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Incinerators



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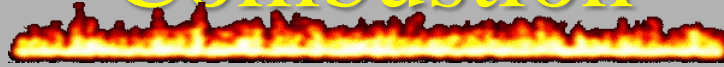


INCINERATION

- “A combustion process, in which the primary purpose is to destroy combustible material.”
- **Biomedical Incinerators: Hospital, Pathological and Crematory Incinerators.**
- **Heat Stripping Ovens (Burn off ovens)**
- **MSW incinerators**
- **Sewage Sludge incinerators**
- **Hazardous Waste incinerators**
- **Commercial and Industrial Incinerators**
- **Air Curtain Incinerators**



Combustion



- Stoichiometric Combustion
- Excess Air Combustion
- Substoichiometric Combustion



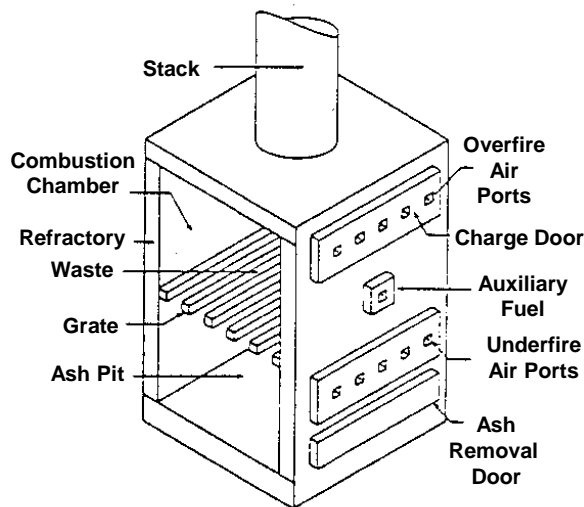
IIA Waste Classification

TYPES 0 - 8

- **Vary by Composition**
- **Vary by Moisture Content**
- **Vary by Btu value per pound fired**

Solid Waste Incinerators

- Open Burning
- Open-Pit Incinerators
- Teepee Burners
- Single Chamber Incinerators
- Multiple Chamber Incinerators
- Controlled Air Incinerators
- Rotary Kiln Incinerators
- Fluidized Bed Incinerators
- Multiple Hearth Incinerators
- Air Curtain Incinerators

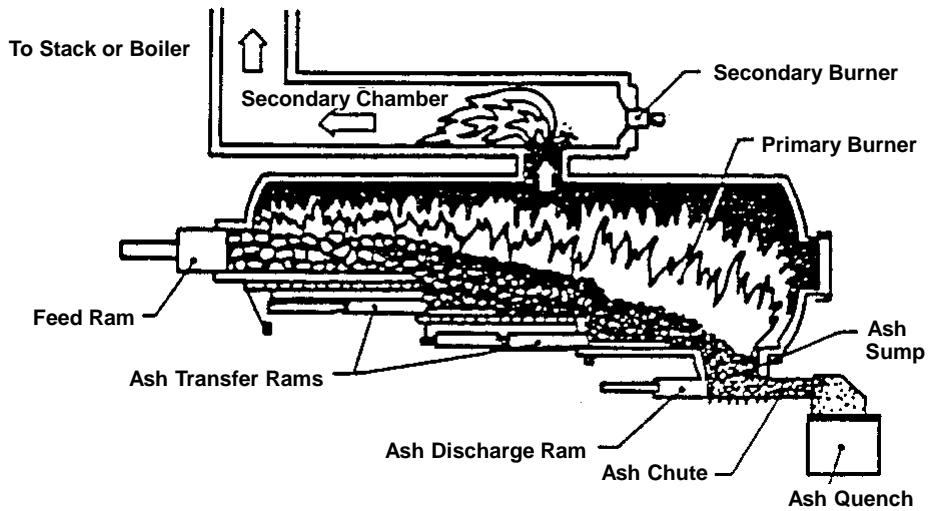


Single Chamber Incinerator

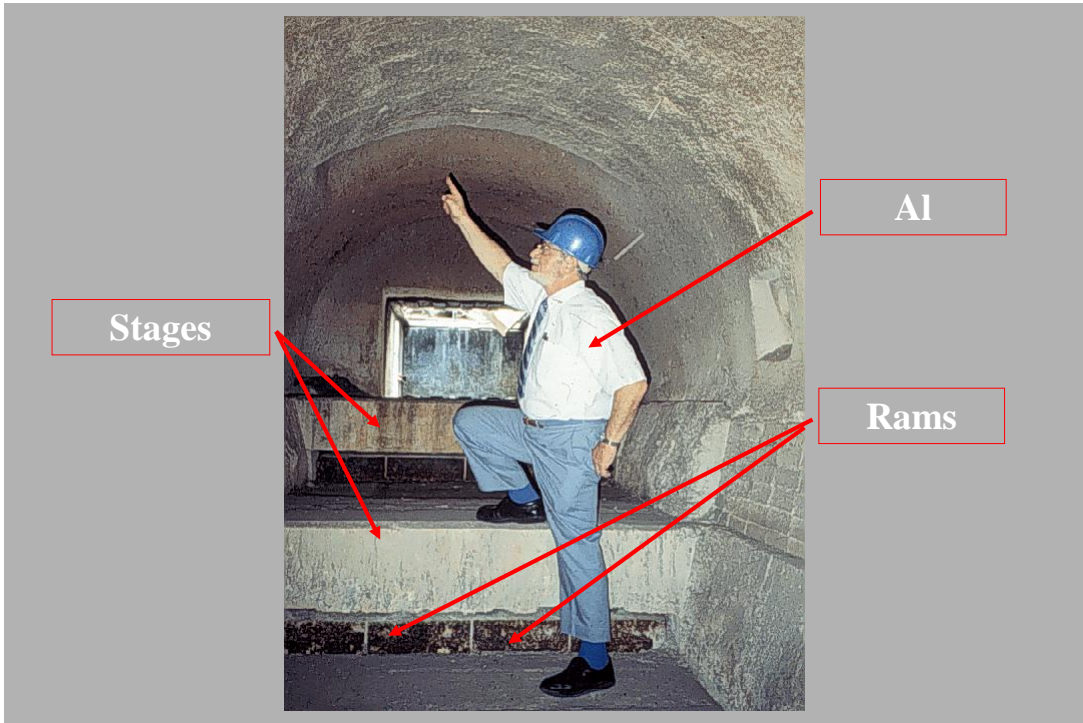
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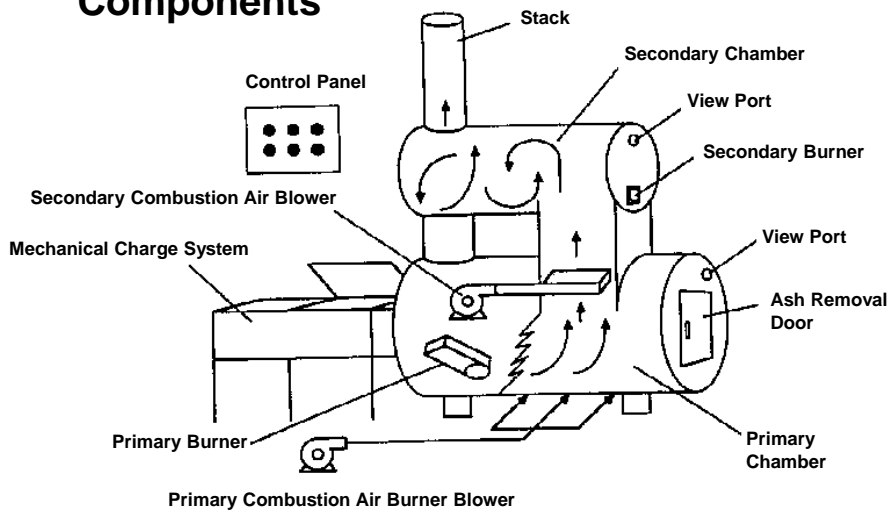
Controlled-Air Incinerator with Staged Hearth and Automatic Ash Removal



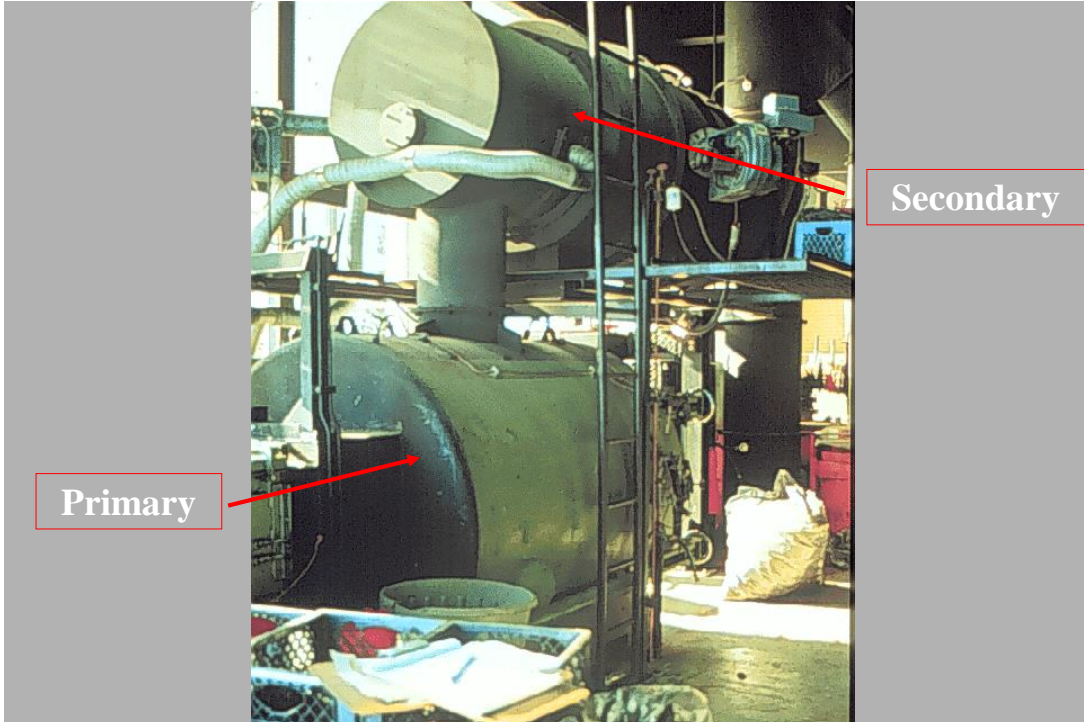
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Controlled Air Incinerator Components

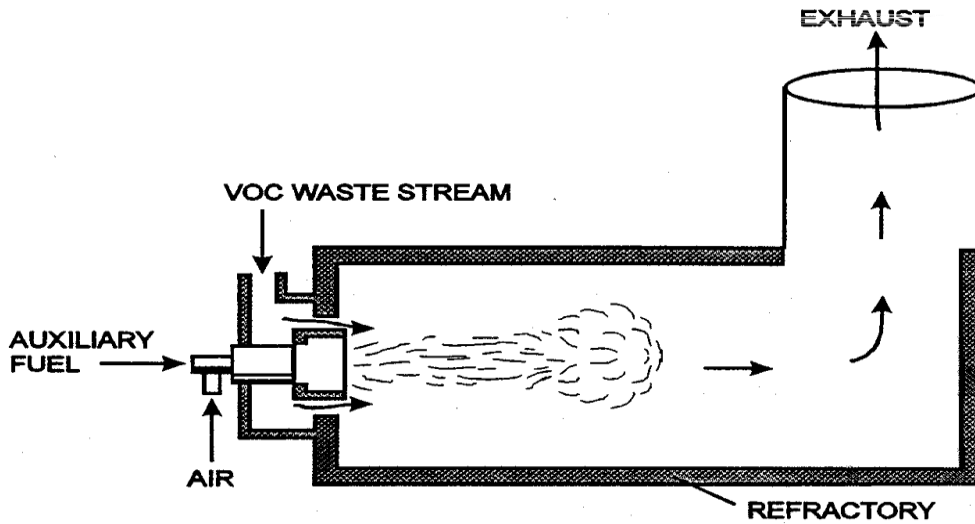


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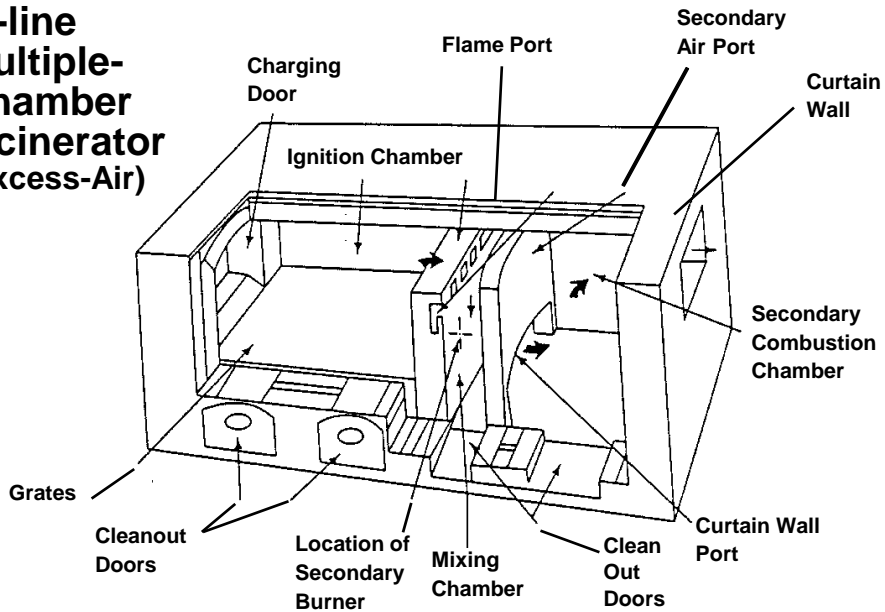


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AFTERBURNER

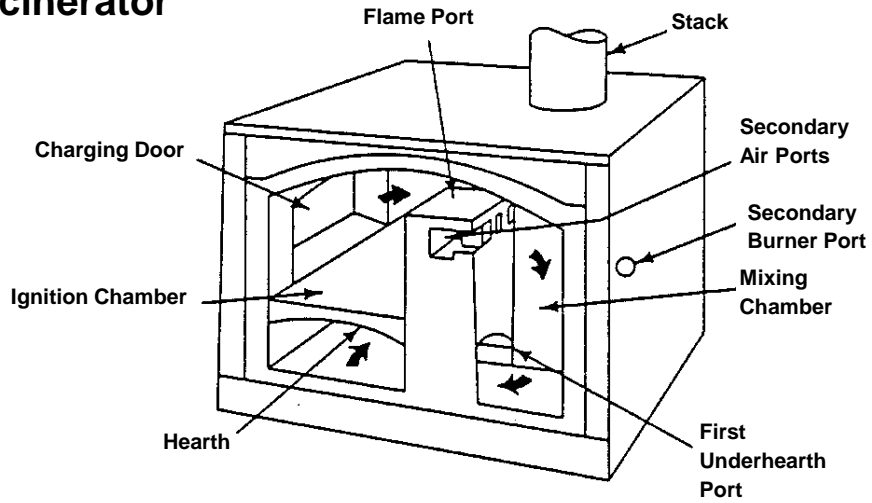


In-line Multiple-Chamber Incinerator (Excess-Air)

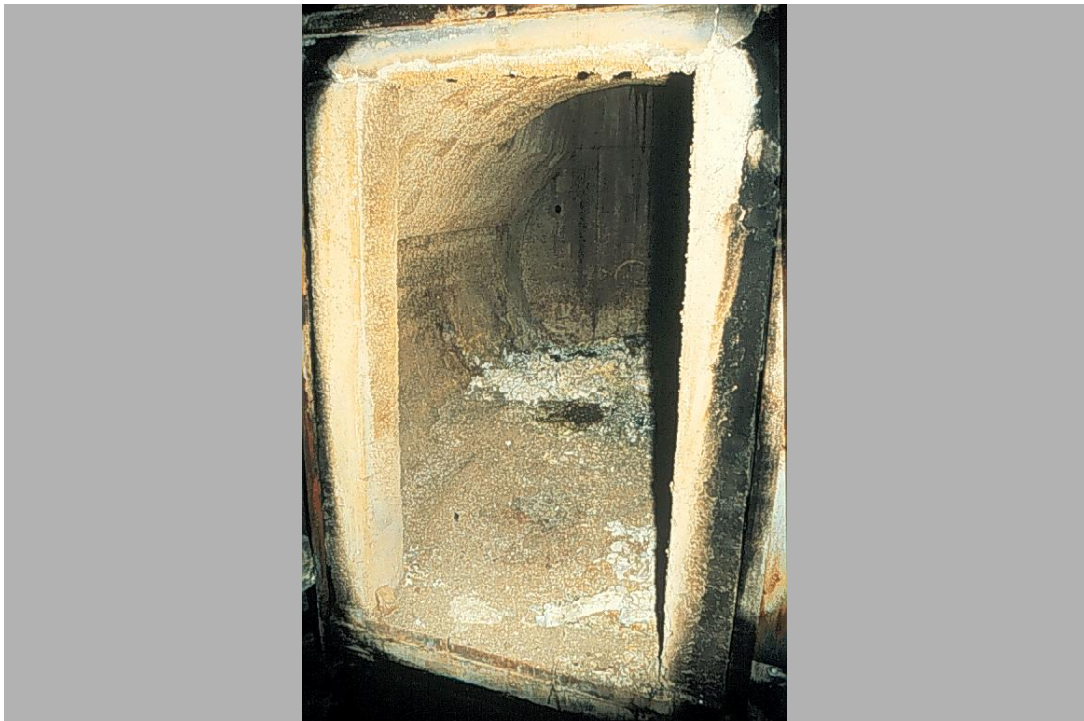
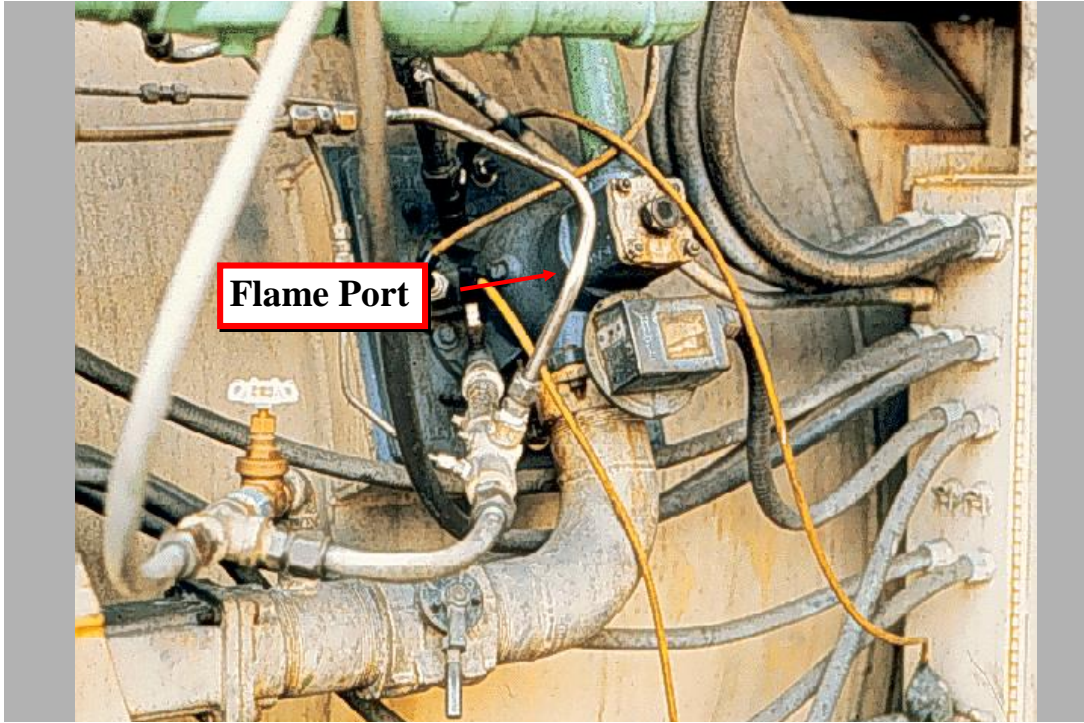


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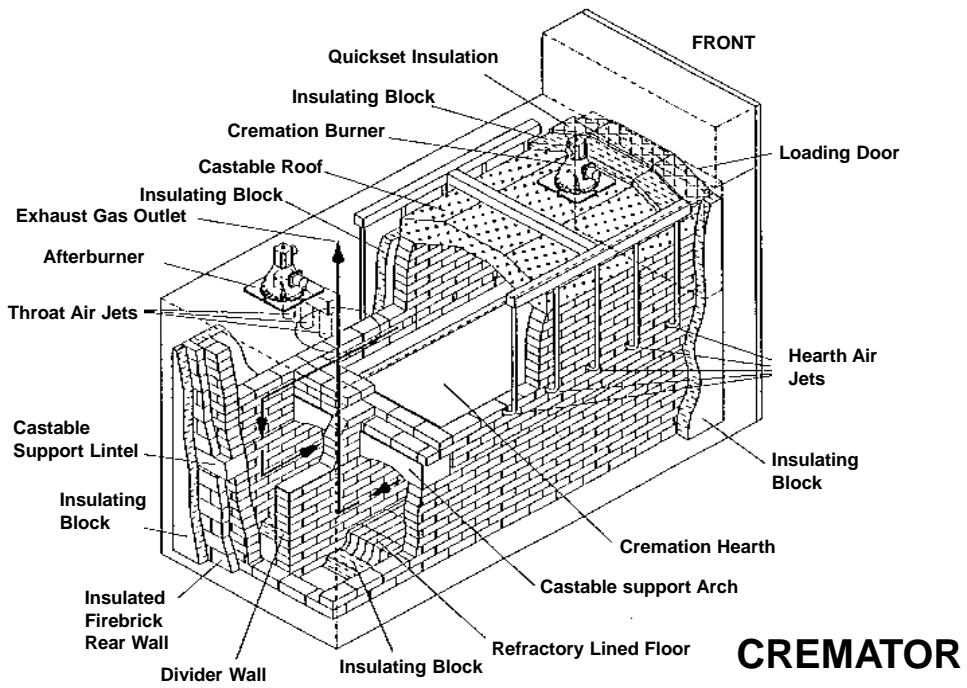
Retort Multiple Chamber Incinerator



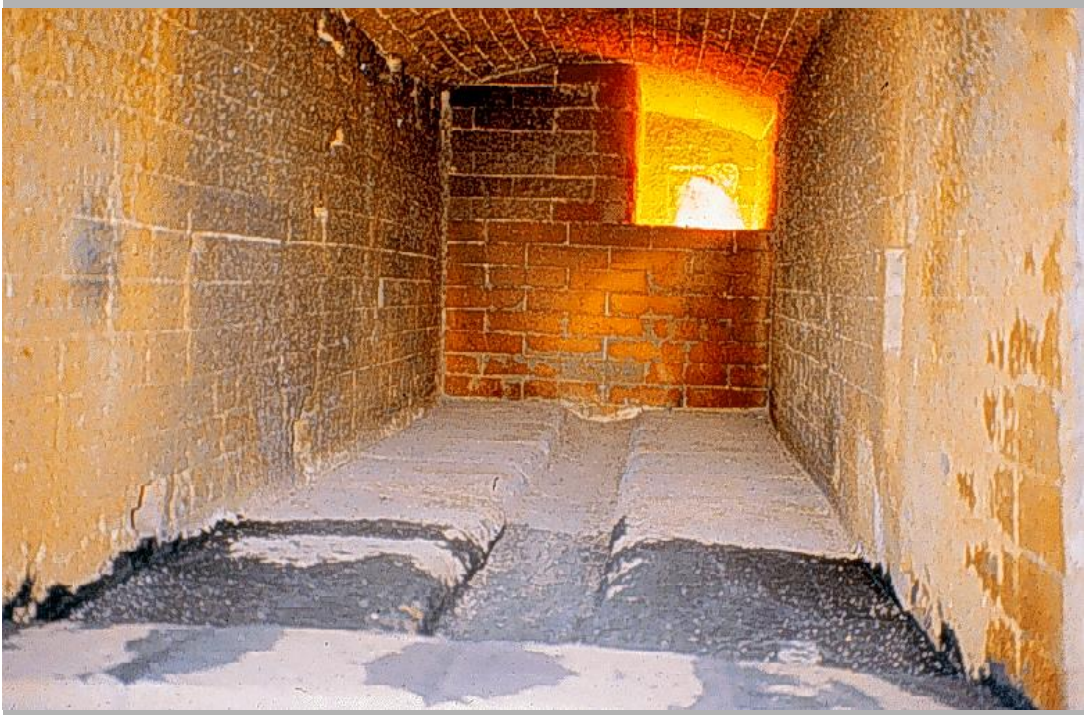
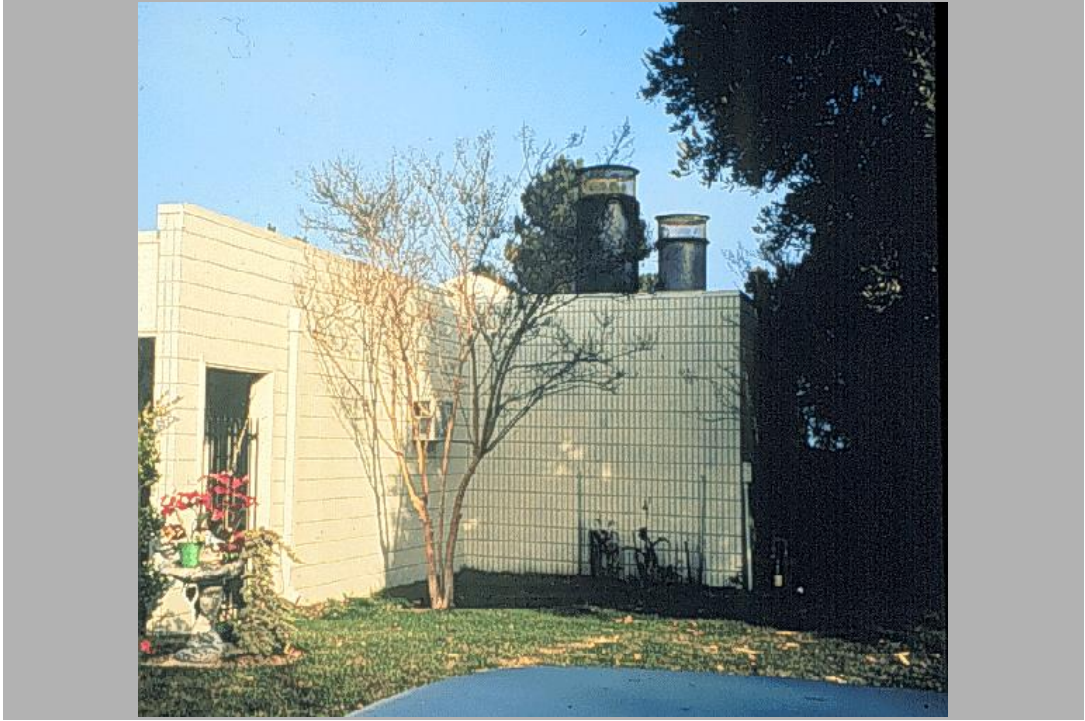
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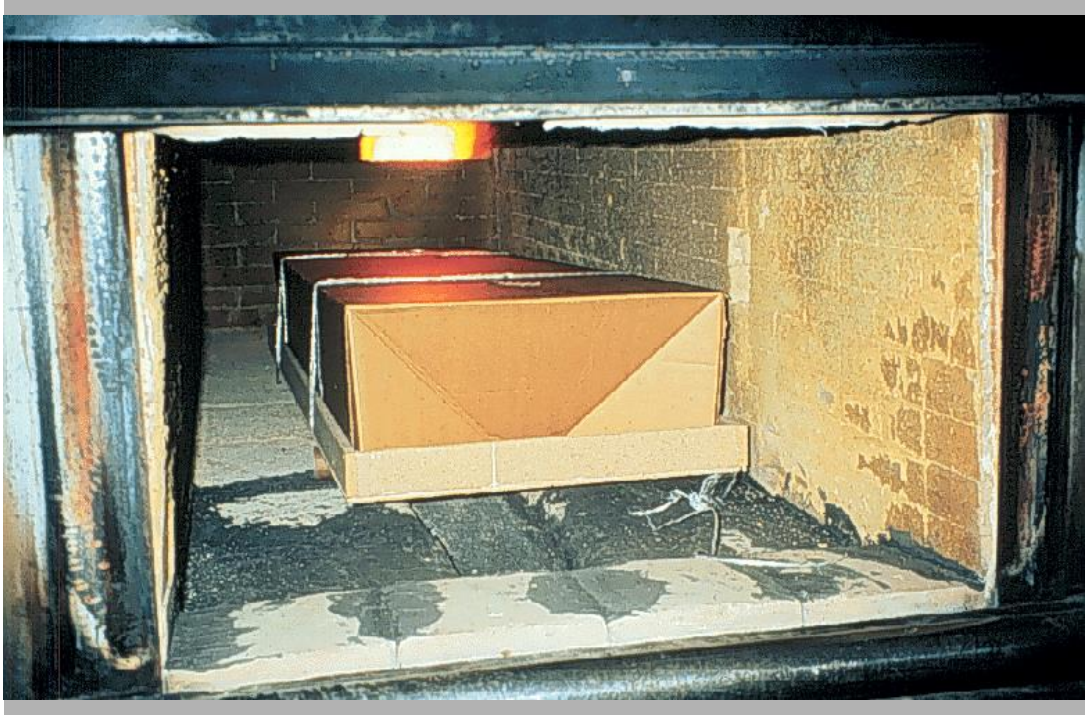
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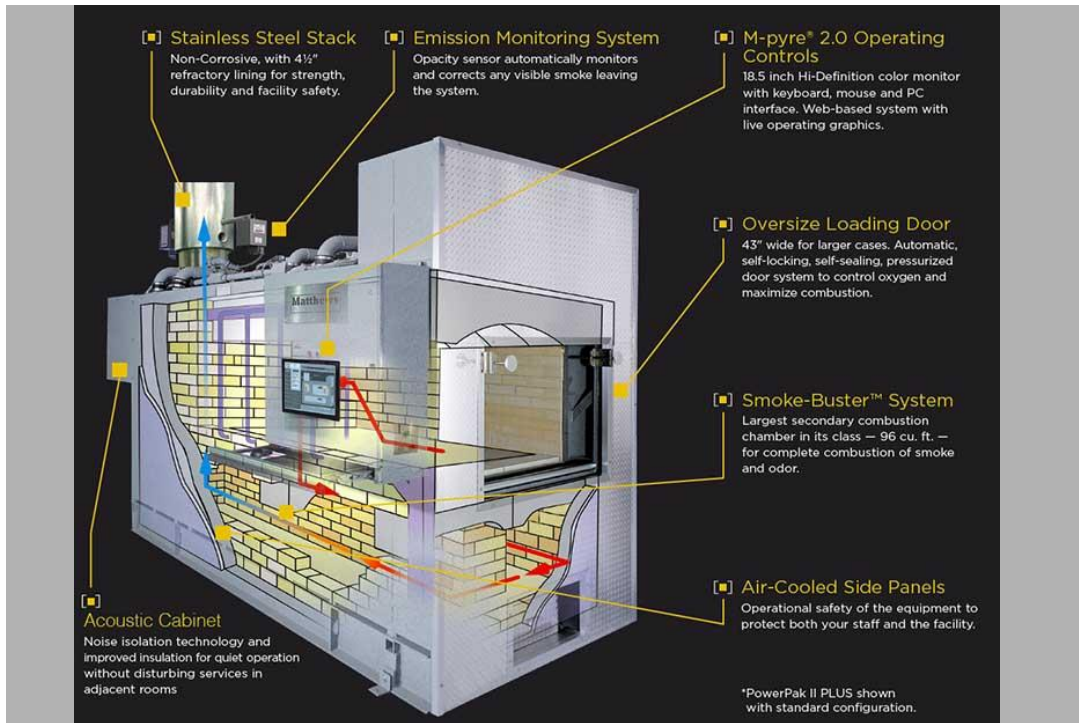
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Categories of Industrial Incinerators

- **Volume Reduction** (trash, wood, solid waste streams)
- **Toxicity Reduction** (any toxic waste stream)
- **Resource Recovery** (copper wire, steel drums, electric motors)
- **Energy Recovery**

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Industrial Heat Cleaning (Burnout) Ovens

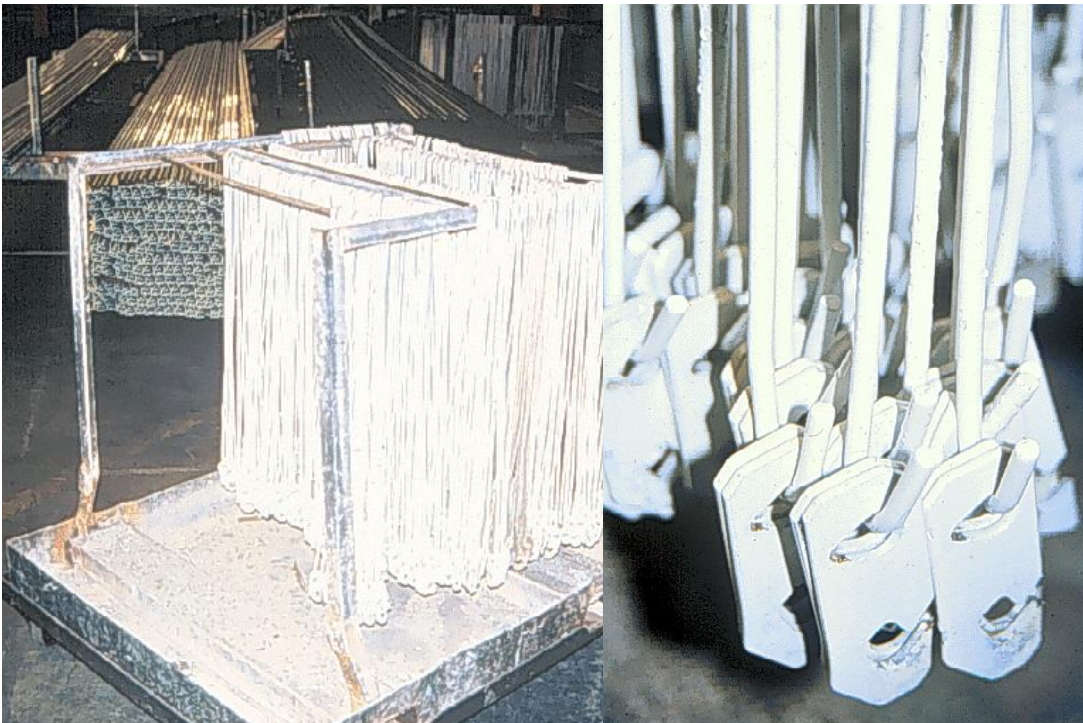
- **Primary Chamber 700 - 750 F**
- **Secondary Chamber 1200 -1400 F**
- **Roasting Condition in Primary**
- **Low Oxygen Environment**
- **Volatiles & Smoke go to Afterburner**
- **Water Mist Injection in Primary**



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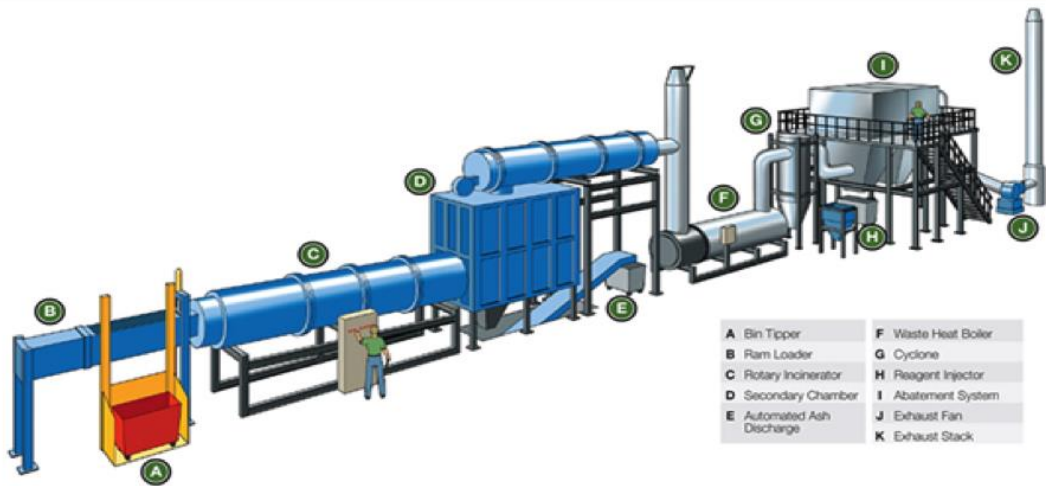
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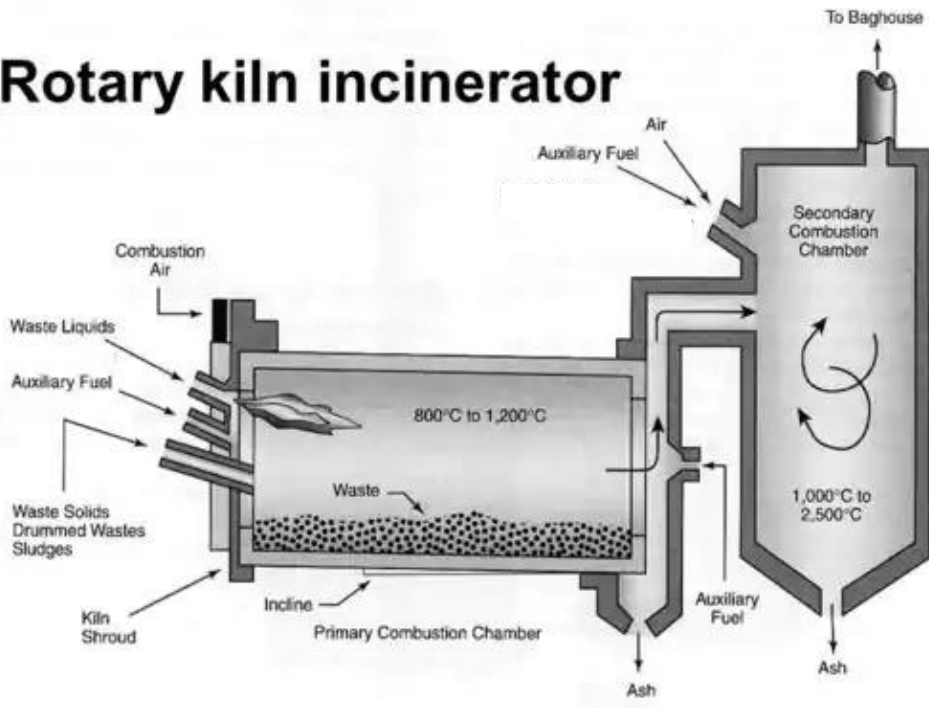
Rotary kiln



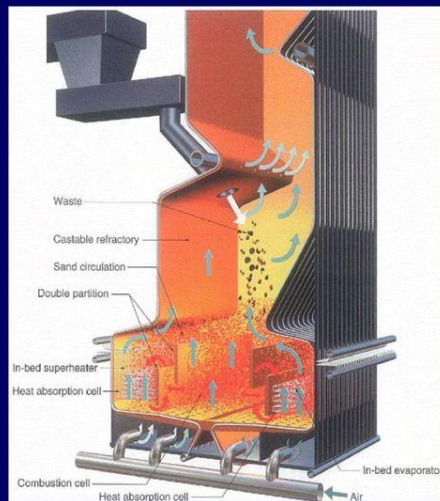
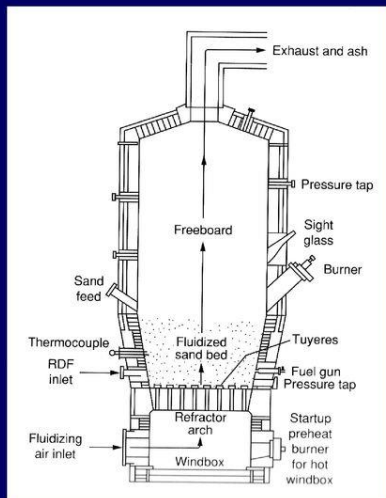
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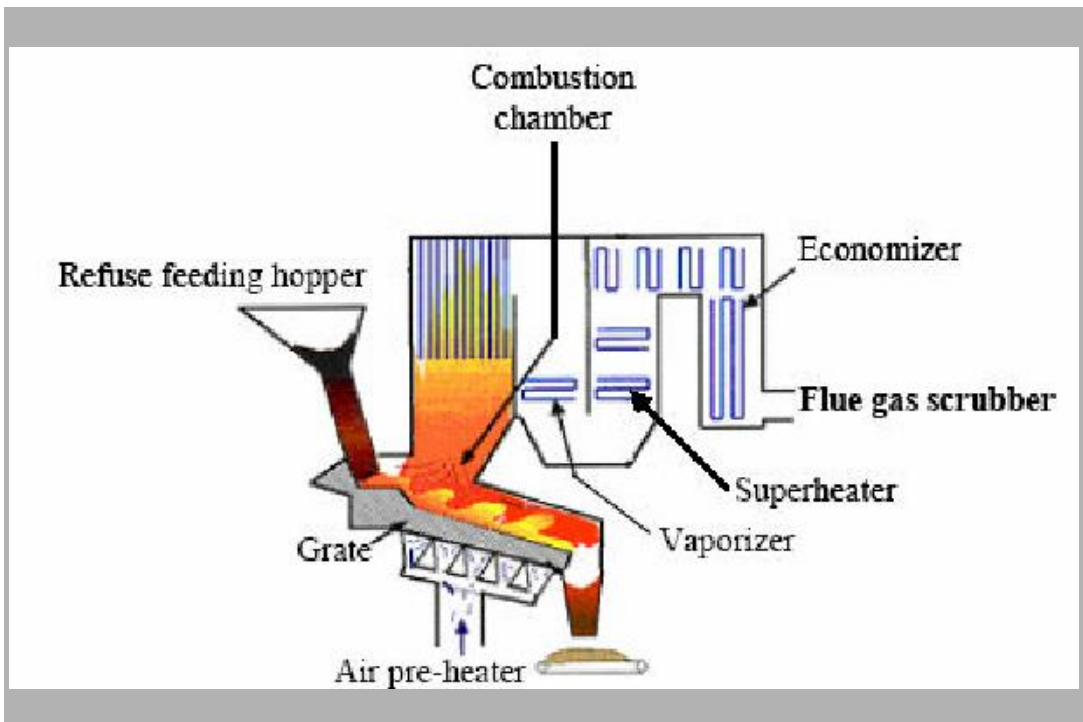
Rotary kiln incinerator



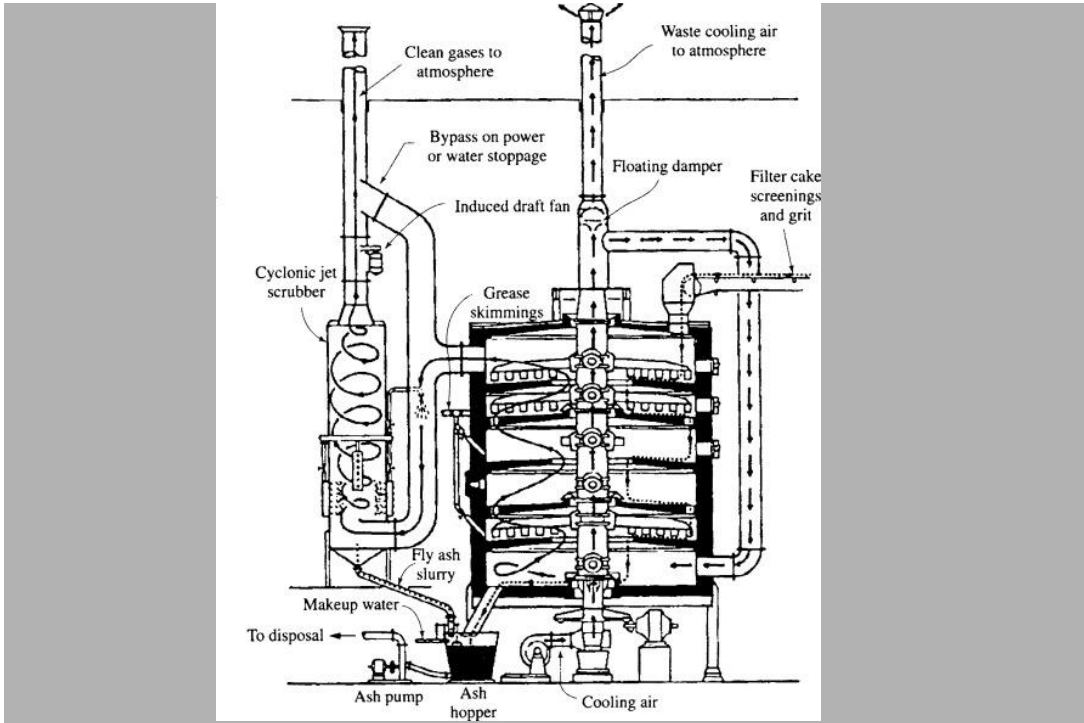
Fluidized bed combustion (FBC)



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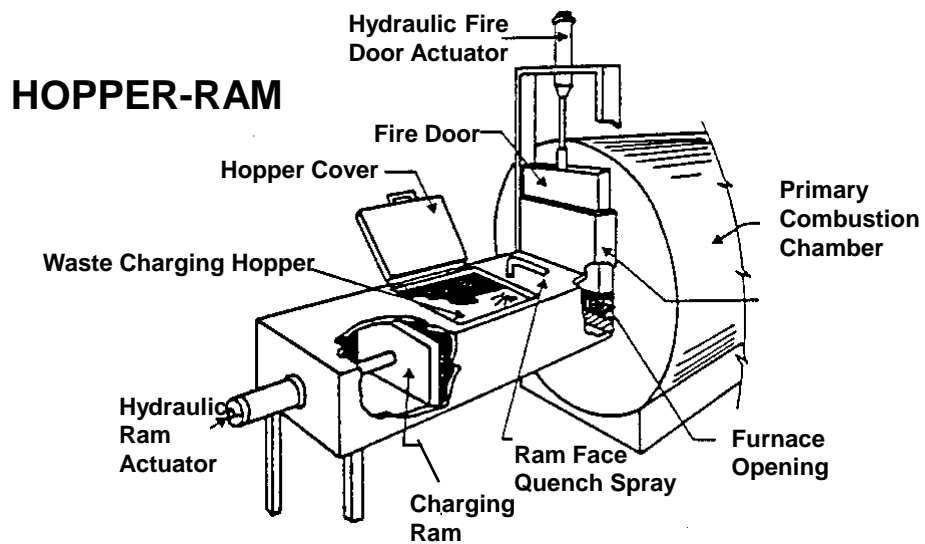
Modes of Operation

WASTE CHARGING:

- Batch
- Intermittent
- Continuous

ASH REMOVAL:

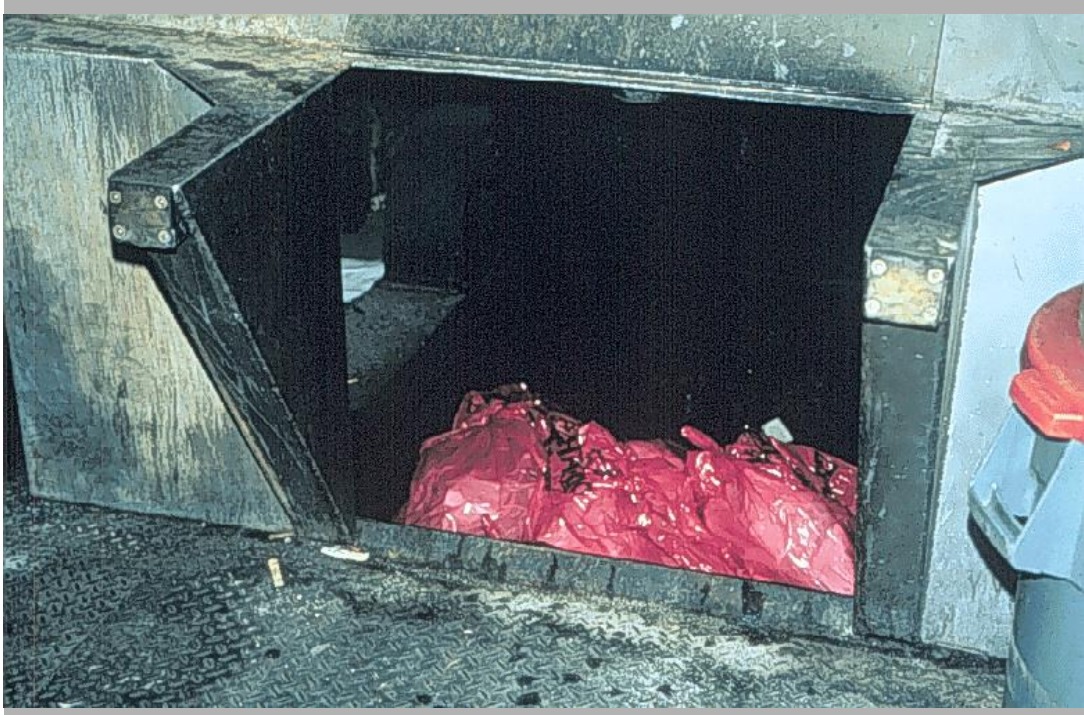
- Manual
- Automatic



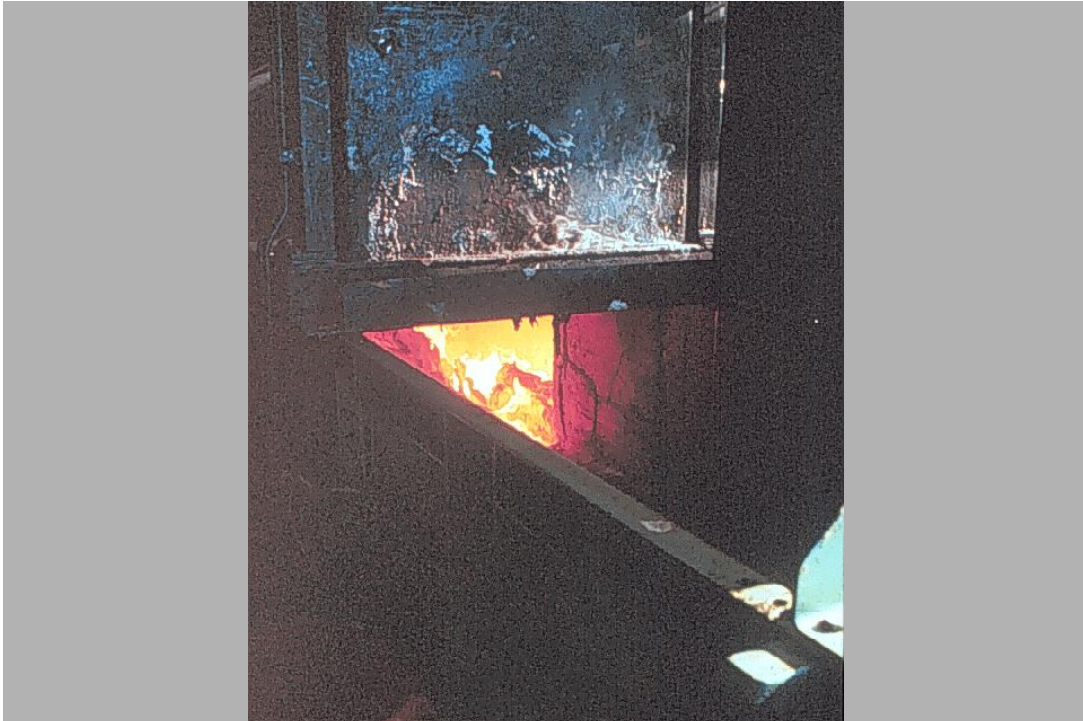
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Typical Incinerator Operating Procedures

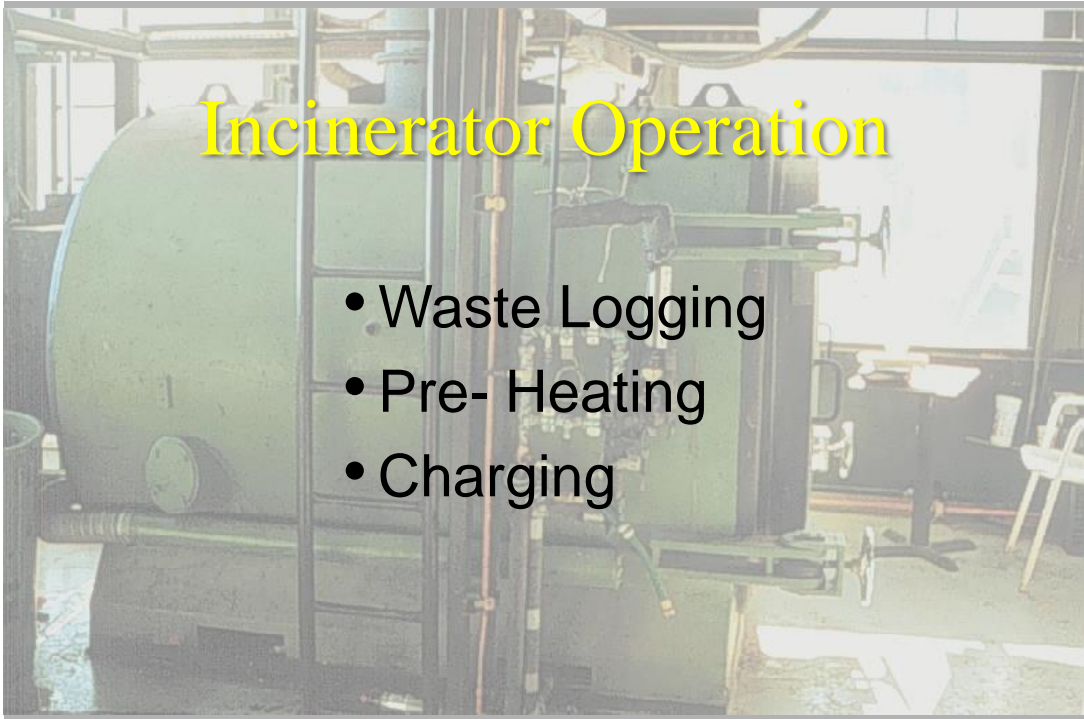
- Before Start-up
- Start-up
- Charging/Burning
- Burn Down
- Shutdown (batch & intermittent)

Before Incinerator Start-up

- Manual Ash Removal
- Automatic Ash Removal
- Routine Daily Inspection
- Burner & Blower Check

Typical Incinerator Operating Procedures

| Operating Step | Typical Duration |
|-----------------------|-------------------------|
| 1. Ash Cleanout | 15 to 30 minutes |
| 2. Pre-Heat | 15 to 60 minutes |
| 3. Charging & Burning | Up to 14 hours |
| 4. Burndown | 2 to 4 hours |
| 5. Cooldown | 5 to 8 hours |



- Waste Logging
- Pre- Heating
- Charging

Shutdown

- Batch or Intermittent Duty:
 - Combustion Blowers left on to cool
 - Typically lasts 5 to 8 hours
 - Ash removed and inspected

Typical Operational Errors

- **Charging before Operating Temps. Are Achieved (failure to Pre-heat)**
- **Overcharging**
- **Waste with Excessive Moisture**

BMWNC medical waste incinerator (smoke from stacks 2)
Matthews, North Carolina

Incinerator Emissions & Control



Emissions

- Visible Emissions (Stack or Fugitive)
- Particulate Matter (Concentration/Weight)
- Acid Gases (NO_x , SO_x , HCl)
- Toxics (Dioxins, Furans, Heavy Metals)

Pollutant Formation Factors

- Fuel Composition
- Charging Method and Rate
- Incinerator Type and Design
- Combustion Conditions (3 T's)
- Excess Air



Incinerator Emissions Control

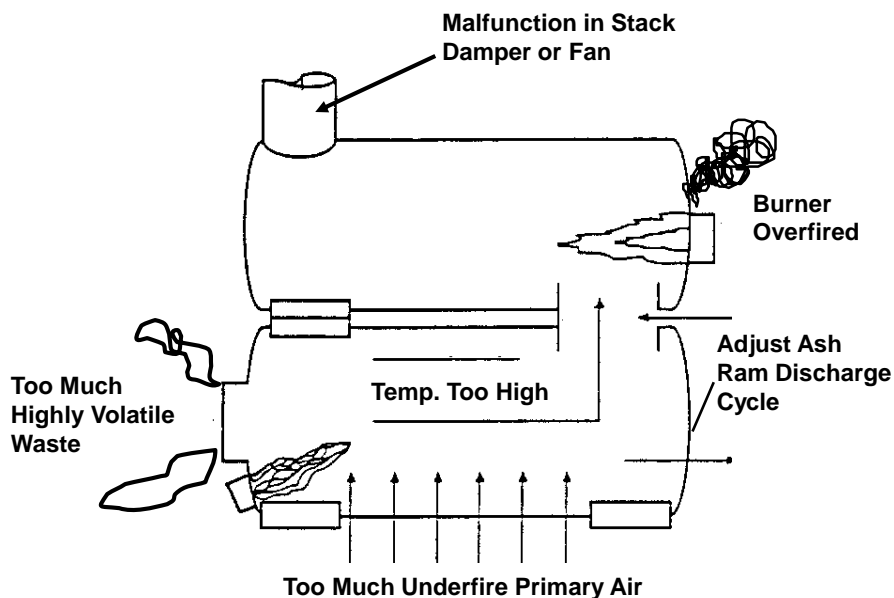
- **Source Separation**
- **Combustion Control**
- **Flue Gas Controls**
 - (APC equipment)

Particulate Matter Formation

- Suspension of Inorganic Substances
- Incomplete Combustion of Fuel Materials
- Condensation of Vaporous Metals

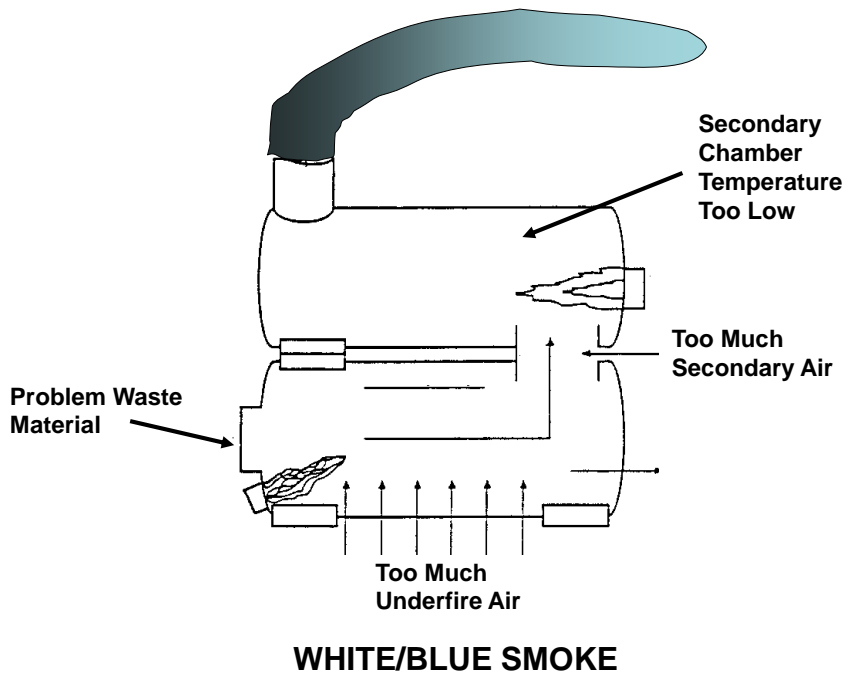
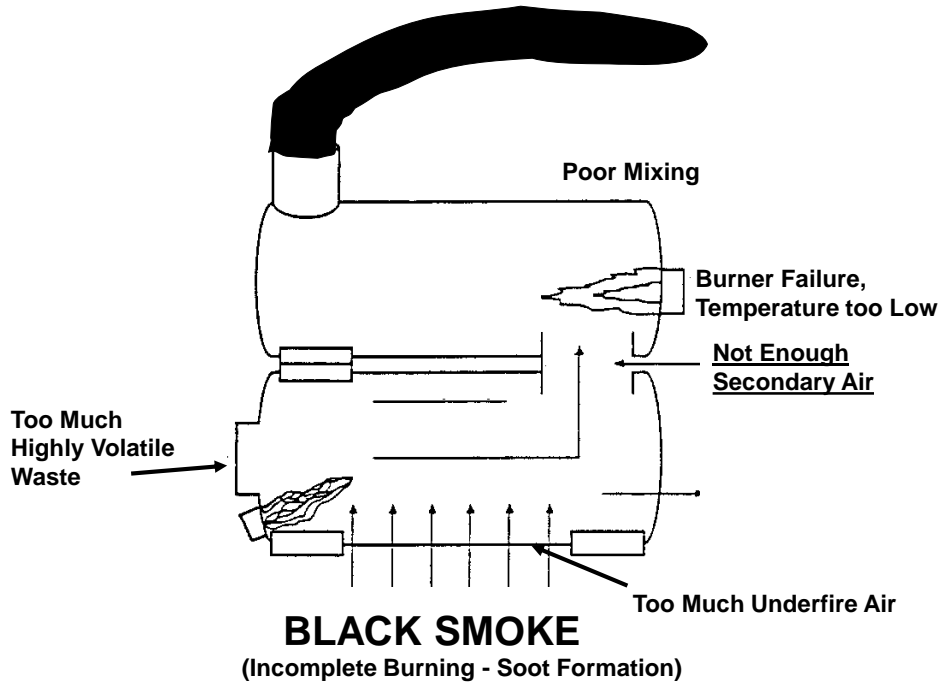
Smoke Formation

- Black Smoke
 - Too Little Oxygen Relative to Fuel
 - Usually Caused by Overcharging
- White Smoke
 - Premature Cooling of Flue Gas
 - Excessive Air
 - Inorganic Particles

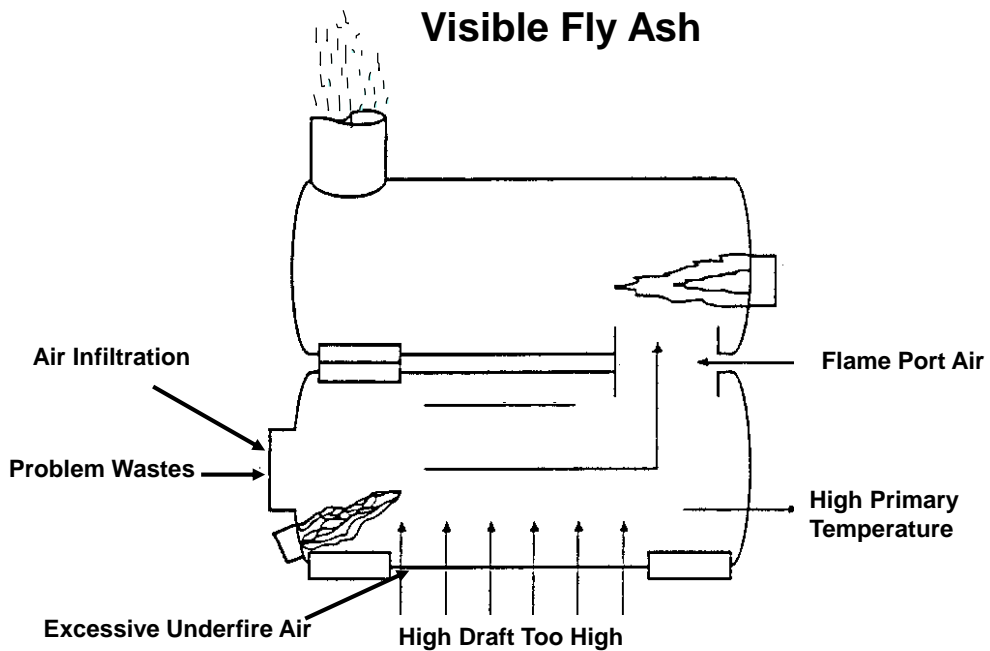


"POSITIVE" CONDITION - SMOKE LEAKING

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Carbon Monoxide Formation

- Insufficient Oxygen for Complete Combustion
- Indicator of Inadequate Combustion Air Turbulence
- Indicator of Combustion Efficiency

Products of Incomplete Combustion (PIC's)

- Greater Combustion Efficiency = Lower Dioxins
- Can occur when charging PVC plastics
- Dioxins are some of the most toxic man-made substances
- Polycyclic Aromatic Hydrocarbons (PAH's)
- Polychlorinated Biphenyls (PCB's)



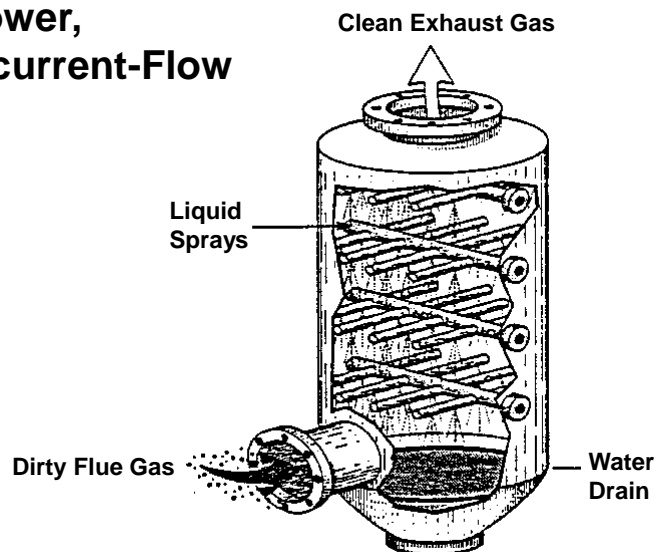
Wet Scrubbers

- Remove both Particulates & Acid Gases
- Rely on Flue Gas Pressure Drop for Particulate Removal with Alkali Reagent for Acid Gas Removal.
- Categories of scrubbers:
 - Spray Chambers
 - Packed Towers (Beds)
 - Venturi

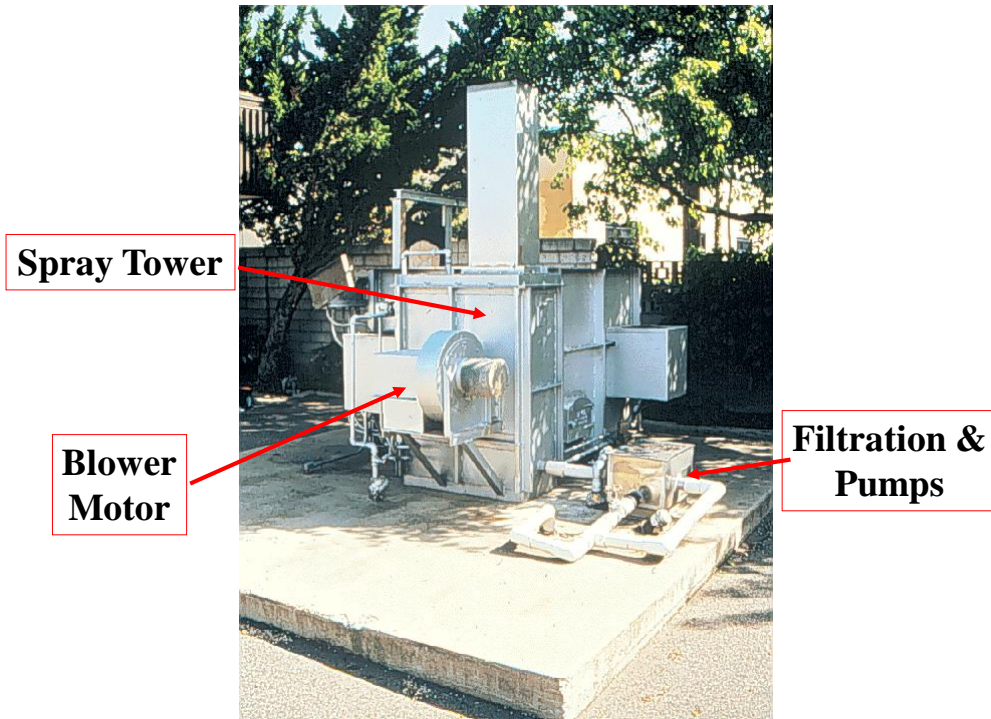
Wet Scrubber Acid Gas Removal

- Sodium Hydroxide (NaOH - Caustic Soda) or Sodium Carbonate (Na₂CO₃)
- Alkali Added to Re-circulation Tank Water (pH of 8-9).

Spray Tower, Countercurrent-Flow Type



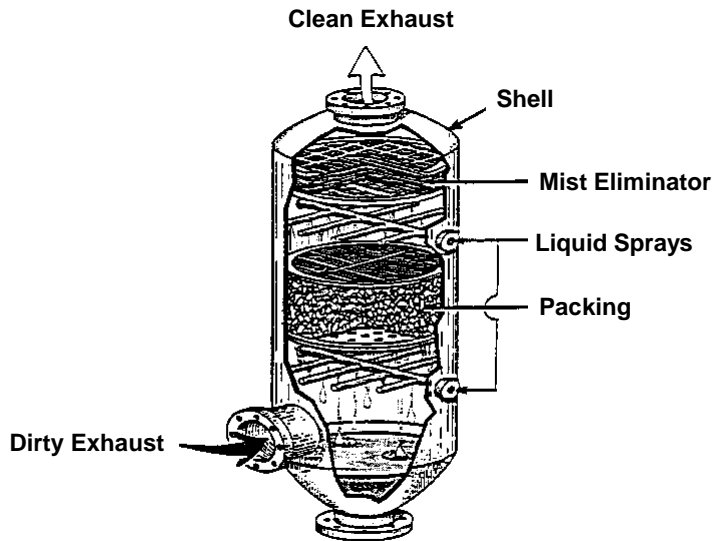
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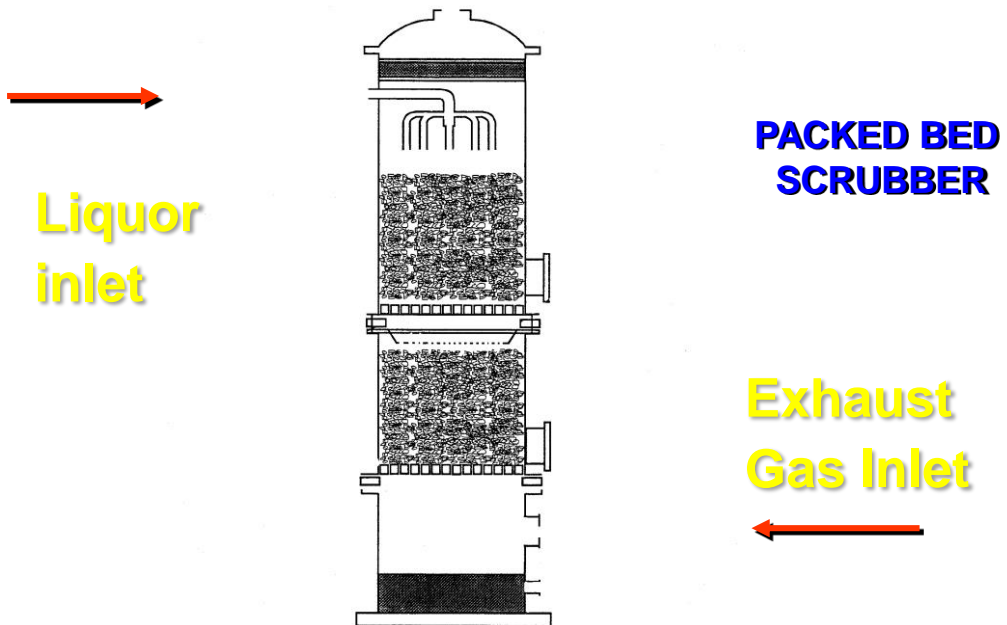
Common Spray Tower Scrubber Problems

- Liquor Spray Nozzles Plugged
- Erosion of Spray Nozzles
- Corrosion of Shell
- Mist Re-entrainment
- pH too low or high

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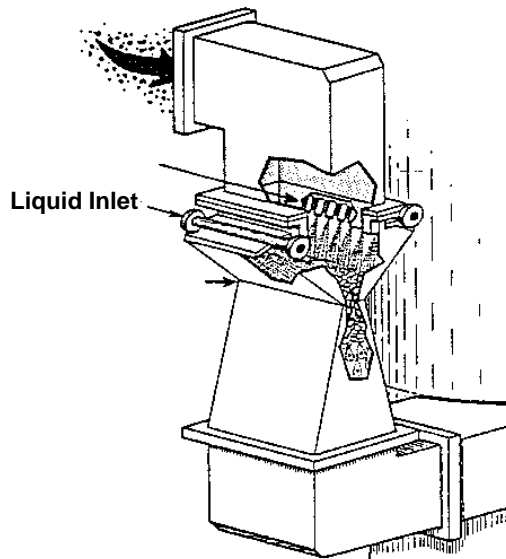


Countercurrent- Flow Packed-Bed Scrubber



Packed-Bed Operating Problems

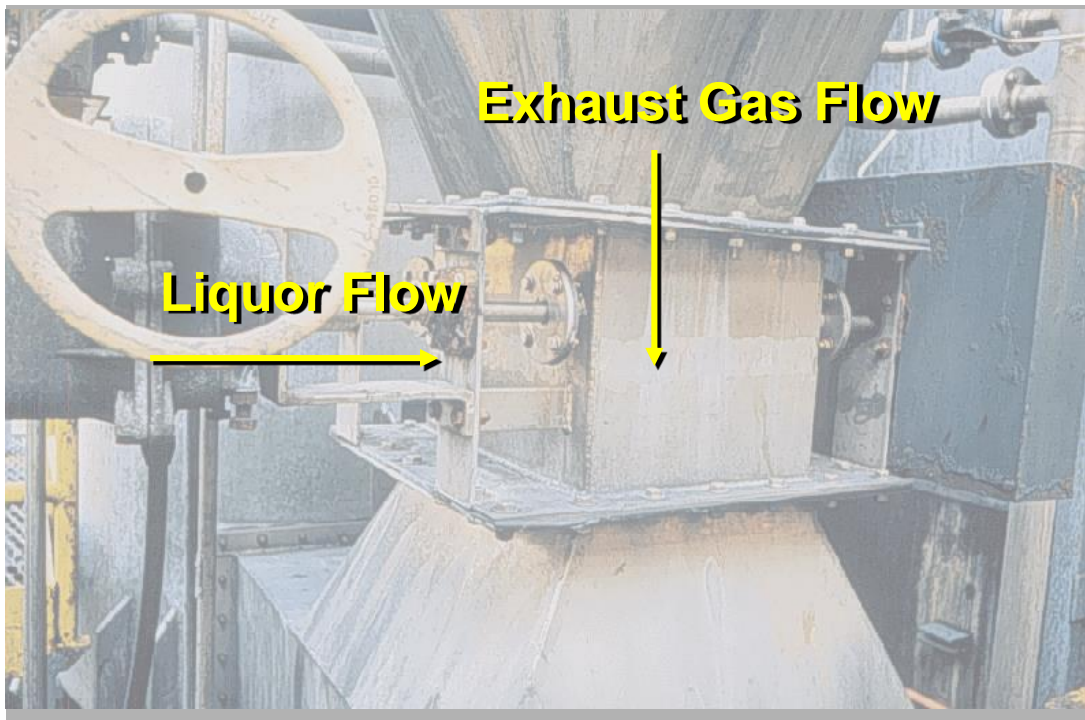
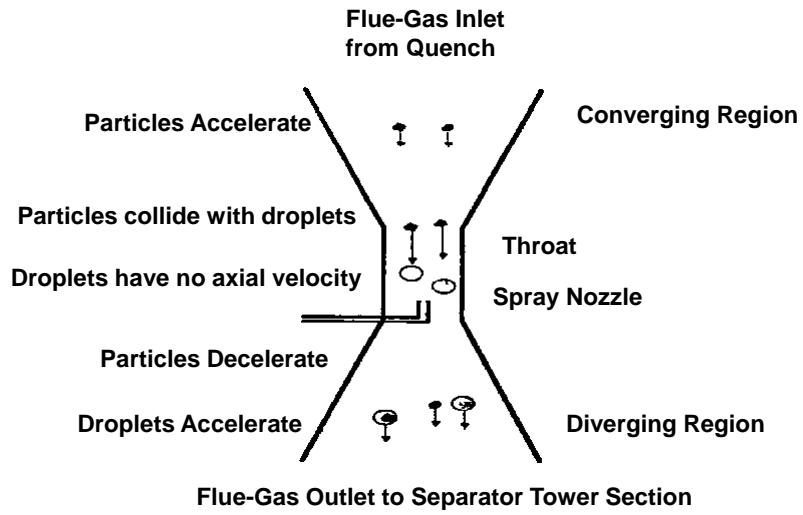
- Accumulation of Solids
- Settling of Packing Material
- Liquor pH (between 5.5-10)



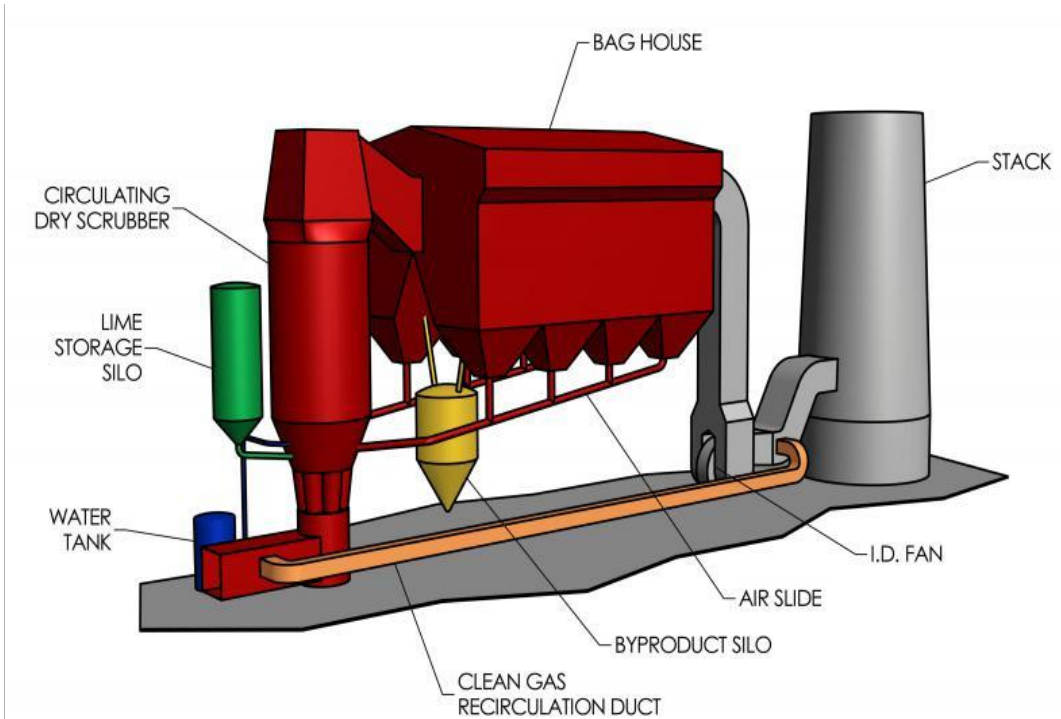
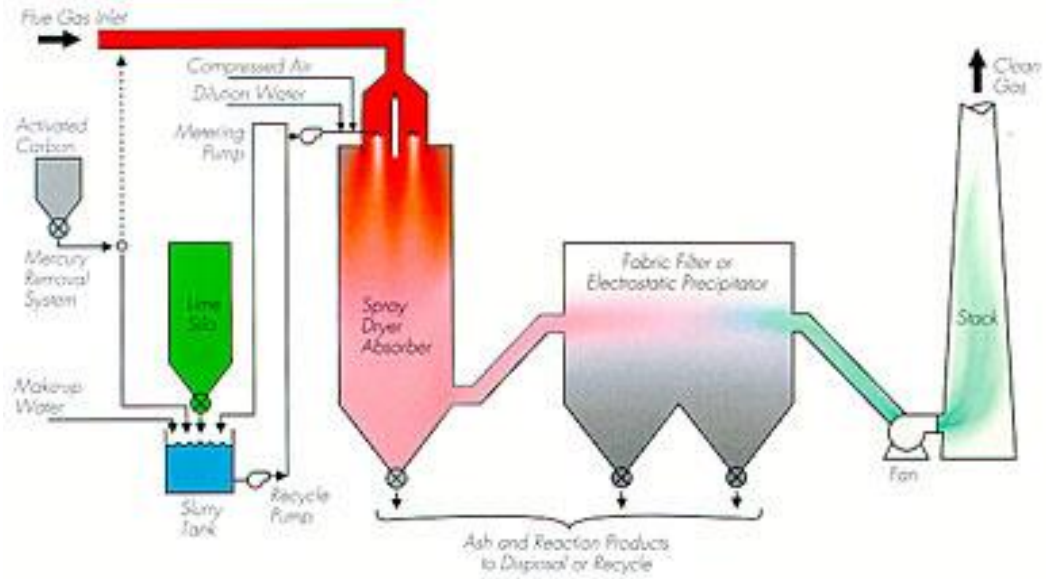
SPRAY VENTURI WITH RECTANGULAR THROAT

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Particle Behavior in Venturi-Scrubber Section

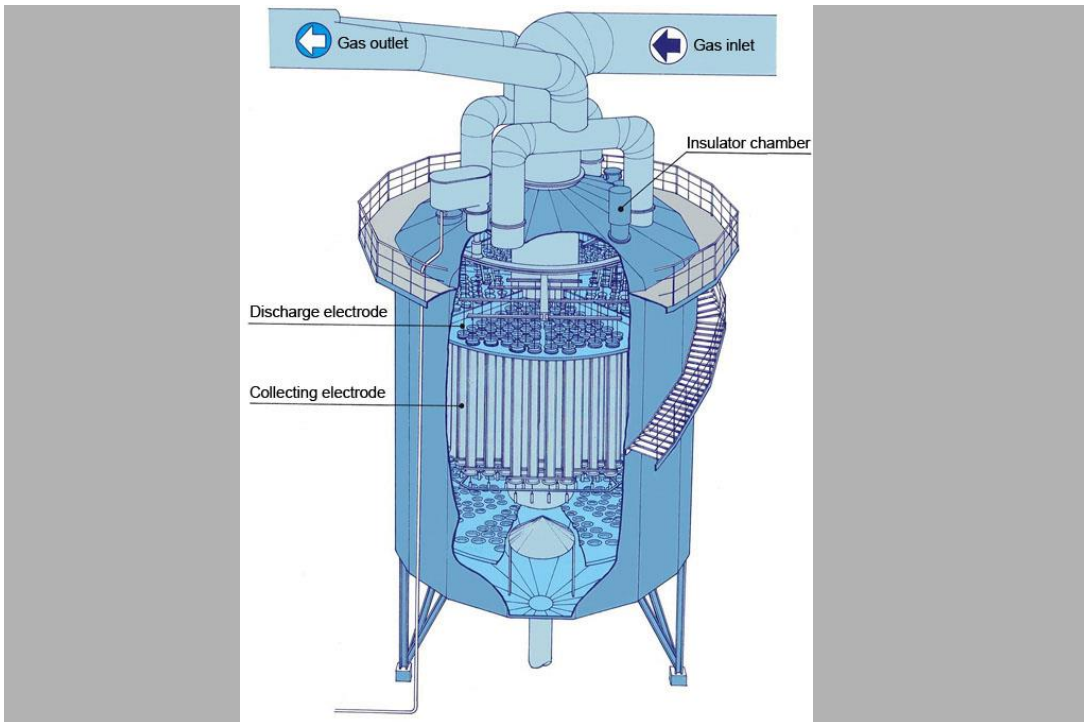
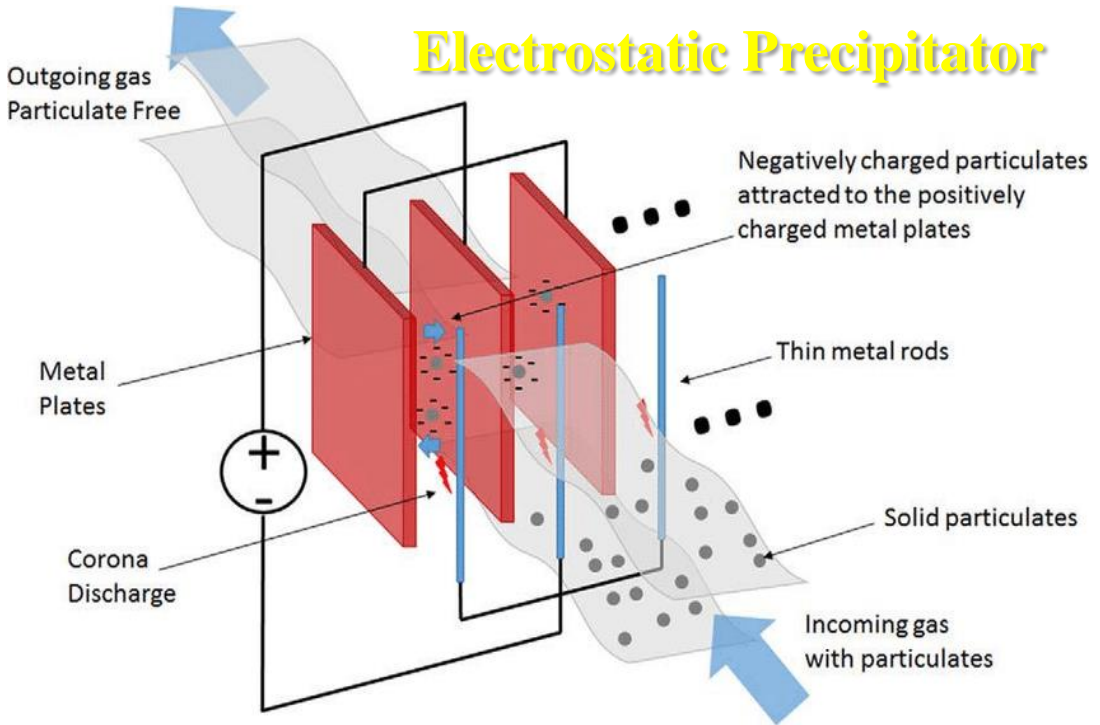


Dry Scrubber / Baghouse

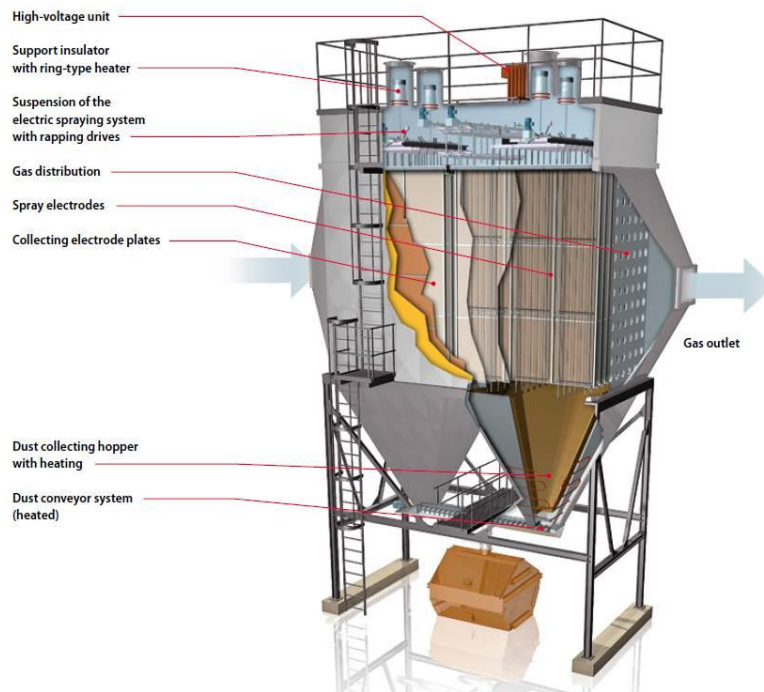


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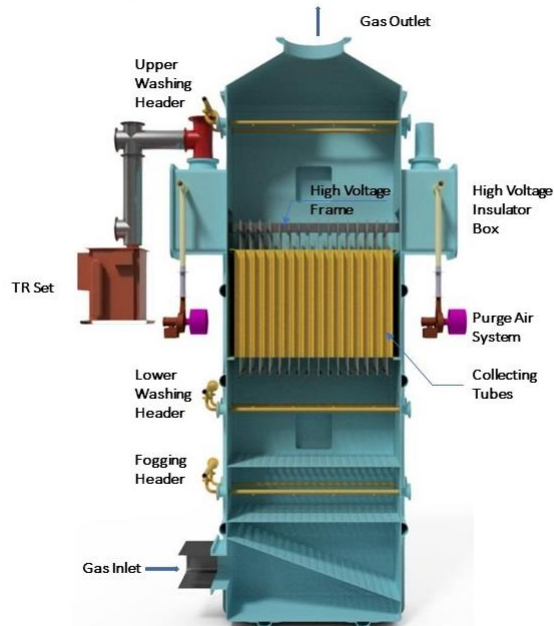
Electrostatic Precipitator



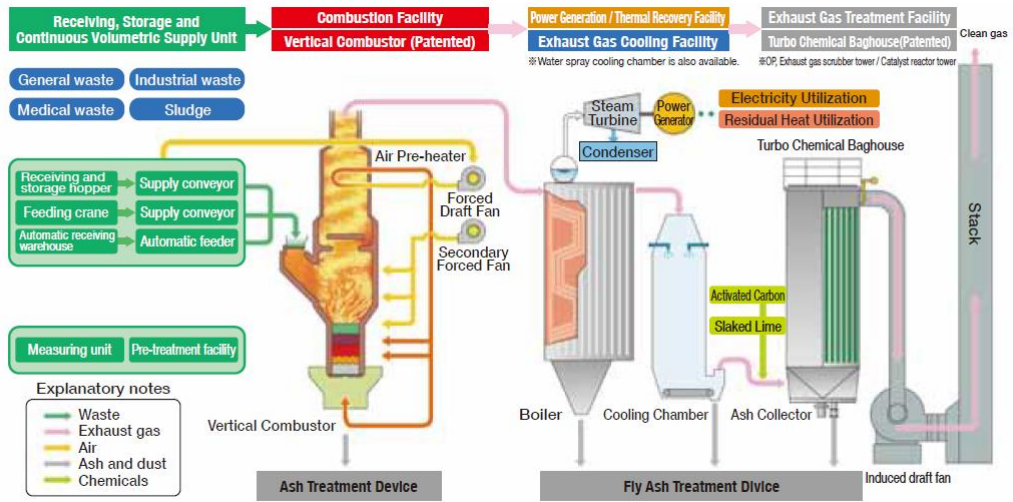
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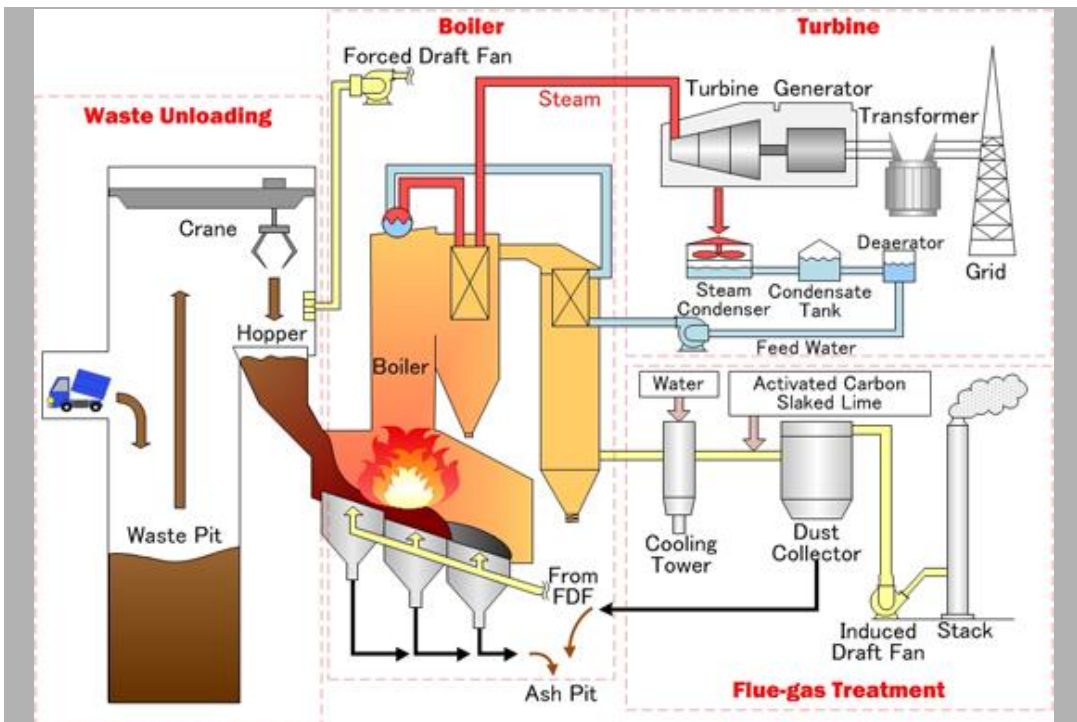
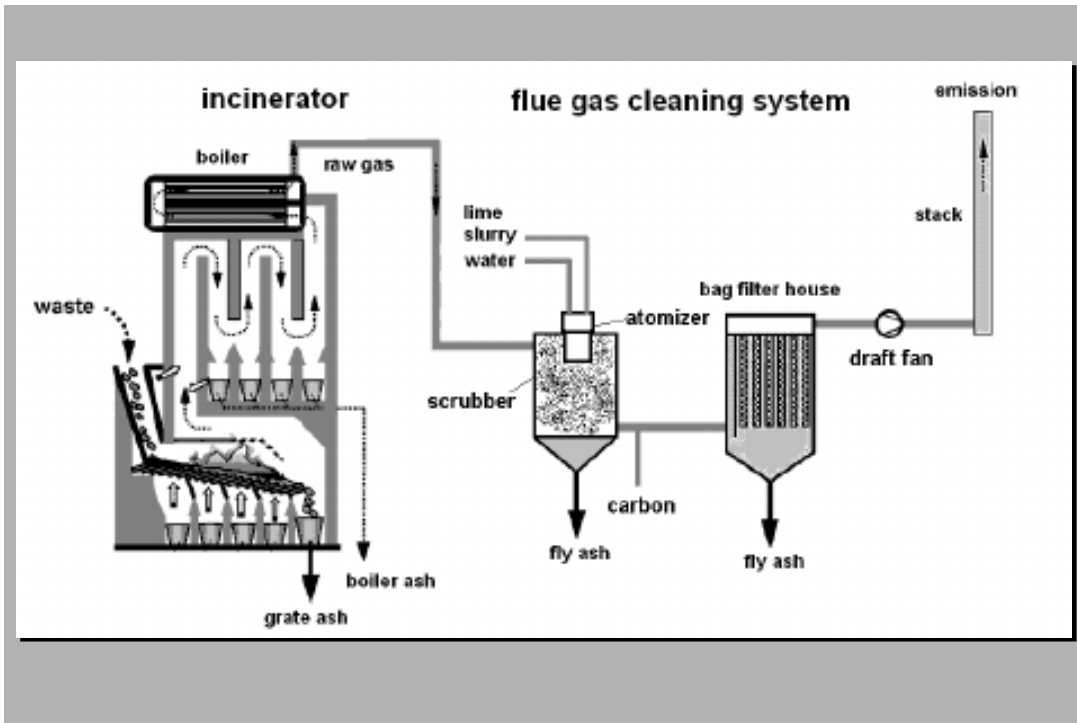
Tubular Electrostatic Precipitator



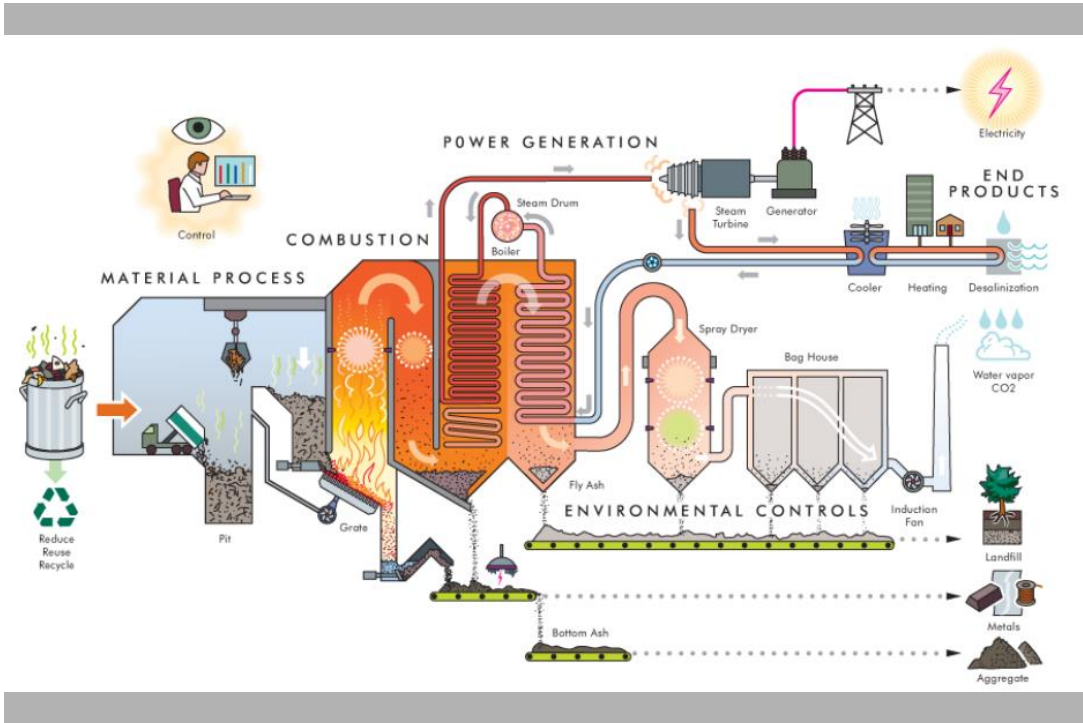
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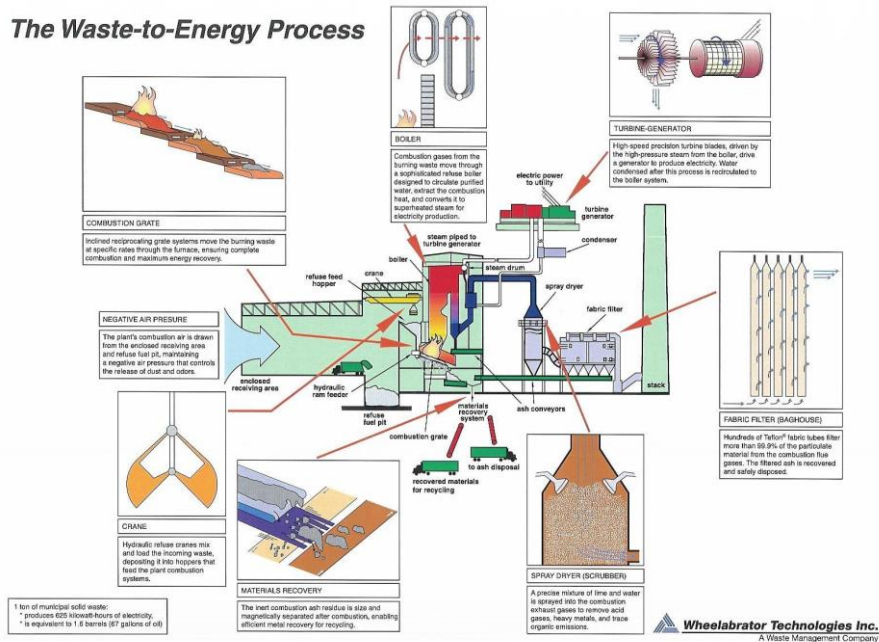
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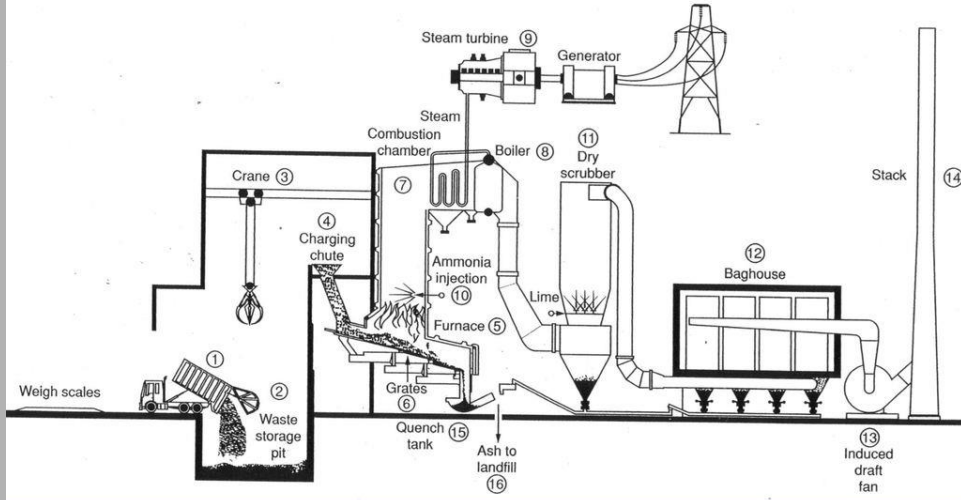


The Waste-to-Energy Process



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How incinerated?



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Regulations

State and Local Regulatory Requirements

- **General Air Emissions Limitations**
 - **Visible Emissions**
 - **Particulate Matter**
 - **Fugitive Dust**
 - **Gaseous Emissions**
 - **Toxic Emissions**
- **Public Nuisance (Odors, Noise)**

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State and Local Agency Incinerator Rules

- **Crematories**
 - **Human**
 - **Animal**
- **Burn Off Ovens**
- **Pathological waste, low-level radioactive waste, and/or chemotherapeutic waste**
- **Acceptable Incinerators**
- **Regulations more stringent than Federal Regs**

Federal Incinerator Rules

- **Large Municipal Waste Combustors**
- **Small Municipal Waste Combustors**
- **Other Solid Waste Incinerators**
- **Hospital, Medical, Infectious Waste Incinerators**
- **Sewage Sludge Incinerators**
- **Commercial Industrial Solid Waste Incinerators**
- **Hazardous Waste Incinerators**

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Large Municipal Waste Combustors

- **40 CFR 60 Subpart E - Construct after 8/17/71**
- **40 CFR 60 Subpart Ea – Construct 12/20/89 to 9/20/94**
- **40 CFR Subpart Eb - Construct after 9/20/94, Mod or Recon after 6/19/96**
- **40 CFR 60 Subpart Cb – EG - Existing on or before 9/20/94**
- **40 CFR 62 Subpart FFF – FP - Existing on or before 9/20/94**

Subpart Eb

- **> 250 tpd MSW**
- **Siting requirements and Materials separation plan**
- **Operator training and certification**
- **Emission limits for PM, Cd, Pb, Hg, SO₂, HCl, Dioxin/Furan, NO_x, CO, Opacity, Fugitive ash**
- **CEMs – O₂ or CO₂, COM, SO₂, NO_x, CO**
- **Initial testing for all contaminants with limits**
- **Annual testing for PM, Hg, Cd, Pb, HCl, D/F (or CEMS)**
- **Monitoring, recordkeeping and reporting**
- **Limits for air curtain incinerators burning yard waste**

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Small Municipal Waste Combustors

- **40 CFR 60 Subpart AAAA - Construct after 8/30/99, Mod or Recon after 6/6/01**
- **40 CFR 60 Subpart BBBB – EG - Existing on or before 8/30/99**
- **40 CFR 62 Subpart JJJ – FP - Existing on or before 8/30/99**

Subpart AAAA

- **35-250 tpd MSW**
- **Siting requirements and Materials separation plan**
- **Operator training and certification**
- **Good combustion practices**
- **Emission limits for PM, Cd, Pb, Hg, SO₂, HCl, Dioxin/Furan, NO_x, CO, Opacity, Fugitive ash**
- **CEMs – O₂ or CO₂, COM, SO₂, CO, NO_x for Class 1**
- **Initial and Annual testing for PM, Hg, Cd, Pb, HCl, D/F**
- **Class 2 may have less annual testing**
- **Monitoring, recordkeeping and reporting**
- **Limits for air curtain incinerators burning yard waste**

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Other Solid Waste Incinerators

- **40 CFR 60 Subpart EEEE - Construct after 12/9/04, Mod or Recon after 6/16/06**
- **40 CFR 60 Subpart FFFF – EG - Existing on or before 12/9/04**

Subpart EEEE

- **<35 tpd MSW and Institutional units**
- **Siting requirements and waste management plan**
- **Operator training and qualification**
- **Good combustion practices**
- **Emission limits for PM, Cd, Pb, Hg, SO₂, HCl, Dioxin/Furan, NO_x, CO, Opacity**
- **CEMs – O₂, CO**
- **Initial and Annual testing for all pollutants**
- **Less frequent than annual testing may be allowed**
- **Monitoring, recordkeeping and reporting**
- **Limits for air curtain incinerators**

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Hospital, Medical, and Infectious Waste Incinerators

- **40 CFR 60 Subpart Ec - Construct after 6/20/96 to 12/1/08, Mod after 3/16/98 to 4/6/10, Construct after 12/1/08, Mod after 4/6/10**
- **40 CFR 60 Subpart Ce – EG – Construct on or before 6/20/96, Mod on or before 3/16/98, Construct after 6/20/96 to 12/1/08, Mod after 3/16/98 to 4/6/10**
- **40 CFR 62 HHH - FP**

Subpart Ec

- **Siting requirements and waste management plan**
- **Operator training and qualification**
- **Emission limits for PM, Cd, Pb, Hg, SO₂, HCl, Dioxin/Furan, NO_x, CO, Opacity, Fugitive ash**
- **Various emission limits for different dates and size of units**
- **CEMs – CO**
- **Initial and Annual testing for all pollutants (or CEMs)**
- **Monitoring, recordkeeping and reporting**

Sewage Sludge Incinerators

- **40 CFR 60 Subpart O - Construct after 6/11/73**
- **40 CFR 60 Subpart LLLL – Construct after 10/14/10, Mod after 9/21/11**
- **40 CFR 60 Subpart MMMM – EG – Construct before 10/14/10**
- **40 CFR 62 LLL – FP - Construct before 10/14/10**

Subpart LLLL

- **Siting requirements**
- **Operator training and qualification**
- **Emission limits for PM, Cd, Pb, Hg, SO₂, HCl, Dioxin/Furan, NO_x, CO, Fugitive ash**
- **Various emission limits for different dates and size of units**
- **CEMs – CO**
- **Initial and Annual testing for all pollutants (or CEMs)**
- **Monitoring, recordkeeping and reporting**

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Commercial and Industrial Solid Waste Incinerators

- **40 CFR 60 Subpart CCCC - Construct after 6/4/10, Mod or Recon after 8/7/13**
- **40 CFR 60 Subpart DDDD – EG – Construct on or before 11/30/99 and not modified or reconstructed after 6/1/01, Construct after 11/30/99 but no later than 6/4/10 or commenced modification or reconstruction after 6/1/01 but no later than 8/7/13, Construct on or before 6/4/10 or commenced modification or reconstruction after 6/4/10 but no later than 8/7/13**
- **40 CFR 62 III – FP - Construct before 11/30/99**

Subpart CCCC

- **Incinerate solid waste as defined in 40 CFR Part 241**
- **Siting requirements and Waste management plan**
- **Operator training and qualification**
- **Emission limits for PM, Cd, Pb, Hg, SO₂, HCl, Dioxin/Furan, NO_x, CO, Fugitive ash**
- **Various emission limits based on dates of construction, mod or recon and type of unit**
- **CEMs – required based on unit type, other monitors required based on APC type**
- **Initial and Annual testing for all pollutants (or CEMs)**
- **Monitoring, recordkeeping and reporting**
- **Air curtain incinerator requirements**

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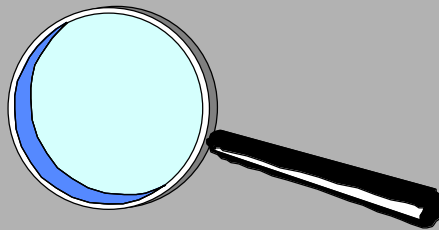
Hazardous Waste Incinerators

- **40 CFR 63 Subpart EEE**

Subpart EEE

- **HWI, Cement kilns, Lightweight Aggregate kilns, some boilers**
- **Operator training and qualification**
- **Emission limits for PM, Cd, Pb, Hg, HCl, Dioxin/Furan, CO, As, Be, Cr, hydrocarbons, Cl gas**
- **DRE 99.99%. But 99.9999% for dioxin listed hazardous waste**
- **CEMs – Hydrocarbon, COM, PM**
- **Extensive unit performance testing**
- **System interlocks (AWFCO) to stop flow of material**
- **Initial and Annual testing for all pollutants**
- **O&M plan**
- **Monitoring, recordkeeping and reporting**

Incinerator Inspection



Inspector Safety Equipment

- **Hard Hat**
- **Safety Glasses or Goggles**
- **Gloves**
- **Steel Tipped Safety Shoes**
- **Ear Protectors**
- **District Safety Policy**



Identify Potential Safety Problems

- **Eye Injuries:**
 - Watching flames through hatches
 - Scrubber liquor
- **Sharps & Infectious Wastes:**
 - Avoid Skin contact
- **Burns:**
 - Contact with hot equipment
- **Inhalation Hazards:**
 - Fugitive leaks, high pressure scrubbers/ducts
 - Alkaline reagent storage/mixing equip Stacks or vents

Common Potential Safety Problems

- **Weak or Slippery Walkways/Ladders**
- **Corroded Ductwork or Control Devices**
- **High Electrical Voltage, Control Cabinets**
- **Rotating Equipment: Fans/Fan Belts**

NACT

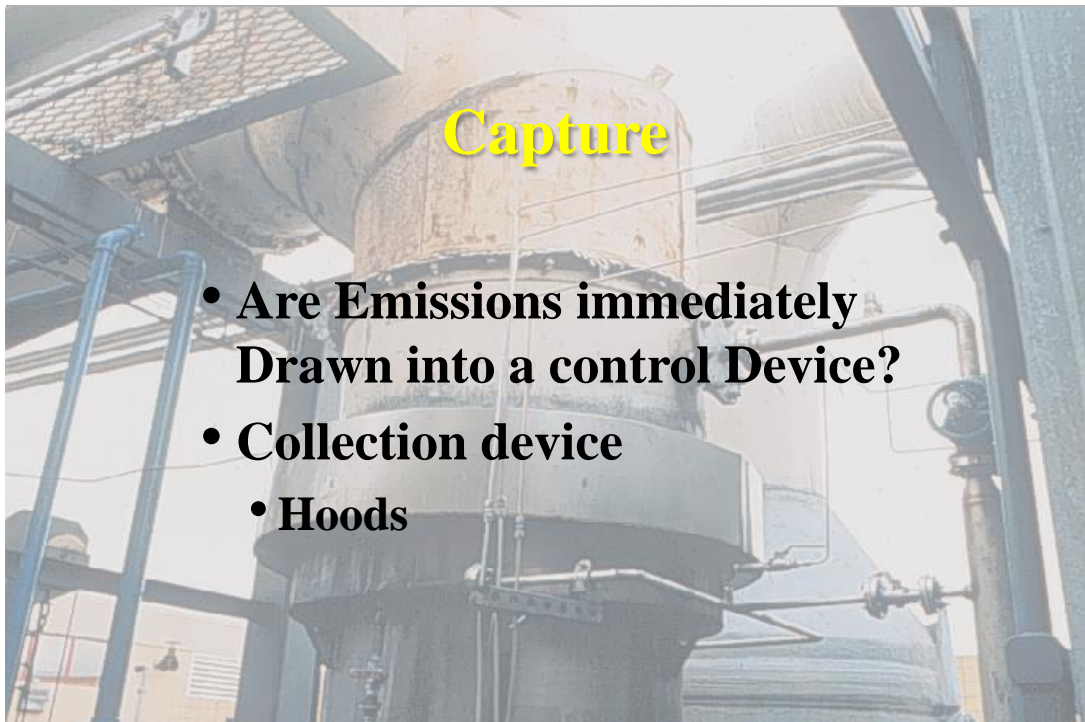


Compliance with Permit Requirements

- **Temperature (preheat and or operating)**
- **Type of Waste**
- **Charging Rate**
- **Hours of Operation**
- **Monitoring**
- **Recordkeeping**
- **Many Others**

Air Pollution Control Points of Inspection

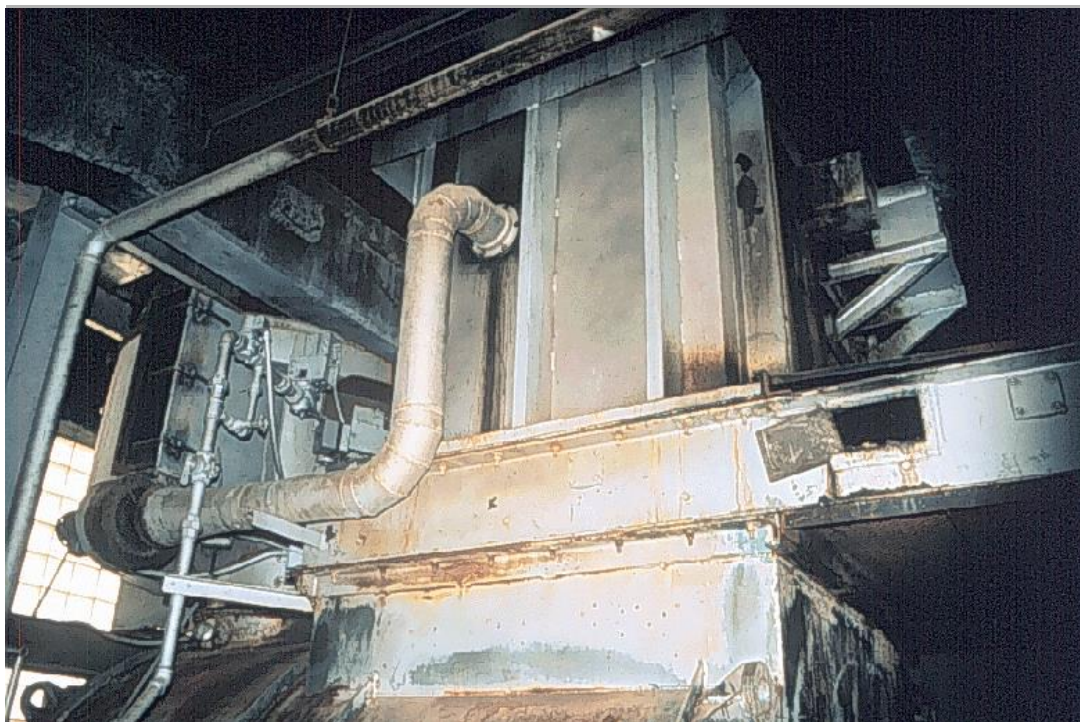
- **Capture**
- **Transport**
- **Air Mover**
- **Instrumentation**
- **Control**
- **Subsystem**



NACT

Transport

- **Are Emissions Moved to the Control Device Without Loss**
- **Are There any Leaks**



NACT



Air Mover

- Is the fan big enough for the Job?
- Is it Operating as Designed and Permitted?



Horsepower ?

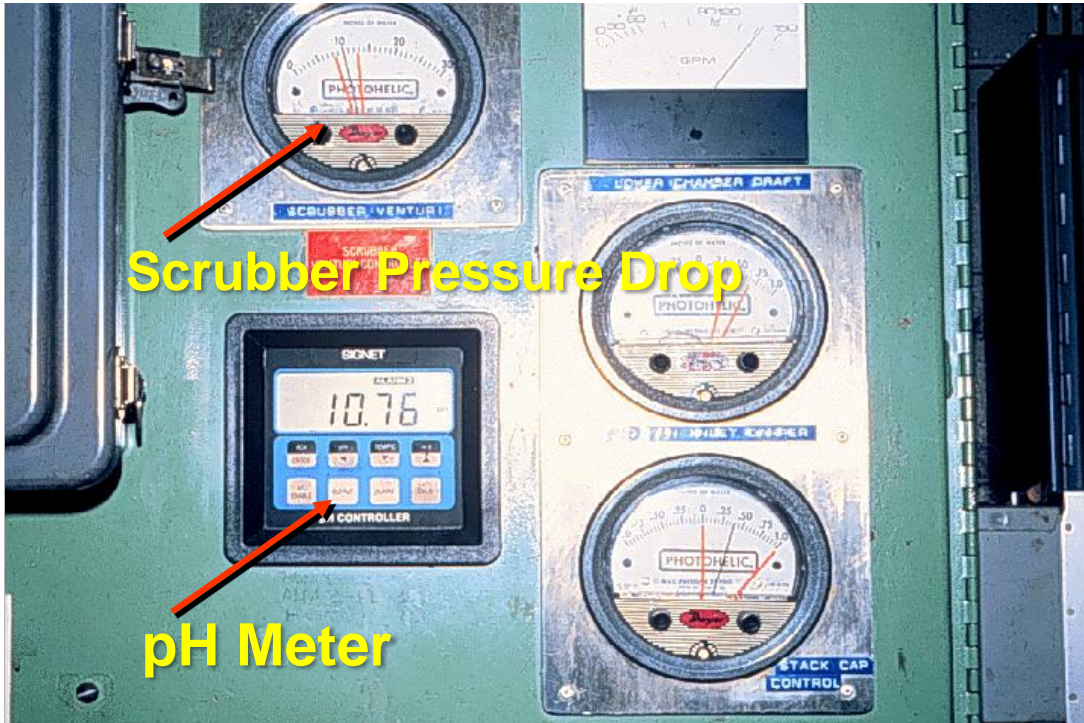
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Instrumentation

- Are the proper instruments present?
- Do these instruments appear to be functioning?
- Are the instruments showing the appropriate units?

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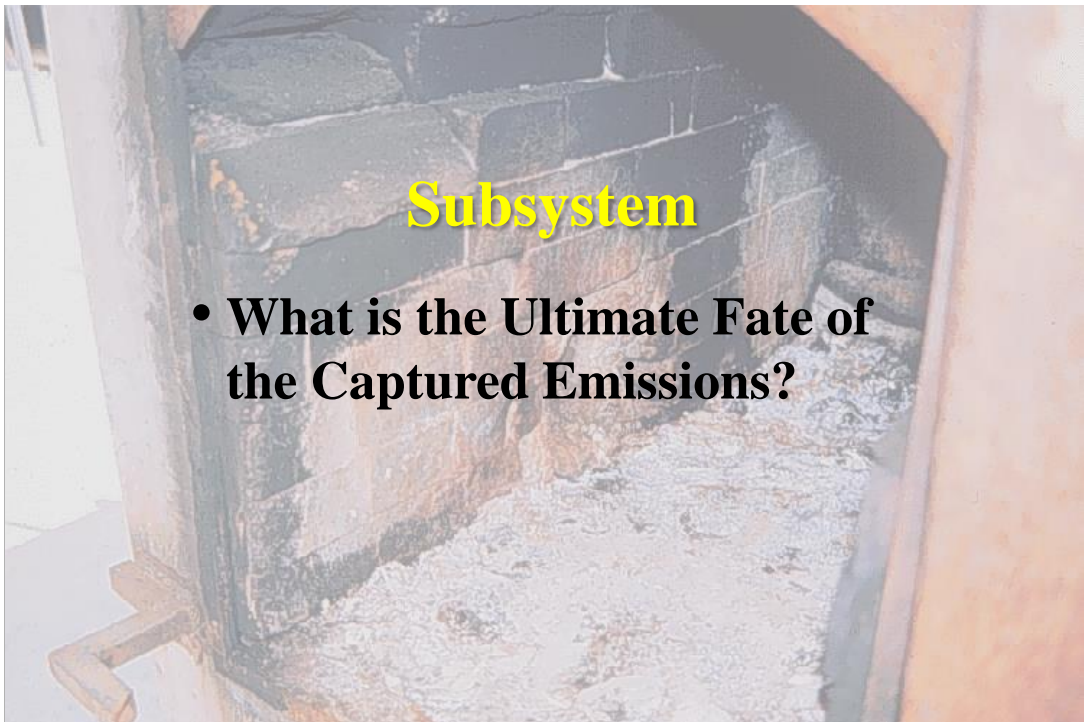
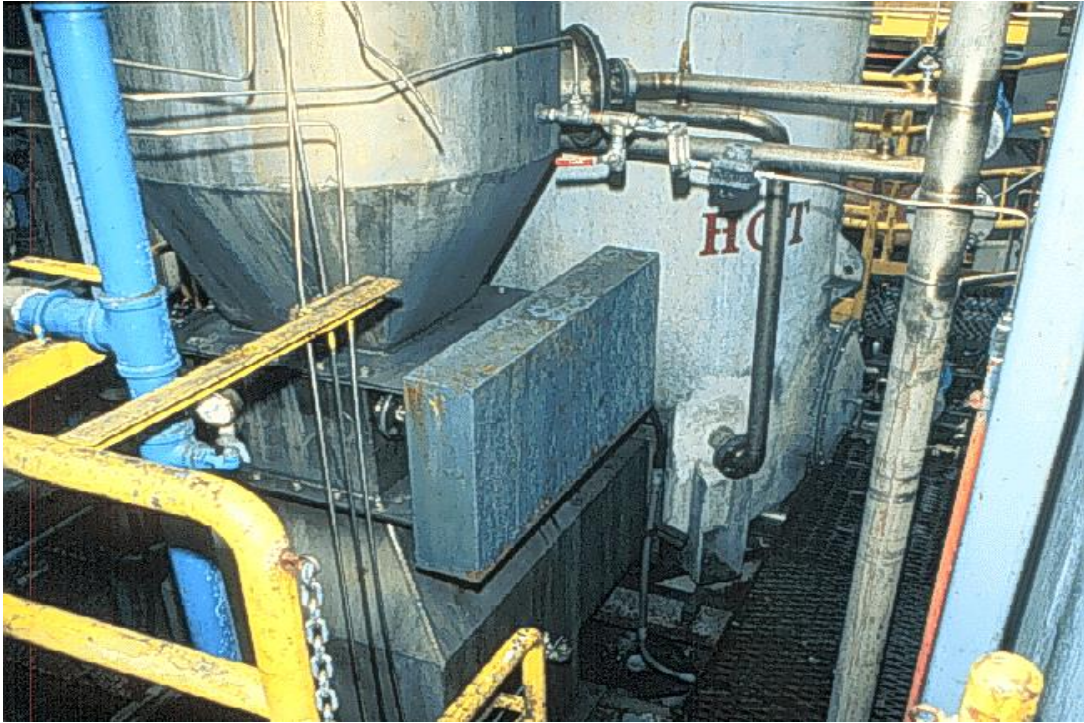


Control Device

- Is it On?
- Visible Emissions?



NACT



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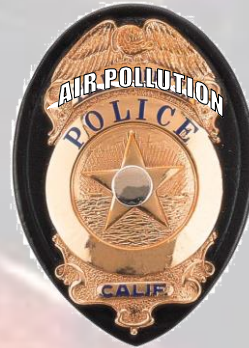


What about Violations?

- **Notice To Comply (NTC)**
 - **Minor Deficiency**
 - **Non-Emissions Related**
 - **Non-Recurring**

What about Violations?

- **Notice Of Violation (NOV)**
 - **Emissions Related**
 - **Same Problem At Last Inspection**



Four Options After A NOV

- **Continue to Operate in Violation**
- **Cease the Non-compliant Activity**
(shut down the operation)
- **Correct the Problem**
- **Apply for a Variance**