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Chapter 1 : Incinerator Consultants Incorporated

This book, INCINERATION SYSTEMS HANDBOOK, published by INCINERATOR CONSULTANTS INCORPORATED (ISBN , pages, hardbound) is an update of Mr. Brunner's previous incineration systems texts.

Few in United States. More common for biosludge incinerators Fixed hearth with secondary chamber Mostly with plant trash co-feed Medical Waste Old IIA design for older facilities Controlled-air primary chamber with afterburner Predominant design in United States since s Rotary kiln with afterburner Few in United States For illustrative purposes, the following discussion focuses on the basic design and operating considerations for one type of furnace. Furnace configurations depend on what they were designed to burn. Older designs, many of which are still used, do not generally permit as efficient combustion as newer designs. Page 40 Share Cite Suggested Citation: Waste Incineration and Public Health. The National Academies Press. Sizing a furnace to match the quantity of waste fed to the incinerator is important with respect to temperature, turbulence, and time. If the heat input from the waste is too low for the furnace size, the temperature in the furnace may drop to such an extent that complete combustion is not achieved, particularly in waterwall furnaces. If the furnace is too small for the quantity of waste fed, the temperature will be high and there may be difficulty in supplying sufficient oxygen for complete combustion, and the quantities of unburnt residues might be increased. Grates In older incinerator systems, traveling grates simply transported refuse into the combustion zone. Newer grate systems are designed to agitate the waste in various ways, causing it to be broken into smaller pieces as combustion proceeds. This process permits exposure of a larger surface area of waste to air and high temperatures, assisting complete combustion by preventing unburnt material from simply being transported through on the grate. Air-Injection Systems For complete combustion to occur, air must be injected into the furnace in at least two locations: Additional controls have been provided in modern municipal solid-waste incinerators to better regulate both the under-fire air at various points on the grate, depending upon burning conditions, and the over-fire air in response to temperature and heat transfer taking place in the furnace. In such advanced systems, primary air is injected into the drying, burning, and burnout zones of the grate, with a separate system for secondary air. Control may be effected by manual or automatic adjustments to dampers. The latter method is preferred, because it allows for automatic control loops with continuous monitoring devices. The temperature and oxygen needs of the furnace can be controlled by adjusting the quantity of primary and secondary air entering the furnace. In plants built before the middle s, particularly those with holes in the furnace walls, the entry of primary and secondary air is not as well controlled, and the excess-air rates required for adequate combustion can be several times the amount that would be required with a more modern design. This can result in larger volumes of flue gas to be treated for contaminant removal, and reduced efficiency of utilization of the exhaust heat. Page 41 Share Cite Suggested Citation: Achieving that residence time is usually accomplished by designing the furnace to retard the upward flow of gases, for example, by installing irregularities into the furnace walls. Modern facilities are configured to achieve improved combustion efficiency by using arches and bull noses. Arches, which are structures above the burning and burnout zones, are used to prolong the stay of combustion gases above the grate area. Bull noses are protrusions that are built into the furnace walls, usually near the point of injection of over-fire air, to upset the normal upward flow of the heated gases volatilizing from the burning waste. The induced gas redirection retards the movement of the combustion gases out of the furnace and promotes mixing with air. Flue-Gas Recirculation Flue-gas recirculation systems are used to recycle into the furnace relatively cool flue gas extracted after the heat exchangers have reduced its temperature that contains combustion products and an oxygen concentration lower than air. The process is used to lower nitrogen oxide formation by limiting the flame temperature and by slightly diluting the flame oxygen concentration. Care must be taken to ensure that not too much flue gas is recirculated, lest the combustion process be adversely affected. Auxiliary Burners Waste feedstock, particularly municipal solid waste, is heterogeneous, and its components, or even the whole waste stream, may vary in combustibility. That can make it difficult to maintain the minimal temperature necessary throughout a furnace. The auxiliary burners are fed fossil fuels and are particularly intended to be used during system startup, shutdown, and upsets. Waste-heat boilers are employed on all new municipal solid waste-to-energy plants, many hazardous-waste incinerators, and some of the larger medical-waste incinerators. Page 42 Share Cite Suggested Citation: Hazardous-waste and medical-waste incinerators usually have just convective boiler sections, typically of fire-tube rather than water-tube design. Most hazardous-waste and medical-waste incinerators, particularly the smaller units, do not have heat-recovery boilers. Combustion gases are quenched by water sprays atomized into the hot gas flow. Other, less common, gas-temperature reduction methods include air-to-gas heat exchangers and direct gas tempering with air. Gas cooling techniques are integral to incineration system design, and can be important with respect to emissions of certain pollutants. As discussed later in this chapter, emissions of mercury and dioxins and furans can be affected by the rate of gas cooling and the air pollution control device APCD operating temperature. Also, as discussed in Chapter 6 , NOx emission limits have been established for some incinerators. In several instances in European plants, increasingly stringent regulations have resulted in use of more than one particulate-control device or more than one type of scrubber in a given incineration facility, and emissions have typically been reduced more than would be expected with the single device alone. Modern municipal solid-waste incinerators in the United States are equipped for particulate, acid gas, and, in many cases, dioxin and mercury removal. These municipal solid-waste incinerators typically employ fabric filters or dry electrostatic precipitators esp for particulate removal. ESPs became common in the s. In the s, fabric filters, also known as baghouses, started to replace, or be used in tandem with, ESPs as the preferred design for particulate removal because of their improved capacity for filtering finer particles. Spray dryer absorbers and dry-lime injection systems are used for acid gasâ€”HCl and sulfur dioxide SO2 â€”removal. Dry powdered activated carbon injection systems provide dioxin and furan and mercury removal. Many small old municipal-waste incinerators do not have effective air-pollution control systems. Some have only a particulate-control device, often a relatively ineffective one designed to meet old standards for emissions of particulate. Newer ones have both particle and acid-gas-control devices, such as wet scrubbers. Page 43 Share Cite Suggested Citation: Recently, however, there has been a trend toward fabric-filter systems particularly in larger incineration facilities because of their superior fine-particle-emission and metal-emission control efficiencies and their ability to produce a dry residue rather than a scrubber wastewater stream. Cement kilns and coal-fired boilers that burn waste as fuel have traditionally used either fabric filters or dry electrostatic precipitators as active control techniques. Passive controls include the neutralization of acid gases by cement materials and the recycling of cement kiln dust back into the process. Particulate Collectors Fine-particle control devices fall into three general categories, which are filtration collectors, including fabric filters baghouses ; electrostatic collectors, including dry and wet electrostatic precipitators ESPs and ionizing wet scrubbers; and wet inertial-impaction collectors, including venturi scrubbers and advanced designs that use flux-force condensation-enhancement techniques. When properly designed and operated, all of them are capable of effective fine-particle control, but they are not all equally effective. Flue gas containing particles passes through suspended filter bags. The particles suspended in the gas streams are collected on the filters and periodically removed and fed to a collection hopper. Fabric filters are widely used today in municipal solid-waste incineration facilities, cement kilns, and lightweight-aggregate kilns because of their highly efficient collection of fine particles. They are used in a smaller number of hazardous-waste incinerators and medical-waste applications. The performance of fabric filters is relatively insensitive to particle loading, or to the size distribution and physical and chemical characteristics of the particles. They are limited to an operating temperature range between the gas dew point on the lower end and the bag-material thermal-stability limit on the upper end. The primary factors affecting the performance of fabric filters are fabric type and weave, air-to-cloth ratio gas flow rate to total bag surface area , cleaning method and frequency, bag cake formation and maintenance, and bag integrity with respect to mechanical, thermal, and chemical breakdown. The fabric type must be matched to the temperature range of the application and the chemical composition of the gas for good performance and bag longevity. The method, intensity, duration, and frequency of the bag-cleaning cycles are important to maintain mechanical integrity of the bags and good cake formation. Good cake formation as measured by baghouse pressure differential is required for good performance of woven and felted bags; it is less critical for laminated membrane bags, which can function using surface filtration alone. In properly designed and operated fabric-filter systems, maintaining bag integrity is the critical determinant of day-to-day performance. Bag integrity can be monitored via pressure drop, visual stack-opacity inspections, continuous online stack-opacity monitors, or other continuous monitoring techniques that use optical sensing or triboelectric sensing. During shutdowns, bag integrity can be checked by visual examination of the clean-gas plenum for localized dust buildup. More-sensitive techniques involve the use of fluorescent submicrometer powder and black-light examination of the plenum. Dry ESPs are widely used today in municipal solid-waste incineration facilities and on cement kilns and coal-fired boilers that burn hazardous waste. Wet ESPs are less widely used and are primarily in hazardous-waste incineration applications. Dry ESPs operate above the dewpoint of the gas. Wet ESPs are constructed from materials that resist acid corrosion and operate under saturated-gas conditions. Dry ESPs are less effective than fabric filters for collection of submicrometer particulate matter 0. Their performance is influenced by a variety of design characteristics and operating conditions, including the number of electric fields used, charged electrode wire or rod and grounded collection plate or cylinder geometry, specific collection area ratio of collection surface area to gas flow rate , electrode design, operating voltage and current, spark rate, collector cleaning method to limit buildup or re-entrainment of dust , fluctuations in gas flow rate and temperature, particulate-loading fluctuations, particle-size distribution, and particle resistivity less important for wet ESPs. Wet ESPs have superior submicron particle collection capabilities because they do not suffer rapping re-entrainment and dust layer back-corona problems associated with dry ESPs. In a properly designed unit, the important monitoring and process-control measures are inlet gas temperature dry ESPs only , gas flow rate, electrical conditions voltage, current, and spark rate , cleaning intensity and frequency, and hopper-ash level dry ESPs only. Wet inertial-impaction scrubbers, primarily venturi scrubbers, have historically been the particulate matter control technology of choice for most hazardous-waste and medical-waste incinerators. They are inherently less efficient for submicrometer particulate matter than fabric filters or ESPs, but nonetheless can meet regulatory requirements in many applications. The primary performance criterion for most wet inertial-impaction scrub- Page 45 Share Cite Suggested Citation: For injector venturi scrubbers, the corresponding criterion is liquid-nozzle pressure drop. Other important design and operating characteristics are the liquid-to-gas ratio, inlet gas temperature to avoid scrubber-liquid evaporation , solid content of recirculated scrubber liquid, mist eliminator efficiency, materials of construction to avoid corrosion and erosion, particulate loading, and particulate-size distribution. In a properly designed unit, the most-important monitoring and process control measures are pressure drops, liquid and gas flow rates, and liquid blowdown rate blowdown is used to control solids buildup. A few designs use steam injection or scrubber-liquid subcooling to enhance flux force and condensation. For those designs, steam-nozzle pressure and scrubber-liquid temperature are additional useful monitoring measures. A scrubbing liquid is trickled through a matrix of random or structured packings through which the gas is simultaneously passed, resulting in gas-liquid contact over a relatively large surface area. The scrubbing liquid can be water or an alkaline solution, which reacts with the acid-gas constituents to form neutral salts. The wastewater discharge from the packed-bed absorber is a salt-water brine that must be managed properly. This effluent may contain unreacted acids, trace organics, metals, and other solids removed from the gas stream. Packed bed absorbers have been used for decades in the United States, primarily in hazardous-waste and medical-waste incineration applications. They have been used in Europe for municipal solid-waste applications. The European installations include duel-stage wet absorbers, in which the first stage is operated with an acidic scrubber liquid and the second stage is operated with an alkaline scrubber liquid. Acid gases, such as HCl, that are highly water soluble are largely collected in the first stage. Acid gases, such as SO2, that are not very water soluble are effectively collected in the second, alkaline stage. The important design and operating criteria for wet acid-gas absorbers are gas velocity, liquid-to-gas ratio, packing mass transfer characteristics, pH of the scrubbing liquid, and materials of construction to prevent corrosion. In recent years, municipal solid-waste and a few larger hazardous-waste and medical-waste incineration facilities have used spray-dryer scrubbers for acid-gas control.

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Chapter 2 : Incineration systems handbook PDF

incineration systems handbook This book, by Calvin R. "Charles" Brunner, published by INCINERATOR CONSULTANTS INCORPORATED (ISBN , pages, hardbound) was reprinted in It is an update of Mr. Brunner's previous incineration systems texts.

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Handbook of incineration systems. [Calvin R Brunner] -- This comprehensive handbook presents the information needed not only to design facilities for incinerating refuse, sludges, gases, radioactive, hazardous and other industrial wastes, but also the.

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