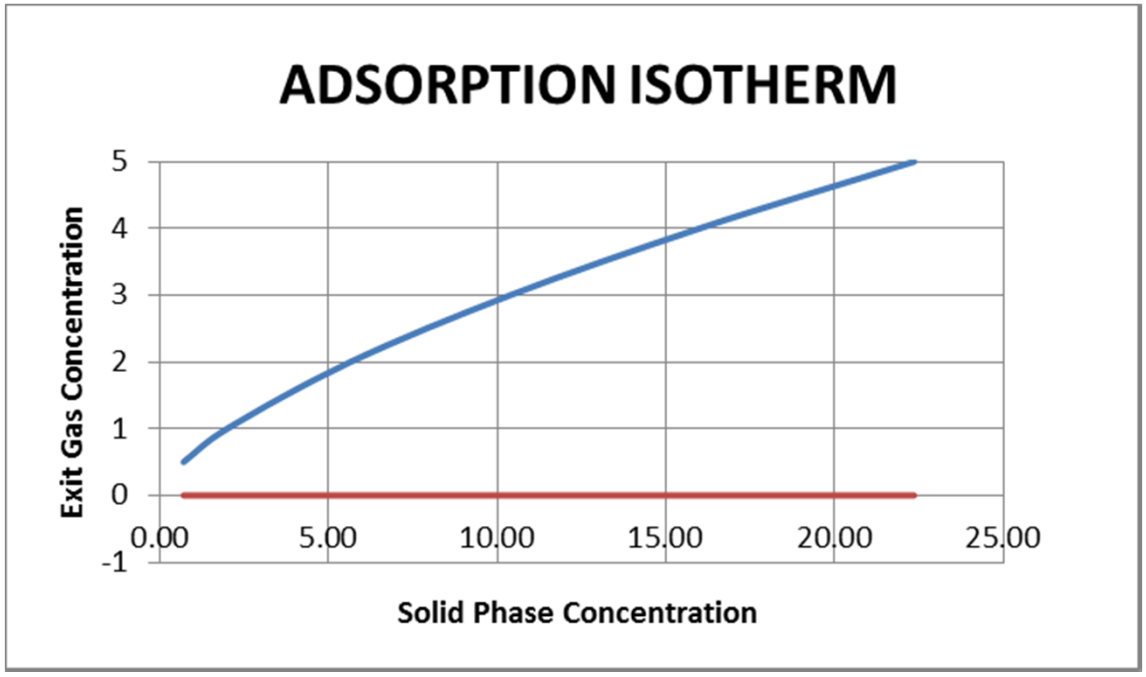
- Largest Hg emissions are from coal fired power plants
  - $HgS + O_2 >> SO_{2(g)} + Hg_{(g)}$
  - $O_2 + Hg_{(g)} >> HgO_{(g)}$
- Hg is in Sewage Sludge

Mercury in SSI

- During combustion, mercury is volatilized and converted to elemental mercury (Hg^0) vapor.
- As flue gas is cooled Hg^0 can react to become ionic mercury (Hg^{++}) compounds and/or adsorbed onto the surface of particulate (Hg_p).
- However, reaction is **Kinetically Limited.**
- Elemental mercury (Hg^0) captured by Chemisorption

How Do We Capture Hg?

- **Conventional Scrubbers** can capture Hg^{++} & Hg_p
- **Chemisorption needed to** capture Hg^0
  - Adsorption (film on your windshield)
  - Similar to Activated Carbon (AC) filled odor scrubbers. But with chemical reaction.



Chemisorption Reaction

- Activated Carbon (AC) has large active surface area and is commonly used for sorption of pollutants.
- Adsorptive quality of AC can be enhanced by additives

Sulfur Impregnated Activated Carbon

- Sulfur reacts directly with mercury at room temperature to form mercuric sulfide

$$Hg^{(0)} + S^{(0)} >> + HgS_{(s)}$$

- Analogous to stable cinnabar found in nature
- Active sites not occupied by sulfur sorb other volatile Hg species such as $HgCl_2$

Unit Operations

1. Remove the heat
2. Remove the large particulate
3. Remove water droplets
4. Heat to >20°F above the dew point
5. Remove ultra-fine particles
6. Adsorb the Hg on Activated Carbon

1. Remove The Heat

- Goal: Prepare the gas for the demister
- Here in NJ every location uses a wet scrubber.
  - Venturi scrubber
  - Tray scrubber
  - VenturiPak scrubber
  - Ring Jet scrubber
  - Packed bed scrubber
- Sometimes preceded by energy recovery units, e.g., heat exchanger
- Results in a saturated gas at 80°F - 100°F.

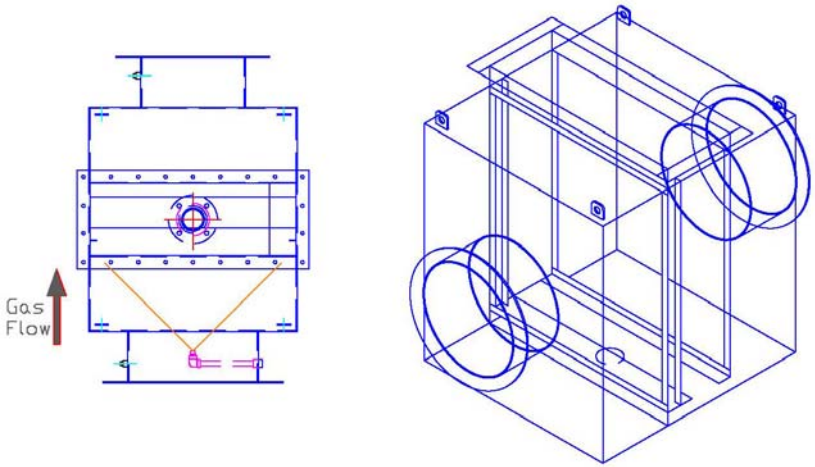
2. Remove The Large Particulate

Goal: Remove particulate, metals, and acid gases

- This is most often done in the wet scrubber system. Results in an ash slurry
- Frequently, a Wet Electrostatic Precipitator (WESP) is added following the scrubber.

3. Remove Water Droplets

Goal: Dry gas is needed for optimized operation of adsorber



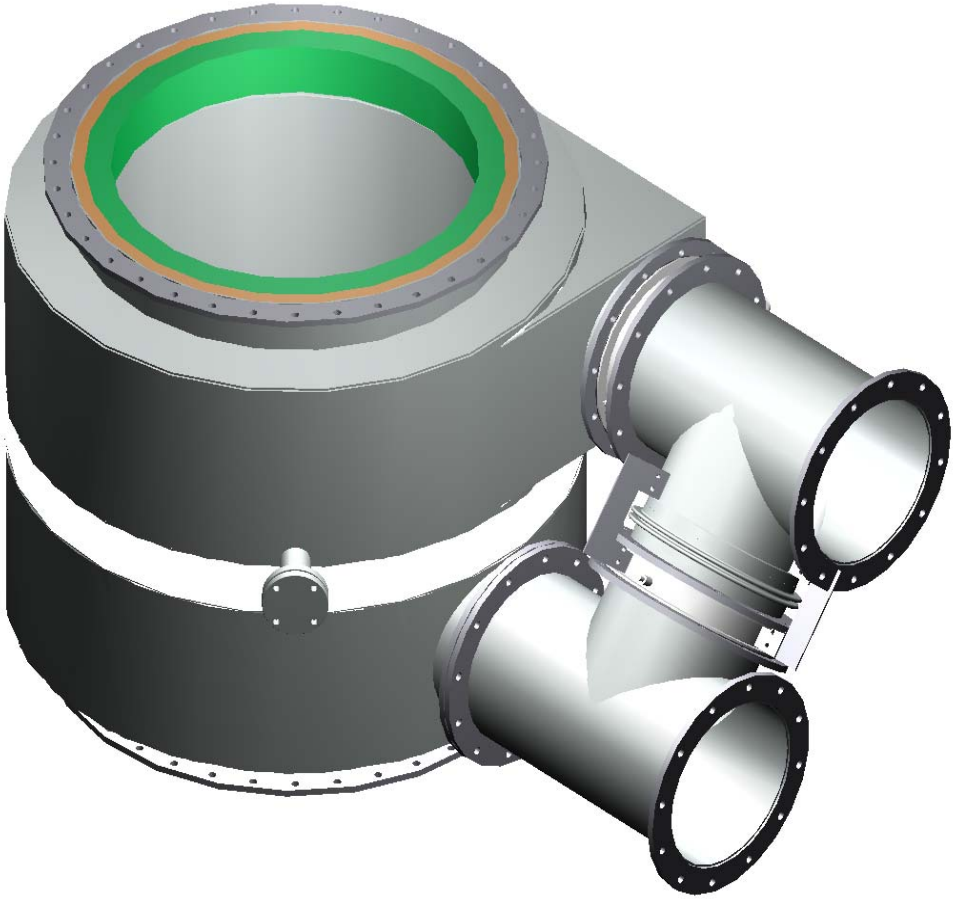
- Mist Eliminator
- Coalescer-Demister
- Chevron Separator
- Mesh pad Separator

4. Heat The Gas

Goal: Raise gas temperature above dew point

- Dry Gas
- Better mass transfer

- Heat Exchanger
- Direct mixing with hot gases
- Duct heaters



5. Remove Ultra-Fine Particles

Goal: Prevent mechanical failure of carbon column (Clog)

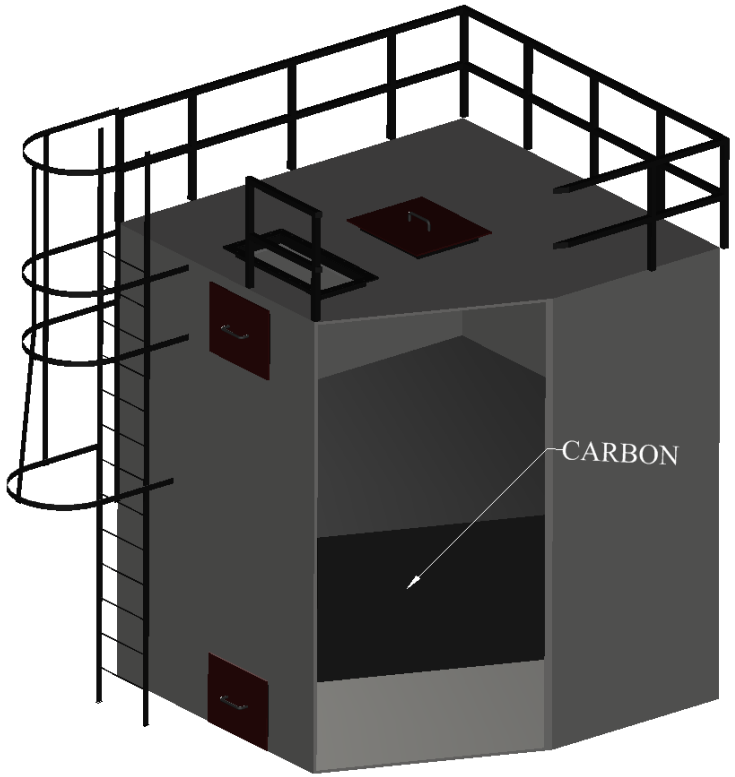
- Remove additional droplets
- Protect from dust buildup

Ultra-High Efficiency Filter

6. Adsorb the Hg

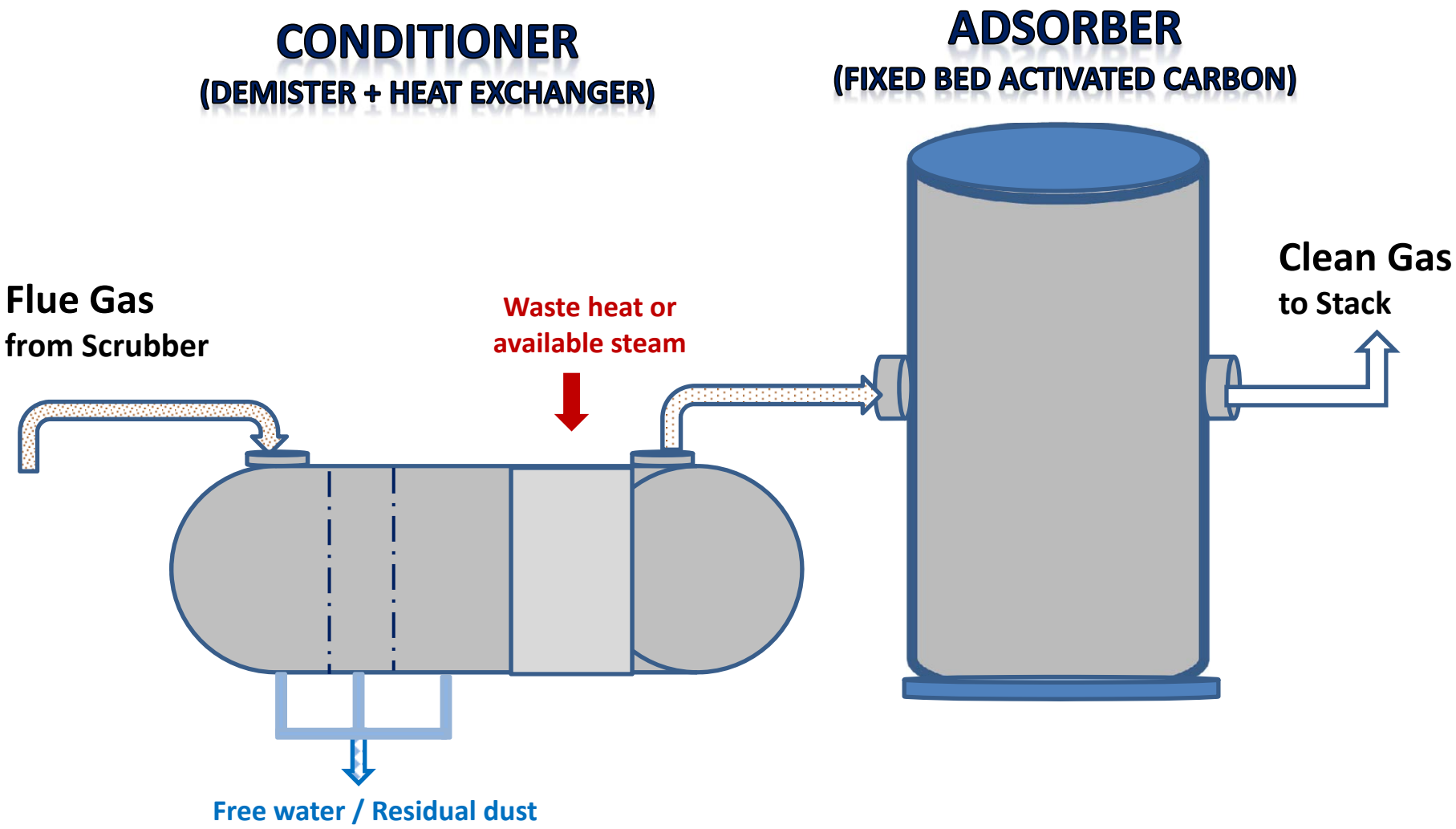
<u>Goal:</u> Expose incinerator exhaust gases to sulfur impregnated carbon

- <u>≥</u> 2 second RT



- Fixed bed adsorber
- Powdered activated carbon injection

Pretreatment In One Container


CONDITIONER
(DEMISTER + HEAT EXCHANGER)
ADSORBER
(FIXED BED ACTIVATED CARBON)
Flue Gas
from Scrubber
Waste heat or
available steam
Clean Gas
to Stack
Free water / Residual dust