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### How do hazardous waste combustors remove pollutants from their stack gases?

Hazardous waste combustors use a number of different air pollution control systems depending upon the type of combustion system and the pollutants being controlled. Below is a list of typical air pollution control equipment used by the six different types of hazardous waste combustors.

- Cement kilns – Electrostatic precipitators and fabric filters for particulate matter control.
- Lightweight aggregate kilns – Fabric filters for particulate matter control, sometimes in combination with dry scrubbing or wet scrubbing for acid gas control.
- Incinerators – A variety of different air pollution control systems. These include:
  - Dry scrubbing in combination with dry particulate control with fabric filters or electrostatic precipitators.
  - Fabric filters or electrostatic precipitators followed by wet scrubbing.
  - Wet scrubbing systems for both particulate matter and acid gas control, including various different combinations of wet scrubbers such as ionizing wet scrubbers, wet electrostatic precipitators, venturi scrubbers, packed beds, and spray towers.
- Solid fuel boilers – Fabric filters or electrostatic precipitators.
- Liquid fuel boilers – Most do not require controls due to extremely low amounts of pollutants produced; some use fabric filters or wet scrubbers.
- Hydrochloric acid production furnaces – Multiple stages of wet scrubbers.

Multiple control devices may be necessary for a given system to control multiple pollutants. The following is a brief description of the air pollution control techniques mentioned above:

- Secondary combustion chambers/afterburners – Used to provide additional reaction time and/or temperature for enhanced destruction of organic compounds or additional oxidation of carbon monoxide. A secondary combustion chamber may be unfired or may be fired with a waste fuel, while an “afterburner” usually contains burners fired with a clean fuel like natural gas.

- Cyclones – Used for coarse particulate removal.
- Fabric filters – Used for coarse and fine particulate removal.
- Ceramic filters – Used for coarse and fine particulate removal, and can also be impregnated with catalysts for organic pollutants, dioxins, or oxides of nitrogen.
- Electrostatic precipitators – Used for coarse and fine particulate removal.
- Venturi scrubbers – Used for both particulate and acid gas control
- Wet scrubbers – Used primarily for acid gas control, and may use a reagent like caustic soda (sodium hydroxide) to neutralize the captured acids. Ionizing wet scrubbers control particulate matter as well as acid gases.
- Spray dryers and dry scrubbers – Used for acid gas control. Dry scrubbing usually uses reagents like lime or sodium bicarbonate to capture and neutralize the acid gases.
- Hybrid wet/dry scrubbing systems – Used for both acid gas and particulate control.
- Flue gas cooling and conditioning – Includes techniques such as water quench, air dilution, waste heat boilers, or heat exchangers.
- Catalytic oxidation – Used for organics control.
- Sulfur-based control – Used for organics control, in particular dioxin.
- Selective or non-selective catalytic reduction – Used for control of oxides of nitrogen.
- Other control techniques – Including activated carbon used for mercury and organics control, earth-based sorbents for semi-volatile metals control, and specific mercury control techniques including selenium coated filters, sodium sulfide injection, and mercury scrubbers.

EPA has provided two good sources of additional details for each of these methods and how each may be used. The first is [https://www3.epa.gov/ttn/catc/cica/atech\\_e.html](https://www3.epa.gov/ttn/catc/cica/atech_e.html). This website provides links to detailed descriptions of several different types of equipment. The second is Volume 1, Chapters 2 and 3 of the Technical Support Document for the 2005 final hazardous waste combustor MACT rule. Chapter 2 is primarily a description of each source category but the last section in each source category discusses the types of air pollution control used by that source category and why it is used. Chapter 3 provides a detailed description on how each piece of equipment works. EPA has not posted the Technical Support Documents on their webpage but a copy of Volume 1 can be found at [www.crwi.org/textfiles/tsd2005v1.pdf](http://www.crwi.org/textfiles/tsd2005v1.pdf). Copies of the other four volumes can be obtained by either contacting CRWI ([mel@crwi.org](mailto:mel@crwi.org) or 703-431-7343) or EPA ([behan.frank@epa.gov](mailto:behan.frank@epa.gov)).