

56. Concentration of Gas Emissions of Waste Burning in Incinerator at Different Temperature

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Abstract

Incineration is one of the most commonly used technique of waste management. It is a technology used for reducing of toxic hospital, municipal solid waste and energy recovery. Incineration is much effective technique than open burning. Open burning creates air pollution, land pollution and releases unburned gases from waste in atmosphere and causes several health deceases. Incineration is used at high temperature which decreases the solid mass of the original waste by 80 to 85%, and the volume which burns 99.9% by 95 to 97 %, depending on composition of waste and amount of recovery of materials for instance metals from the residue (ash) for recycling. In this research, the concentration of gases and their moisture at different temperature was observed. It was observed that emission of toxic gases vary with composition of waste material and temperature of incinerator. The accuracy of concentration result was about 98-99% at different temperature from 300°C to 1200°C.

Keywords: Acid Gases; Fly ash; Total average emissions; waste burning; concentration

1. Introduction

When Organic or Inorganic waste is burned in open atmosphere it creates unusual gases and makes environmental pollution. When people use material for their life different types of waste produced and generated from different sites (municipal solid waste and hospital waste). Different types of waste management methods are used and each of them divided into various categories. And those sources include animal feeding, composting, recycling, reduction and reuse landfill, fermentation and incineration. And all these methods are used in every country.

One of the conventional methods to diminish waste from various sources is Incineration innovation. Individuals used to decrease waste by smoldering. The majority of waste is singed in open atmosphere which makes noxious and lethal gasses and wellbeing impacts as contrast with incinerators. These are utilized at high temperature and make less contamination. Furthermore, cremation is a waste treatment rehearse that incorporates the smoldering of organic substances contained in waste material [1]. Incinerators diminish the strong mass of the first waste by 80–85% and the volume (effectively compacted fairly in dump trucks) by 95–97%, contingent upon organization and level of recuperation of materials, for example, metals from the slag for reusing [2].

Another technique is resource recuperation and this is the way toward taking valuable disposed of things for a particular after that utilization. These pointless things are then handled to separate or recuperate materials and assets or change them to energy as useable warmth, fuel or into electrical energy.

The materials from which the things are prepared can be reprocessed into new items. Material for reusing might be gathered separately from normal waste utilizing devoted holders and collection vehicles, or sorted straightforwardly from blended waste streams. The most widely recognized and regular buyer items reused incorporate aluminum, for example, refreshment jars, copper, for example, wire, old steel furniture or hardware, PET(polyethylene terephthalate) and polyethylene jugs, containers and glass jugs, steel nourishment and airborne jars, paperboard containers, newspapers, light magazines and paper , and folded fiberboard boxes. The sort of reusing material acknowledged changes by town and nation. Every town and nation has diverse reusing programs set up that can hold the distinctive sorts of recyclable materials.

Other strategy is Composting and is a basic and normal bio-degeneration handle that takes natural squanders i.e. stays of plants and terrace and kitchen waste and transforms into supplement rich nourishment for plants. Treating the soil, typically utilized for natural cultivating, happens by permitting natural materials to amass in one spot for a considerable length of time until organisms decay it. Treating the soil is one of the best technique for waste transfer as it can bend perilous natural items into safe compost. On the opposite side, it is moderate process and takes part of region and space. Different systems are additionally utilized for waste management.

1.2 Emission of Gases

The motivation behind this paper is to distinguish diverse gasses which make from blazing of waste in incinerator at various temperature. In this paper we have exhibited grouping of gas discharges of natural waste amid copying at various temperature by utilizing Testo 350 Flue Gas Analyzer. The 350 Gas Analyzer can quantify O₂, NO₂, CO, H₂S, Nitrogen Monoxide, Hydrocarbons, SO₂, CO₂, weight, temperature, stream, and speed. Testo 350 discharge analyzer is a versatile gadget utilized for motor testing since Rich-copy motor fumes, when uncontrolled, can have wide fixation ranges and both CO and NO_x can vacillate fundamentally. Turbine Testing, High torque and low discharges are regular of turbines and subsequently, you require an analyzer that is particularly prepared to handle low limits and still convey the most astounding precision.

The amount of deposits, for example, fly fiery debris from metropolitan waste incinerators and coal-let go power plants is developing. Fly fiery remains is generally sullied with dangerous overwhelming metals that filter out on contact with water and contaminate the groundwater. In this manner, secluded and costly transfer of the powder is required. Reuse of fiery remains as a filler for concrete or asphalts just permits least filter capacity of metals and most extreme draining estimations of different metals from reused fly slag are endorsed by national enactment. Supercritical-liquid extraction (SFE) offers a technique to diminish the metal substance so that filter capacity is decreased and the requests of enactment are watched [3]. The new softening expertise makes incinerator deposits, floor fiery remains and fly slag, stable and non-harmful. Besides, this sort of treatment permits the dissolved slag to be utilized as an asset over once more. In Japan, the softening procedure was created in the 1980's and has been in down to earth capacity at around 24 city strong waste (MSW) burning offices including planned ones[4]. These are more prudent and financially savvy innovations and can be actualized to Asian nations to control air contamination. Open waste smoldering is enormous issue in urban zones which likewise makes various types of infections in people and additionally in other living creatures.

2. Related Work

The discharges of green-house gasses in the air attributable to human exercises are relied upon to be in charge of a huge increment in the world's temperature. [5]. Different gasses make issue for environmental change and an Earth-wide temperature boost and these gasses likewise consequences for biological community.

IN the previous couple of years, numerous laborers have noticed that the consolidated impact on atmosphere of increments in the groupings of countless gasses could match or even surpass that of the expanding centralization of carbon dioxide. These follow gasses, mainly methane, nitrous oxide and chlorofluorocarbons, are available at focuses that are two to six requests of greatness minor than that of carbon dioxide, yet are huge in light of the fact that, per particle, they retain infrared radiation significantly more firmly than carbon dioxide [6]. Carbon dioxide is the real nursery gas, and its anthropogenic sources are fundamentally fossil fuel ignition and biomass blazing procedures prompting a carbon de-stockpiling from the earthbound biosphere. Both sources are sensibly very much measured. All together of significance, methane is the second most essential nursery gas, and it should be in charge of roughly 17% of the anthropogenic radiative constraining [5]. At the point when these gasses comes to at troposphere then they starts atmosphere dampness and this can be seen via programmed climate station [7]. Nursery gasses will dependably be a most hostile issue, regardless of what the lessening rate [5].

2.1 Design of Incinerator

Incinerator can be design by two ways, it can be design by single chamber or double chamber and there working principle is same [8]. The incinerator is design on the bases of the these concepts: The system must be simple in construction Easy to operate Low cost Most of the maintenance work can be done by local workers using locally available material. The working principle of the incinerator is of an intermittent controlled-air type. The incinerator is designed to work with a waste-charging device. The incinerator has a de-ashing door allowing convenient ash removal from the chamber.

2.2 Incinerator temperature

The Burring chamber is a single type with high temperature which works both for the primary and secondary chamber at the maximum temperature 1000 °C. The combustion air is supplied by a blower installed at the right side wall of incinerator, and it directly fire waste in the chamber, the flow rate of which can be adjusted by a butterfly valve to match the controlled-air principle. The chamber of incinerator is trapezoidal so that any unburned waste can be burned by the slightly it goes down to the bottom of chamber. The incinerator is design on a single chamber which works for the both primary and secondary chamber. In this incinerator the chamber is design in a trapezoidal shape so that the waste is completely burned. The burner is fixing at the one side centre of the wall. The waste feeding system is on the cone shape body. The mouth of the feeding door is design narrowly so that it can be more efficient for maintaining the temperature inside it reduces the heat losses. All type of waste has some non combustible fraction, which is not burn up and it is called fly and bottom ash . Due to this reason removal of ash is essential, so to meet this requirement the de-ashing pocket is design. The fly ash, by far, constitutes more of a potential health hazard than does the bottom ash because the fly ash often contain high concentrations of weighty metals such as lead, cadmium, zinc and copper as well as small amounts of dioxins and furans[9] The de-ashing pocket is located on the back of the incinerator. The pocket can turn freely and rectangle in shape. Moreover, the bottom ash generated with various chemical constituents in the Solid waste and it was assessed by using muffle furnace [10].

2.3 Air Distribution

The combustion air is fed into the incinerator according to the controlled-air principle. The air is supplied by a blower which draws atmospheric air into a conditioning room before being distributed in the chamber. The desired air flow rate may be regulated by a butterfly valve which is installed in the chamber. The incineration and burning air of the chamber is injected as under-fire air into the hearth of the incinerator from one side. The combined gas cleaning system consists of a radiator, a scrubber and a wet-type electrostatic precipitator also known as (ESP). Dioxins can be decomposed effectively using after-burners downstream of the incinerator by maintaining the gas temperature and waste around 850 ± 20 °C[11].

2.4 Control System

The automatic control system of the incinerator is divided in two parts: temperature control and timing control. The temperature of chamber of the incinerator is to be controlled to near preset values. This is done by feeding thermocouple signals from chamber to the controller where it is compared with the set values. Timing control of the incinerator is done by a timer.

2.5 Operating of incinerator

Where there is smoke there is fire because when waste burns it produces smoke and that smokes emits into atmosphere. Normally incinerator operates at high temperature and it operates more than 900 °C and produces less smoke. The mixed waste is initially dried in the open atmosphere where 80 to 90% moisture to be removed. The dried waste is feed into the incinerator by the feeding door. The feeding of waste is continuous till above half of the chamber to be filled, after that feeding door is tightly closed. Keeping in the mind all safety measures applied properly to prevent accidents. Opening the gas control valve and switch on the air blower, the firing system is auto pilot. The burning

process becomes started and it will be continuous till when the completely waste is converted into the ash. After that leave the incinerator 30minutes for cooling down and then open the slab plate draw down the ash into the ash pocket then remove it safely.

3. The Experimental Work

The waste was gathered from the distinctive and arbitrary locales and areas at various time. Civil waste and distinctive natural waste was dried for 2days preceding burning. Drying of waste is utilized to accomplish a diminishment of the mass and volume of dampness substance of natural waste before its further method. . It likewise serves to build the calorific estimation of such waste, in readiness to a conceivable warm use. The main impetus of drying is the distinction between the incomplete vapor weight inside the waste and the encompassing air. The hotter the air the further water vapor can be transported in atmosphere.

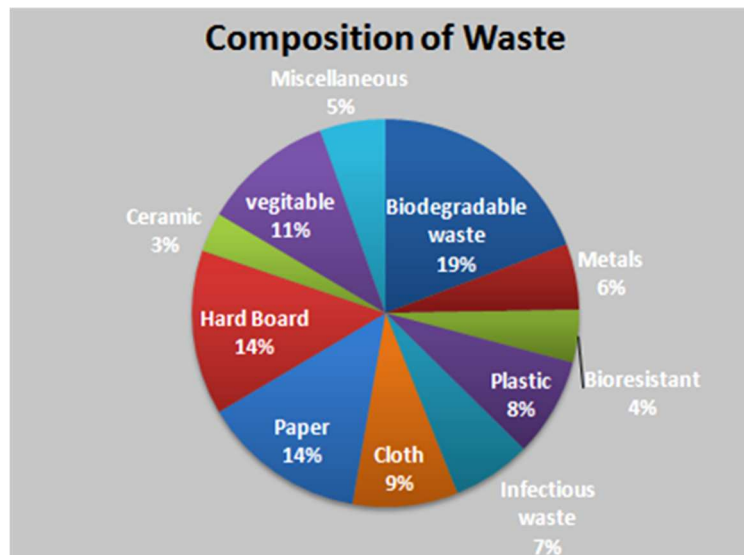


FIG.1.Composition of municipal solid waste

3.1 Emissions Result

Distinctive examples were tried in incinerator by Test 350 vent gas analyzer with 35 waste specimens at various time with various temperature. Once in a while levels of gasses expanded when contrasted with less temperature and afterward this was distinguished by method for gas analyzer, on the grounds that diverse examples were brought from various destinations with various structures. The event of overwhelming metals in incinerator vent gasses is of natural worry due to their related lethal and noxious properties. The substantial metals are connected with fly fiery remains. Fly fiery debris is appeared to incorporate a wide assortment of substantial metals and comprises of complex potassium, calcium alumino silicates, and sodium. A test approach has been embraced to expel and diminish harmful gasses with high temperature. The primary goal of this study is likewise to explore gasses which make environmental change and additionally an unnatural weather change and to expel these gasses and dust.

Table: 1 Concentration of Different Gases at 5 Minutes Timing

Gases	Concentration at Different Temperatures				
	300 °C	500 °C	700 °C	900 °C	1200 °C
Oxygen (O ₂)	41.61%	39.8%	38%	35.3%	21.22%
CARBON MONOXIDE (CO)	2230(ppm)	2150(ppm)	2050.53(ppm)	1980.78(ppm)	1700(ppm)
CARBON DIOXIDE(CO ₂)	11.55(ppm)	11.3(ppm)	9.5(ppm)	9.5(ppm)	8.32(ppm)
NITROGEN MONOXIDE(NO)	75(ppm)	75(ppm)	72(ppm)	69.6(ppm)	66(ppm)
NITROGEN DIOXIDE(NO ₂)	5.7(ppm)	5.75(ppm)	5.21(ppm)	6(ppm)	5.1(ppm)
SULFUR DIOXIDE (SO ₂)	45(ppm)	45(ppm)	42(ppm)	42.4(ppm)	40(ppm)
HYDROCARBON (HC)	1145(ppm)	1133(ppm)	1110(ppm)	1008(ppm)	700(ppm)

Where ppm means “parts per million”
1ppm = 1/1000000 = 0.000001 = 1×10⁻⁶

One ppm is equal to 0.0001%:

$$1\text{ppm} = 0.0001\%$$

Table: 2 Concentration of Different Gases at 10 Minutes Timing

Gases	Concentration at Different Temperatures				
	300 °C	500 °C	700 °C	900 °C	1200 °C
Oxygen (O ₂)	36.52%	36%	32.5%	31%	28.1%
CARBON MONOXIDE (CO)	2190(ppm)	2130(ppm)	2010(ppm)	1940(ppm)	1600(ppm)
CARBON DIOXIDE(CO ₂)	11(ppm)	11(ppm)	10.5(ppm)	9(ppm)	8.12(ppm)
NITROGEN MONOXIDE(NO)	67(ppm)	66.5(ppm)	65.2(ppm)	62(ppm)	60(ppm)
NITROGEN DIOXIDE(NO ₂)	5.6(ppm)	5.3(ppm)	5.25(ppm)	5(ppm)	4.5(ppm)
SULFUR DIOXIDE (SO ₂)	43(ppm)	38(ppm)	37.6(ppm)	36.6(ppm)	35(ppm)
HYDROCARBON (HC)	1105(ppm)	1100(ppm)	1050(ppm)	870(ppm)	680(ppm)

Fig.1: Shows the composition of waste which was collected from experimental site. And the research site was located in the Jamshoro Medical area of Liaquat Hospital. Work experiment was taken several times for getting deep results of gases which goes in atmosphere and creates air pollution. It can be seen that the percentage of Biodegradable waste is greater than other wastes. On the other hand the percentage of paper and Hard Board is same and is near about 14% and these are also types of untreated organic waste which can be burn easily in incinerator.

Incineration has various yields, for example, the base powder and the discharge to the atmosphere of vent gas. past to the pipe gas cleaning framework, if introduced, the vent gasses may incorporate substantial metals, particulate matter, dioxins , sulfur dioxide, furans and hydrochloric corrosive. In the event that plants have deficient vent gas cleaning,

these yields may incorporate a noteworthy contamination component to stack emanations.

Incineration is directed with various yields, which incorporate powder and pipe gas emanation. Prior to the pipe gas cleaning frameworks were presented, the vent gas needs to move to atmosphere along these lines critical to contamination.

Carbon monoxide (CO) is likewise an outcome and result of fragmented ignition. Carbon monoxide emanations are generally related to shorter living arrangement times, lower temperatures, and sub-par blending conditions than are ideal. At the point when ignition has not continued to consummation, CO is shaped in sort of carbon dioxide (CO₂).

Carbon monoxide (CO) - CO is a scentless, dry, harmful yet non-disturbing gas. It is an item by fragmented burning of fuel, for example, regular gas, coal or wood. Vehicular fumes is a noteworthy wellspring of carbon monoxide.

Unpredictable natural mixes (VOC) - VOCs are an outstanding open air toxin. They are sorted as either methane (CH₄) or non-methane (NMVOCs). Methane is a to a great degree effective nursery gas which adds to upgraded an Earth-wide temperature boost and environmental change. Other hydrocarbon VOCs are additionally huge nursery gasses as a result of their part in making ozone and dragging out the life of methane in the climate. This impact shifts relying upon neighborhood air quality. The fragrant Non-methane unstable natural mixes benzene, xylene and toluene are suspected cancer-causing agents and may prompt leukemia (it is a dynamic Disease) with delayed introduction. 1,3-butadiene is another perilous and risky compound frequently connected with modern use.

Air poison emanation components are accounted for delegate values that endeavor to relate the amount of a contamination discharged to the encompassing air with an action connected with the arrival of that toxin. These components are normally communicated as the heaviness of poison separated by a unit weight, volume, separation, or term of the action discharging the contamination (e.g., kilograms of particulate transmitted per ton of coal copied). Such components encourage estimation of outflows from different wellsprings of air contamination. In the larger part cases, these variables are just midpoints of every accessible dat of adequate quality, and are for the most part thought to be illustrative of long haul midpoints. There are 12 mixes in the rundown of diligent natural contaminations. Dioxins and furans are two of them and purposefully made by ignition of organics, similar to open smoldering of plastics. These mixes are likewise endocrine disruptors and can transform the human qualities. High populace development rate in Pakistan and also in different nations requirements for fibber and sustenance requires more land to ranch, and it makes troubles to oversee waste at state level and to control sicknesses which make from lethal waste [12].

Air contamination is besides a noteworthy peril and hazard element for various contamination related sicknesses and wellbeing conditions which originates from blazing of waste including respiratory diseases, coronary illness, perpetual obstructive aspiratory ailment lung growth and stroke. The wellbeing physical conditions impacts brought about via air contamination may incorporate trouble in, wheezing, breathing, asthma, hacking and compounding of existing respiratory and cardiovascular conditions. These impacts can bring about expanded solution use, expanded specialist or crisis room visits, more doctor's facility affirmations and sudden passing. The human wellbeing impacts of poor air quality are sweeping, yet chiefly influence the body's respiratory framework and the cardiovascular framework. Singular responses to air poisons rely on upon the sort of contamination a man is presented to, the level of introduction, and the individual's wellbeing status and hereditary qualities. The most widely recognized wellsprings of air contamination incorporate particulates, nitrogen dioxide, ozone and sulfur dioxide. Youngsters matured under four to five years that live in creating nations are the for the most part helpless populace as far as aggregate passings inferable from indoor and outside air contamination of squanders which blazes in open air.

3.2 Oxides of Nitrogen

Nitrogen oxides (NO_x) represent a mixture primarily of nitrogen dioxide (NO₂) and nitric oxide (NO). In combustion systems, Nitrogen Monoxide predominates due to kinetic restrictions in the oxidation of NO to NO₂. Nitrogen oxides are formed by one of two general mechanisms. "Thermal NO_x" is also the result of the high-temperature reaction stuck between molecular nitrogen and molecular oxygen, both of which enter the combustion zone in the burning air. "Fuel NO_x" results from the oxidation of nitrogen that is chemically bound within the fuel structure. Thermal NO_x

formation is extremely sensitive to temperature, whereas fuel NO_x is not. At the lower adiabatic temperatures which characterize Municipal Waste Incinerators, fuel like NO_x accounts for generally NO_x emissions, while thermal NO_x generally contributes less than 10 Parts per Million. Incinerator data indicate that NO_x levels are on the order of 200 230 to ppm. Combustion of medical wastes can produce acid gas emissions in the form of hydrochloric acid (HCl) and sulfur dioxide (SO₂), as well as lesser quantities of other compounds. Acid gas control is achieved by neutralization of the acid and/or collection of the acid constituents in dry sorbents or aqueous solutions.

Nitrogen oxides (NO_x) - Nitrogen oxides, especially nitrogen dioxide, are removed from high and also medium temperature ignition of waste, and are additionally created amid low temperature in open environment. They can be seen as a chestnut fog vault above or a crest downwind of urban areas. Nitrogen dioxide is a synthetic compound with the equation NO₂. It is one of copious nitrogen oxides. A standout amongst the most well known air toxins, this rosy cocoa harmful gas has a trademark sharp, gnawing smell. Sulfur oxides (SO_x) - for the most part sulfur dioxide, a substance compound with the recipe SO₂. SO₂ is created by volcanoes and in different modern procedures. Coal and petroleum frequently contain sulfur mixes, and their ignition creates sulfur dioxide. Further oxidation of SO₂, more often than not within the sight of an impetus, for example, frames H₂SO₄, Nitrogen Dioxide (NO₂), and in this way corrosive downpour which effortlessly impacts ashore and water quality. This is one of the reasons for unease over the ecological effect of the utilization of these fills as vitality force sources.

Table: 3 Concentrations of Different Gases at 15 Minutes Timing

Gases	Concentration at Different Temperatures				
	300 °C	500 °C	700 °C	900 °C	1200 °C
Oxygen (O ₂)	21.61%	21.6%	20.92%	20.8%	20.22%
CARBON MONOXIDE (CO)	2200(ppm)	2110(ppm)	2050(ppm)	1980(ppm)	1300(ppm)
CARBON DIOXIDE(CO ₂)	10.8(ppm)	10.5(ppm)	9.2(ppm)	8.5(ppm)	7.2(ppm)
NITROGEN MONOXIDE(NO)	73.1(ppm)	70(ppm)	65(ppm)	61(ppm)	48.8(ppm)
NITROGEN DIOXIDE(NO ₂)	5.3(ppm)	5.1(ppm)	5.00(ppm)	4(ppm)	3.5(ppm)
SULFUR DIOXIDE (SO ₂)	43(ppm)	42(ppm)	40(ppm)	35.1(ppm)	29(ppm)
HYDROCARBON (HC)	1120(ppm)	1090(ppm)	1050(ppm)	800(ppm)	600(ppm)

It can be seen in table.2 that the concentration of different gases decrease with time when waste is burned at different temperature at 15 minutes timing and the result is clear that most of the gases concentration reduced with time which is directly related to temperature .

4. Conclusion and Scope of Future Work

In this paper, a new approach was taken and it was observed that when temperature increases in burning system it results in decreasing concentration of emissions. When gases emits in atmosphere at low concentration it produces less environmental pollution, and it results less acid rain and air pollution.

The major most concern, which has caught thoughts of environmentalists about MSW's incineration, is fabrication of a huge amount of toxic and health effects gases. These are considered staidly injurious and damaging to physical condition. New generators are arranged with special equipments and materials to clean toxic emission of gases from

these injurious components for health. Today there are strict and rigid policies and regulations to follow and conduct incineration. A series of processes are concerned for the cleaning up of flue harmful gas.

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