A Seminar Report on

# “Incineration Plants”

## Need:

Garbage disposal has been a long-standing problem and will continue to be a problem in the future. As the population of the world continues to increase, so will the garbage produced. It is therefore important to seek out the ways that can best be employed to minimize the amount of garbage. Incineration is a method that has become more widely used as the garbage problem has worsened.

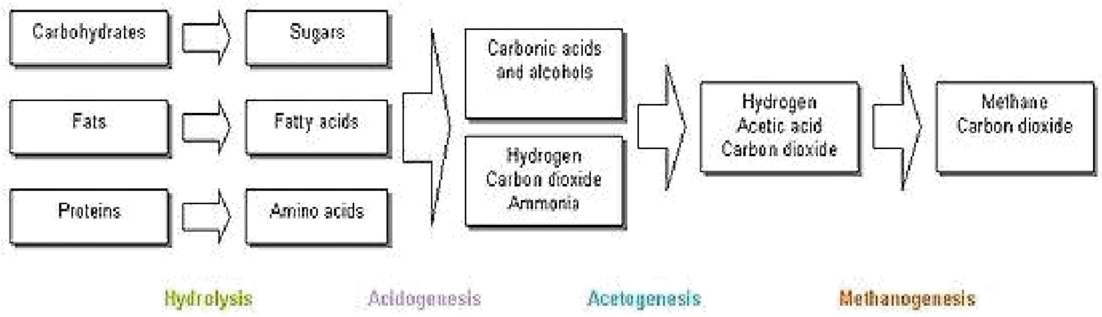
## 1.3 Waste Treatment methods:

### a) Anaerobic digestion:

It is used as part of the process to treat biodegradable waste and sewage sludge. As part of an integrated waste management system, anaerobic digestion reduces the emission of landfill gas into the atmosphere. Anaerobic digesters can also be fed with purpose-grown energy crops, such as maize.

It is a collection of processes by which micro-organisms breakdown bio-degradable material in the absence of oxygen. The process is used for industrial or domestic purposes to manage waste and/or to produce fuels. Much of the fermentation used industrially to produce food and drink products, as well as home fermentation, uses anaerobic digestion. Silage is produced by anaerobic digestion.

The digestion process begins with bacterial hydrolysis of the input materials. Insoluble organic polymers, such as carbohydrates, are broken down to soluble derivatives that become available for other bacteria. Acidogenic bacteria then convert the sugars and amino acids into carbon dioxide, hydrogen, ammonia, and organic acids. These bacteria convert these resulting organic acids into acetic acid, along with additional ammonia, hydrogen, and carbon dioxide. Finally, methanogens convert these products to methane and carbon dioxide. The methanogenic archaea populations play an indispensable role in anaerobic wastewater treatments.




Fig#1.1 Anaerobic Digestion

Anaerobic digestion is widely used as a source of renewable energy. The process produces a biogas, consisting of methane, carbon dioxide and traces of other ‘contaminant’ gases. This biogas can be used directly as fuel, in combined heat and power gas engines or upgraded to natural gas-quality biomethane. The nutrient-rich digestate also produced can be used as fertilizer.

With the re-use of waste as a resource and new technological approaches which have lowered capital costs, anaerobic digestion has in recent years received increased attention among governments in a number of countries, among these the United Kingdom (2011), Germany and Denmark (2011).

If the put rescible waste processed in anaerobic digesters were disposed of in a landfill, it would break down naturally and often anaerobically. In this case, the gas will eventually escape into the atmosphere. As methane is about 20 times more potent as a greenhouse gas than carbon dioxide, this has significant negative environmental effects.

In developing countries, simple home and farm-based anaerobic digestion systems offer the potential for low-cost energy for cooking and lighting. From 1975, China and India have both had large, government-backed schemes for adaptation of small biogas plants for use in the household for cooking and lighting. At present, projects for anaerobic digestion in the developing world can gain financial support through the United Nations Clean Development Mechanism if they are able to show they provide reduced carbon emissions.

Some countries offer incentives in the form of, for example, feed-in tariffs for feeding electricity onto the power grid to subsidize green energy production.

**b) Pyrolysis:**

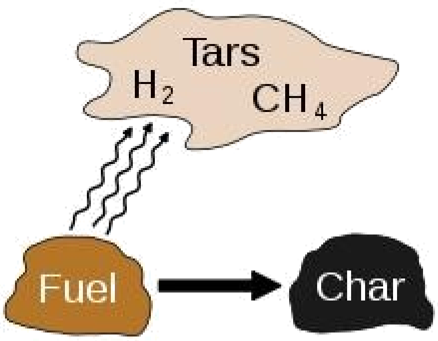
Pyrolysis is a thermochemical decomposition of organic material at elevated temperatures in the absence of oxygen (or any halogen). It involves the simultaneous change of chemical composition and physical phase, and is irreversible. The word is coined from the Greek-derived elements *pyro* "fire" and *lysis* "separating".

Pyrolysis is a type of thermolysis, and is most commonly observed in organic materials exposed to high temperatures. It is one of the processes involved in charring wood, starting at 200–300 °C (390–570 °F). It also occurs in fires where solid fuels are burning or when vegetation comes into contact with lava in volcanic eruptions. In general, pyrolysis of organic substances produces gas and liquid products and leaves a solid residue richer in carbon content, char. Extreme pyrolysis, which leaves mostly carbon as the residue, is called carbonization.

The process is used heavily in the chemical industry, for example, to produce charcoal, activated carbon, methanol, and other chemicals from wood,

to convert ethylene dichloride into vinyl chloride to make PVC, to produce coke from coal, to convert biomass into syngas and biochar, to turn

waste into safely disposable substances, and for transforming medium-weight hydrocarbons from oil into lighter ones like gasoline. These specialized uses of pyrolysis may be called various names, such as dry distillation, destructive distillation, or cracking.




Fig#1.2 Pyrolysis

Pyrolysis also plays an important role in several cooking procedures, such as baking, frying, grilling, and caramelizing. In addition, it is a tool of chemical analysis, for example, in mass spectrometry and in carbon-14 dating. Indeed, many important chemical substances, such as phosphorus and sulfuric acid, were first obtained by this process. Pyrolysis has been assumed to take place during catagenesis, the conversion of buried organic matter to fossil fuels. It is also the basis of pyrography. In their embalming process, the ancient Egyptians used a mixture of substances, including methanol, which they obtained from the pyrolysis of wood.

Pyrolysis differs from other high-temperature processes like combustion and hydrolysis in that it usually does not involve reactions with oxygen, water, or any other reagents. In practice, it is not possible to achieve a completely oxygen-free atmosphere. Because some oxygen is present in any pyrolysis system, a small amount of oxidation occurs.

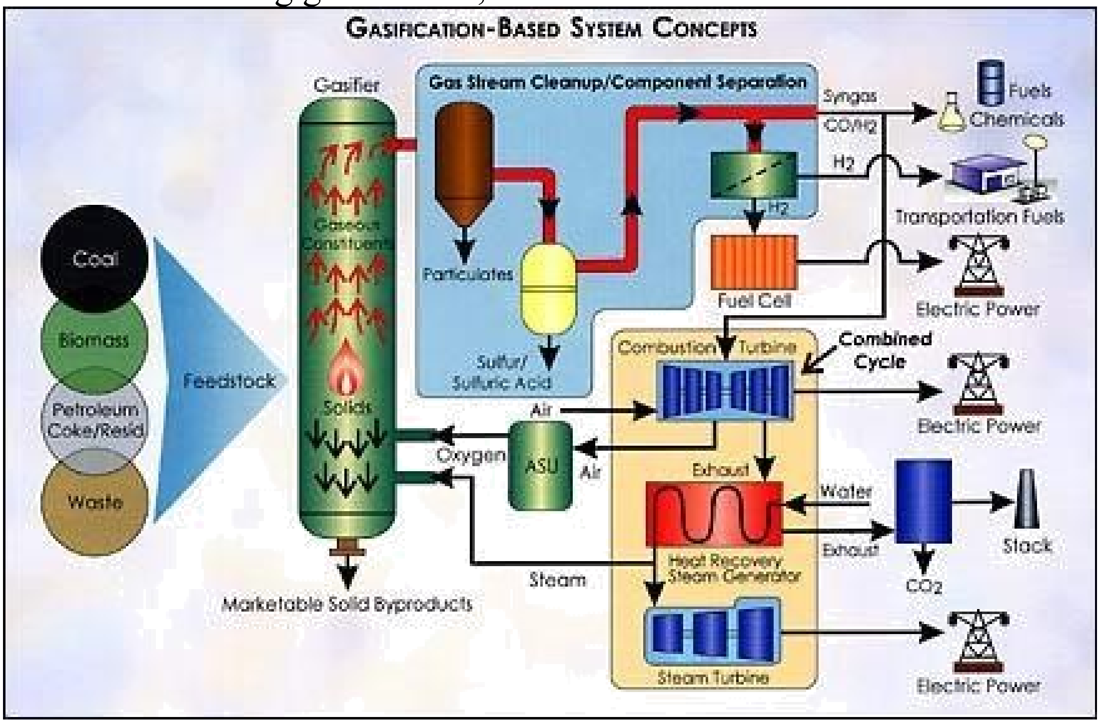
**c) GASIFICATION**:

Gasification is a process that converts organic or fossil based carbonaceous materials into carbon monoxide, hydrogen and carbon dioxide. This is achieved by reacting the material at high temperatures (>700 °C), without combustion, with a controlled amount of oxygen and/or steam. The resulting gas mixture is called *syngas* (from *synthesis gas* or *synthetic gas*) or *producer gas* and is itself a fuel. The power derived from gasification and combustion of the resultant gas is considered to be a source of renewable energy if the gasified compounds were obtained from biomass.

The advantage of gasification is that using the syngas is potentially more efficient than direct combustion of the original fuel because it can be combusted at higher temperatures or even in fuel cells, so that the thermodynamic upper limit to the efficiency defined by Carnot's rule is higher or not applicable. Syngas may be burned directly in gas engines, used to produce methanol and hydrogen, or converted via the Fischer–Tropsch process into synthetic fuel. Gasification can also begin with material which would otherwise have been disposed of such as biodegradable waste. In addition, the high-temperature process refines out corrosive ash elements such as chloride and potassium, allowing clean gas production from otherwise problematic fuels. Gasification of fossil fuels is currently widely used on industrial scales to generate electricity

Scottish engineer William Murdoch gets credit for developing the basic process. In the late 1790s, using coal as a feedstock, he produced syngas in sufficient quantity to light his home. Eventually, cities in Europe and America began using syngas or "town gas" as it was known then to light city streets and homes. Eventually, natural gas and electricity generated from coal-burning power plants replaced town gas as the preferred source of heat and light.

Today, with a global climate crisis looming on the horizon and power-hungry nations on the hunt for alternative energy sources, gasification is making a comeback. The Gasification Technologies Council expects world gasification capacity to grow by more than 70 percent by 2015. Much of that growth will occur in Asia, driven by rapid development in China and India. But the United States is embracing gasification, as well.




Fig#1.3 Gasificaton

**Coal Gasification**

The heart of a coal-fired power plant is a boiler, in which coal is burned by combustion to turn water into steam. The following equation shows what burning coal looks like chemically: $C + O_2 \rightarrow CO_2$. Coal isn't made of pure carbon, but of carbon bound to many other elements. Still, coal's carbon content is high, and it's the carbon that combines with oxygen in combustion to produce carbon dioxide, the major culprit in global warming. Other byproducts of coal combustion include sulfur oxides, nitrogen oxides, mercury and naturally occurring radioactive materials.

The heart of a power plant that incorporates gasification isn't a boiler, but a **gasifier**, a cylindrical pressure vessel about 40 feet (12 meters) high by 13 feet (4 meters) across. Feedstocks enter the gasifier at the top, while steam and oxygen enter from below. Any kind of carbon-containing material can be a feedstock, but coal gasification, of course, requires coal. A typical gasification plant could use 16,000 tons (14,515 metric tons) of lignite, a brownish type of coal, daily.

A gasifier operates at higher temperatures and pressures than a coal boiler -- about 2,600 degrees Fahrenheit (1,427 degrees Celsius) and 1,000 pounds per square inch (6,895 kilopascals), respectively. This causes the coal to undergo different chemical reactions. First, partial oxidation of the coal's carbon releases heat that helps feed the gasification reactions. The first of these is pyrolysis, which occurs as coal's volatile matter degrades into several gases, leaving behind char, a charcoal-like substance. Then, reduction reactions transform the remaining carbon in the char to a gaseous mixture known as syngas.

Carbon monoxide and hydrogen are the two primary components of syngas. During a process known as gas cleanup, can remove harmful impurities, including sulfur, mercury and unconverted carbon. Even carbon dioxide can be pulled out of the gas and either stored underground or used in ammonia or methanol production.

That leaves pure hydrogen and carbon monoxide, which can be combusted cleanly in gas turbines to produce electricity. Or, some power plants convert the syngas to natural gas by passing the cleaned gas over a nickel catalyst, causing carbon monoxide and carbon dioxide to react with free hydrogen to form methane. This "substitute natural gas" behaves like regular natural gas and can be used to generate electricity or heat homes and businesses.

Biomass gasification works just like coal gasification: A feedstock enters a gasifier, which cooks the carbon-containing material in a low-oxygen environment to produce syngas.

**Feedstock**

There are a large number of different feedstock types for use in a gasifier, each with different characteristics, including size, shape, bulk density, moisture content, energy content, chemical composition, ash fusion characteristics, and homogeneity of all these properties. Coal and petroleum coke are used as primary feedstocks for many large gasification plants worldwide. Additionally, a variety of biomass and waste-derived feedstocks can be gasified, with wood pellets and chips, waste wood, plastics and aluminium, Municipal Solid Waste (MSW), Refuse-derived fuel (RDF), agricultural and industrial wastes, sewage sludge, switch grass, discarded seed corn, corn stover and other crop residues all being used.

**2.3 How do Incinerators work:**

**Reception Area/Tipping Hall**

On entering the incineration facility, waste trucks make their way to the tipping hall. Here the waste is offloaded into large bunkers for storage. The air in the reception area and in the bunkers is maintained at a lower pressure than outside (negative pressure) and this prevents odours escaping.

**Grab System**

Waste will be received from both household and commercial sources. Some of the waste will be bulky in nature, so it may need to be broken down into smaller pieces. Overhead traverse cranes fitted with grapples mix the waste before feeding it into the furnace hoppers. The mixing of the waste is useful in producing a more uniform fuel that will help maintaining a steady combustion process within the desired operating conditions

**Combustion Chamber**

The cranes and grabs transfer the mixed waste from the bunker to the furnace 'hopper'. This process can be fully automatic in modern incineration plants. At the bottom of the hopper a metering ram pushes the waste onto the combustion grate, which agitates and transports the waste through the combustion chamber. Combustion takes place at temperatures of 850 – 1100 $^{o}$ C, the temperature at which odour of gases and all dioxins will be destroyed.

**Fly Ash**

Fly ash is the particulate removed during the gas cleaning phase. It is generally about 1-3% by weight of the original waste. Fly ash is considered hazardous and so it must be disposed of in a specially designed facility. At present there are no hazardous waste facilities in Ireland, so hazardous material will be exported for safe disposal.

**Flue Gases**

The combustion process produces flue gas containing water vapour, nitrogen, carbon dioxide, nitrogen oxides, oxygen and particulate matter. Some of these compounds are harmful to health and therefore the flue gas is thoroughly cleaned before it is discharged to the air. The flue gas cleaning equipment of a modern incineration plant is complex and can take up about half of the space within the plant. There are various flue gas cleaning designs, but modern plants generally include the following stages:

Electrostatic Precipitators (ESP): The ESP will initially remove 99% or more of particulates. These are primarily dust and ash particles, but may also include minute quantities of heavy metals, dioxins and furans.

Acid Gas Scrubbing: This consists of a lime mixture being injected into the gas stream. This reacts to neutralise acid gases such as sulphur dioxide, hydrogen fluoride and hydrogen chloride. Activated Carbon Activated carbon injection is used to remove organic compounds such as dioxins and also volatile metals such as mercury or cadmium. The activated carbon provides a surface onto which the heavy metals can adhere and these will then be filtered out at a later stage.
Filtration : The final filtration of particulate matter typically uses a bag house filter (fabric filter). At this stage of the cleaning process, particulate matter is primarily made up of spent activated carbon and spent hydrated lime (from the earlier part of the cleaning process). This material is usually recycled back into the combustion chamber to ensure that dioxins are properly destroyed in the high temperatures.

**Electricity Generation**

A boiler converts the energy from the combustion into high pressure steam. The combustion chamber is surrounded by water tube walls, which are heated by radiation from the combustion. The hot flue gases release additional heat in additional tube panels in the boiler. The steam goes into a turbine, which drives an electric generator. Generally, about 10% of the electricity is used on site and the remainder is fed into the national grid. The incineration of 400,000 tonnes of waste can supply the annual electricity consumption of more than 30,000 homes. The heat remaining after the electricity production can be used to heat water, which can be directly piped to people's homes in a district heating system. This can supply the annual requirements for heating and domestic hot water for approximately 25,000 homes.

## 2.5 Bottom Ash

At the end of the grate the solid waste has been completely burned out. The remaining residue is called bottom ash, which is ejected at the bottom of the combustion chamber. The bottom ash corresponds to about 15 - 20% by weight or 4-6% by volume of the original waste. After storage the bottom ash may be screened into fine and coarse fractions and the ferrous metals (iron or steel) in the ash will be extracted using large magnets. The metals represent 5 - 10% of the bottom ash and are sent to the steel works for recycling. The remaining bottom ash is non-hazardous and is typically used in other applications such as an aggregate in concrete or for road building.

## 2.6 Selection & Installation:

As we have discussed the basics of incineration process, it is equally important to be aware of the dimensions of Incineration plants, converting Waste-to-Energy, serving as a means of disposing vast amount of waste for benefit of masses. An Incinerator manufacturing company “S.A. Incinerator Co. (Pty) Ltd” provides the sizes of plant, room, chimney as per the Kg/hr of general waste, figure and table are to be included as below:

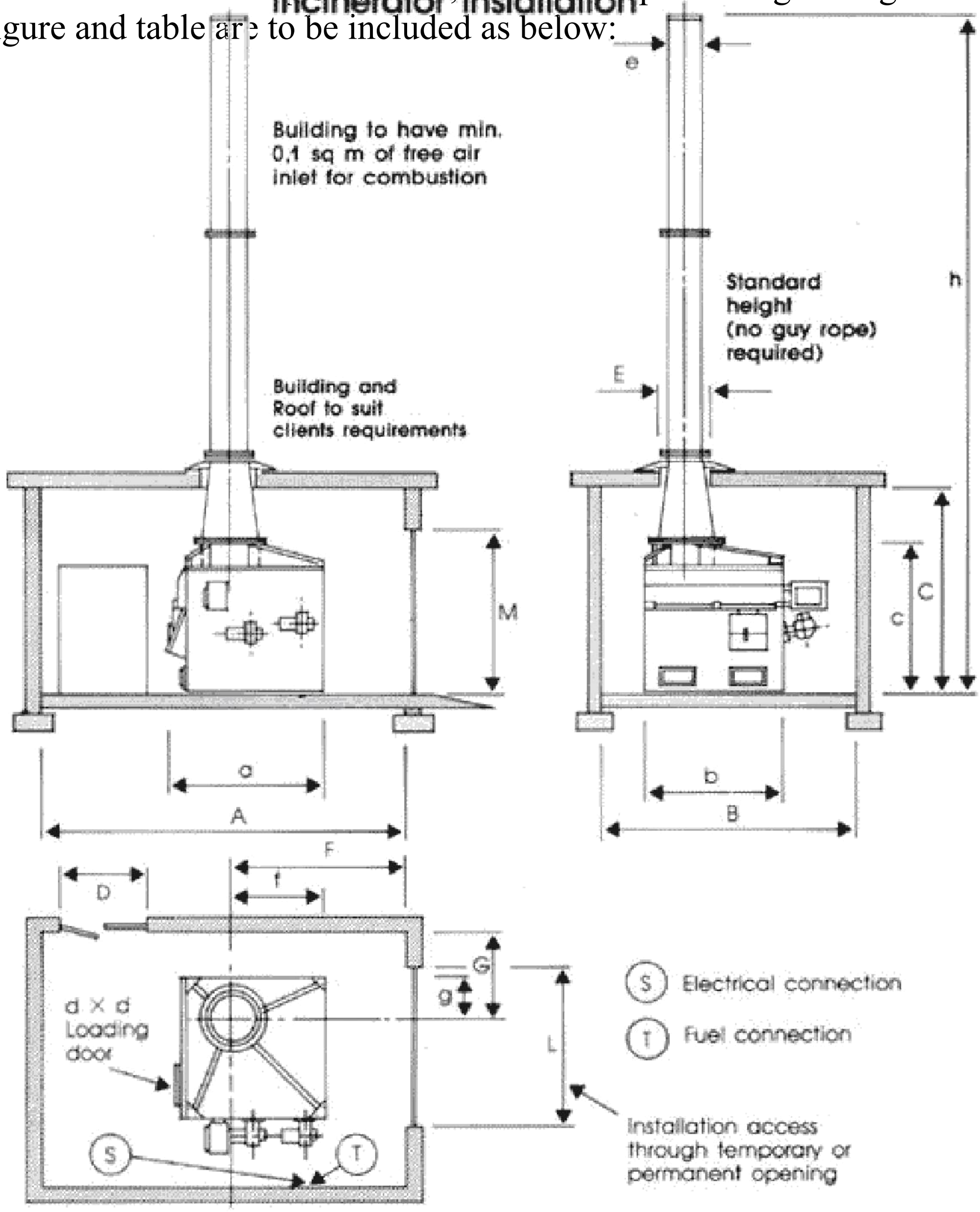


Table 1 gives the capacities of our incinerators in kg per hour of general waste, the incinerator dimensions and capacity data, including the chimney dimension and room sizes:

**General**

Waste in Kg/hr

**Incinerator Dimensions**

15kg 25kg 50kg
70kg 120kg
160kg 220kg
330kg 500kg

Length
a mm
900
1 050
1 700
1 940
2 125
2 590
2 840
3 030
1.66
Width
b mm
930
990
1 450
1 650
1 890
2 140
2 450
2 760
3 430
Height
c mm
780
1 270
1 730
2 090
2 125
2 410
2 710
3 200
3 440

Loading Door
d mm
330
450
610
610
610
610
750
750

**Chimney Dimensions**

Diameter
e mm
230
290
380
380
430
480
560
770
920
Position
f mm
-
795
960
1 060
1 275
1 500
1 663
1 442
2 210
Position
g mm
-
247
375
490
550
633
653
800
1 000

Standard Height (No Guys)
h mm
6 000
8 470
10 430
10 790
11 000
11 500
12 000
15 000
15 240

**Capacity Data**

Grate Heath Area
$m^2$
0.24
0.28
0.58
0.90
1.19
1.50
2.00
2.70
3.70

Primary Volume
$m^2$
0.11
0.16
0.45
0.78
1.05
1.36
2.40
3.82
5.60

Secondary Volume (Total)
$m^2$
0.15
0.18
0.45
0.71
1.19
1.74

2.72
3.64
5.08

Incinerator Mass
kg
600
1 680
3 100
4 800
6 400
8 150
13 200
19 200
13 500

Chimney Mass (Std)
kg
40
160
260
260
500
580
780
1 490
1 790

**Recommended Room Sizes**

Length
A mm
4 000
4 000
5 000
5 500
5 500
6 000
6 500
9 000
10 600

Width
B mm
3 000
3 000
3 000
3 500
4 000
4 000

4 500
6 000
6 500
Height
C mm
2 800
2 800
3 000
3 300
3 400
3 700
3 700
5 000
5 500
Doorway
D mm
-
1 600
1 600
1 600
1 800
1 800
1 800
2 000
2 000
Flue Outlet Hole
Dia.
E mm
-
400
600
600
650
700
780
1 000
1 200
Flue Position
F mm
-
1 800
1 960
2 060
2 280
2 500
2 670
2 390
3 210
Flue Position
G mm
-
1 250
1 380
1 500
1 550

1 640
1 650
1 830
2000
Across Opening Width
L mm
-
1 890
2 300
2 650
2 900
3 140
3 500
3 900
4 000
Across Opening Height
M mm
-
1 770
2 200
2 600
2 620
2 900
3 200
4 000
4 000

Table#2.1 Incinerator Dimensions based on Capacity

# CHAPTER-3

# Effects of Incineration

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### 3.1 Incinerator emissions and their effects

By-products of incineration include polychlorinated dibenzo-p-dioxins and polychlorinated dibenzo furans. These substances have been shown to cause cancer. Studies have shown that these substances are also present due to background exposure. A comparison of the background exposure with the exposure due to incinerators reveals that furans and dioxins emitted from incinerators is small compared to the background exposure. Table 1 compares the two types of exposure. The data indicate that exposure from the incinerator makes up a very small fraction of the exposure due to other background sources. Much debate exists on this subject though. Dioxins and furans can be a real problem if a population is exposed long enough. These substances have been found to build up in the fatty tissue of the body. Most substances will pass through the body and will not remain and large amounts of exposure are required to reach toxic levels. This is not the case with dioxins and furans. A process known as bio-concentration traps the cancerous substances in the fatty tissue and it continues to accumulate and increases the chance of reaching toxic levels. This property of dioxins and furans is cause for much concern.

**Table#3.1**-Comparison of Background and Incinerator Exposure to dioxins and furans

Exposure to these substances occurs in many different ways. Inhalation is the most common way. The substances can accumulate on plants and in backyard garden produce also. Ingestion of soil and dust that has been contaminated poses a threat especially to small children who may be playing in the backyard where a sandbox might be contaminated.

Furthermore, fish and animals can become exposed through drinking and consuming contaminated water and plant life. Thus, the food consumed could expose a person further. It has also been found that cow’s milk and the nursing mother’s milk is another source of dioxins and furans. The Munich Region of the German Medical Association made this declaration in 1990: “According to the German Health Agency, milk from nursing women is twenty times more contaminated with dioxin than cow’s milk. The multitude of contaminants a woman has accumulated in her body over a time span of two to three decades reappears during nursing and is transferred to the baby." Also, a Dutch government report stated in 1989 that: "The contribution of waste incineration to PCDD (dioxin) and PCDF (furan) contamination of the general population amounts to approximately 30 per cent. Waste incineration constitutes the greatest point source of emission of these substances".

**Predicted Average Daily Intake of TCDD through the Food Chain**

| Food group | Daily intake (pg/d)[a] | Daily intake (%) |
|---|---|---|
| Fruits and vegetables | 0.14 | 3.9 |
| Potatoes | 0.001 | 0.03 |
| Leafy vegetables | 0.061 | 1.7 |
| Nondried legumes | 0.008 | 0.2 |
| Dried legumes | 0.007 | 0.2 |
| Root vegetables | 0.0002 | 0.01 |
| Garden fruits | 0.067 | 1.8 |
| Grains and cereals | 0.0003 | 0.01 |
| Milk and dairy products | 0.72 | 19.7 |
| Meat (total) | 2.43 | 65.9 |
| Beef | 1.95 | 53.0 |
| Beef liver | 0.37 | 10.0 |
| Pork | 0.018 | 0.5 |
| Poultry | 0.086 | 2.4 |
| Lamb | 0.001 | 0.01 |
| Eggs | 0.08 | 2.1 |
| Soil ingestion[b] | 0.06 | 1.6 |
| Inhalation[c] | 0.25 | 6.8 |
| Total | 3.68 | 100.0 |

[a] Picograms per day.
[b] Calculated using a soil concentration of $1.6 \times 10^{-6}$ μg/g DW.
[c] Calculated using an average inhalation rate of 20 $m^3$/d.

Table#3.2 Predicted avg. Daily intake of TCDD

Table 2 shows the exposure to these substances through the food chain. Meat constitutes the largest percentage of exposure due most likely to the many ways that animals are exposed. The table doesn't indicate how the substances got there in the first place but is still useful in understanding the main sources of exposure. Table 3 shows the new cases of cancer due to MSW incinerators. Once again, these data will continue to be updated as exposure to these substances is better understood. It is not known exactly how much exposure is due to an incinerator and how much is due to background sources. It is known that these substances are carcinogenic and that incinerators can contribute to the

**Estimated Nationwide Cancer Risk from Inhalation Exposure to MWC Emissions (baseline scenario)**

| | Organics[a] | | Metals[b] | | Combined | |
|---|---|---|---|---|---|---|
| | Ann. incid.[c] | Max. indiv.[d] | Ann. incid. | Max. indiv. | Ann. incid. | Max. indiv. |
| Existing sources (1985) | | | | | | |
| Massburn (nonheat recovery) | 1—30[e] | $10^{-4}$—$10^{-3}$ | 0.2 | $10^{-5}$ | 1—30 | $10^{-4}$—$10^{-3}$ |
| Massburn (heat recovery) | 0.2—4 | $10^{-4}$—$10^{-3}$ | 0.04 | $10^{-6}$ | 0.2—4 | $10^{-4}$—$10^{-3}$ |
| RDF | 0.1—3 | $10^{-5}$—$10^{-3}$ | 0.2 | $10^{-5}$ | 0.3—3 | $10^{-5}$—$10^{-3}$ |
| Modular | 0.0008—0.01 | $10^{-6}$—$10^{-4}$ | 0.01 | $10^{-6}$ | 0.01—0.02 | $10^{-6}$—$10^{-4}$ |
| Existing total[f] | 2—40 | $10^{-6}$—$10^{-3}$ | 0.5 | $10^{-5}$ | 2—40 | $10^{-6}$—$10^{-3}$ |
| Projected sources (1993) | | | | | | |
| Massburn (heat recovery) | 0.3—7 | $10^{-6}$—$10^{-5}$ | 0.3 | $10^{-6}$ | 0.6—7 | $10^{-6}$—$10^{-5}$ |
| RDF | 0.8—10 | $10^{-5}$—$10^{-4}$ | 0.1 | $10^{-6}$ | 0.9—10 | $10^{-5}$—$10^{-4}$ |
| Modular | 0.04—0.9 | $10^{-6}$—$10^{-5}$ | 0.01 | $10^{-6}$ | 0.05—0.9 | $10^{-6}$—$10^{-5}$ |
| Projected total[f] | 1—20 | $10^{-6}$—$10^{-4}$ | 0.4 | $10^{-6}$ | 2—20 | $10^{-6}$—$10^{-4}$ |
| Combined total[f] | 3—60 | $10^{-6}$—$10^{-3}$ | 0.9 | $10^{-5}$ | 4—60 | $10^{-6}$—$10^{-3}$ |

[a] CDDs, chlorophenols, chlorobenzenes, formaldehyde, PCB, PAH. Risk ranges for organics result from assumptions about the carcinogenicity of pollutant classes and the recovery efficiency for CDD/CDF in stack tests.
[b] Arsenic, beryllium, cadium, chromium (+6).
[c] Annual incidence is the modeled number of cancer cases per year in population within 50 km of all municipal waste combustors in the U.S.
[d] Maximum individual risk is the modeled portability that a person exposed to the highest modeled concentration of pollutants from a municipal waste combustor will develop cancer over his or her 70 year lifespan.
[e] rounded to one significant figure. See text for assumptions involved in producing these estimates.
[f] Totals do not add due to rounding.

Table#3.3-Cancer risk due to exposure to MWC Emissions

Bottom ash is another source of pollution. This is the ash that doesn't escape but is collected by the facility. This ash is highly toxic and must be properly treated or high amounts of exposure will exist. The bottom ash consists of 70- 95% inorganic which are not harmful. The remaining 5-30% consists of organics which contain the harmful dioxins, furans, and trace metals. The residual ash is generally taken to a landfill where proper disposal takes place. Proper disposal of the ash in a sanitary landfill is paramount to eliminating the contamination potential that exists. A well constructed sanitary landfill will help to contain the harmful leachate that forms when water drains through the landfill. If the leachate were not contained, it could very easily contaminate groundwater which could be the cause of exposure in many sources. Although the contaminants that result from the process of incineration are harmful, different methods of reducing them exist.

**3.2 Emission reduction methods**

The amounts of dioxins and furans that are produced are controlled in part by different combustion parameters. The temperature during the incineration process can greatly affect the amounts present. The higher the temperature, the lower the amounts. Retention time also plays a role in how much contaminant is left over. The longer the waste is burnt, the lower the amounts of dioxins and furans that are formed. The pollution control equipment that is used varies in the amount of oxygen and carbon dioxide that is used which affect the emissions also. Oxygen is needed to aid in the combustion process.

The type of combustion system installed will also be important. Some incinerators have a two-stage process that the waste goes through while others only have a single stage. The waste that is put in the incinerator will have an obvious affect on the emissions. As stated earlier, a waste stream containing high amounts of metals will yield higher levels of trace metals. The physical and chemical properties of the metals are also important as some trace metals are more toxic than others. The use of scrubbers to catch some of the fly ash is an effective way to reduce the emissions. The scrubber traps the harmful ash and disposes of it along with the bottom ash. The use of a scrubber can reduce the dioxin and furan emissions by a total of 86%. The use of baghouses produces a similar result as they reduce the emissions. The use of baghouses in an incineration facility can reduce the number of cancer cases by an order of magnitude. Although incinerator supporters are seeking to reduce the emissions, many are still not convinced. Paul Connett, a researcher and dioxin expert at St.

Lawrence University says this: "There's no such thing as a 'safe' incinerator because there's a Catch-22, the better the incinerator is at protecting the air, the more toxic the ash is going to get."

Although there is much truth to this statement, proper handling of the toxic ash by disposing of it in a sanitary landfill is a safe way to deal with the ash whereas the fly ash could contaminate many sources unimpeded. As concern over exposure to these pollutants increases, the effectiveness of reducing the emissions will become more important if incineration is to survive.

### 3.3 Hazardous Waste Incineration

Hazardous waste incineration poses similar threats and the process is much the same. The main emissions of concern are unburned organic wastes, heavy metals, by products of incomplete combustion, and acid gases. One of the key advantages in any incineration process. is that it can destroy organic substances permanently. Metals are not destroyed but are often changed physically and chemically. Most emissions in hazardous waste incinerators are in the particulate matter form. The main problem with particulate matter is that it causes respiratory problems in those exposed to the fine particles. Particulate matter emissions are found in municipal hazardous waste incinerators also. One difference between a hazardous waste incinerator and a municipal one is in the amounts of permissible outputs of heavy metals and toxic organic compounds. Higher outputs are allowed in municipal incinerators. Thus, a hazardous waste facility with only primary control on emissions show detectable increased amounts of heavy metals and other emissions within only a few miles of the facility. The data on the effects of a hazardous waste facility are again fairly arbitrary due to the limited amount of data on the subject. It has been shown that people living near a hazardous waste incinerator facility are more likely to have respiratory problems than those who do not live near one. Studies have shown that the substances emitted by a hazardous waste facility bio-concentrate in the same manner as in the municipal waste incinerators. This seems to be another fairly important issue. It has also been observed that higher levels of anxiety exist in communities located near a hazardous waste incineration facility. One way to reduce the anxiety level would be to educate the people on the incineration process. Overall, a comparison of a hazardous waste incineration facility and a municipal one shows that the processes produce similar emissions. Living near a hazardous waste incinerator is probably safer due to the stricter regulations placed on this type of facility.

### 3.4 Persistence of engineered nanoparticles in a municipal solid-waste incineration plant

Engineered nanoparticles are often designed to be evenly distributed, insoluble and stable when incorporated into consumer goods. However, these characteristics can pose problems when the nanoparticles enter the natural environment. For example, the use of persistent chemicals such as fluoro-chloro-hydrocarbons in fridges has depleted the stratospheric ozone layer, and the use of fibrous solids such as asbestos in building materials has resulted in high incidences of mesothelioma. Furthermore, the widespread use of insecticides has seen various fluorinated compounds, dioxins and halogenated biphenyl compounds accumulate in the food web. It is expected that exposure of the biosphere to persistent nanoparticles may also result in similar undesirable outcomes, so the best precautionary measure is to limit their presence and residence time in the environment. This means that there is a need for proper disposal of persistent nanoparticles.

So in a research performed by Walser, the nanoparticles were introduced either directly onto the waste before incineration or into the gas stream exiting the furnace of an incinerator that processes 200,000 tonnes of waste per year. Nanoparticles that attached to the surface of the solid residues did not become a fixed part of the residues and did not demonstrate any physical or chemical changes. And observations show that although it is possible to incinerate waste without releasing nanoparticles into the atmosphere, the residues to which they bind eventually end up in landfills or recovered raw materials, confirming that there is a clear environmental need to develop degradable nanoparticles.

### 3.5 Other issues related to Pollution:

Older models of incinerators have inconvenience that this produce odor pollution. However, in modern plants are saved from producing dust and odor pollution. They are designed to store waste in enclosed containers along with a negative pressure to keep from odour and dirt dispersal. Another issue that is affecting community is increased load of traffic due to WCV for hauling waste materials. This is the issue, which has forced incinerators to move in to industrial areas.

# Chapter-4

# Debate over Incineration Plants

### 4.1 Incineration vs. Recycling

The relationship between incineration and recycling is debatable and is viewed as a complementary relationship by some and a competing relationship by others. An incinerator burns everything that is in the waste stream. One way that incineration would then compete with recycling is by burning products that could be recycled. Products like bottles, paper, and plastics are recyclable materials that get wasted in an incinerator.

Yard wastes are another example of products that get wasted in the incineration process. Yard wastes could be recycled in their own right through the process of composting. The by-products turn into an effective fertilizer that can be sold and used. The problem with recycling is getting the people to do it. In Japan, over half of the garbage is reused. In the United States, only about 10% of the garbage is recycled. Competition also is evident between recycling and incineration by nature of the incineration process demands. The incineration process requires a city to sign a contract stating that they will have a steady stream of garbage to incinerate or they will pay the plant for the time when there is none. This provides an incentive to make more garbage. Recycling would be in direct competition with this motive. More garbage is available if recycling is not taking place.

Incineration also gives the idea that the growing garbage problem can be solved by burning it. This false security discourages people to recycle and reuse the recyclable goods that are out there. It doesn't solve the problem but rather it delays the solution in a way. Although it seems that incineration only impedes the recycling process, it could also enhance it. As of today, possibly the best solution to the garbage problem is a combination of incineration and recycling. The two best ways to reduce the volume of garbage once it has been produced are to recycle and incinerate. Incineration of garbage doesn't rely on public involvement as recycling does though. The garbage will be burnt and thus reduced with or without the public's participation. The recycling process is different this way. It depends on the participation of the people to work. If the people are not sold on the idea of recycling, then it will not be an effective way to reduce the waste stream.

If recycling is taken seriously, it would compliment the incineration process in different ways. Although it may reduce the garbage coming into an incineration plant, recycling of wastes such as paper and plastics would reduce the amounts of furans, dioxins, and other harmful pollutants that are introduced into the environment via incineration. This reduction of garbage may fail to meet the quota of garbage needed by an incinerator to be economical but would be an effective means to reduce the pollutants emitted into the environment. The recycling of metal products would also be an effective way to reduce the pollution that is harmful to human health. This would be especially helpful in reducing the trace metal production which has been proven to be especially harmful to the respiratory system. In some countries, the people are very active in the recycling process. The support of the people in the recycling process is essential if this is to be an effective means of garbage management. In the United States, recycling is starting to catch on but is not as widely accepted as in other countries. The people are basically too lazy to make it work. In some third-world countries, garbage is considered to be a valuable resource. Some people in these countries make a living out of collecting garbage that can be sold for money to facilities that will recycle it. Metals are the most valuable to the people who do this as they are usually worth the most.

Another way in which the two processes of incineration and recycling might compliment each other is if the recycling process occurred right at the plant. In some plants, the garbage is already sorted to a small extent. In plants that use refuse-derived fuel, garbage separation is used extensively to enhance the combustibility of the waste stream. Therefore, since some plants already separate some of their garbage, it could be possible to get them to separate more of it for recycling purposes. This would obviously cost more to do but would be an option to consider. This method would not rely on the people to recycle the wastes but would be handled directly by the plant. The plant would stand to make a profit from the recyclable goods they find and these could be sold. Although it seems that recycling and incineration can counteract each other, it is also possible that these two methods used together could be the most effective way to deal with the growing garbage problem. With no other solution out there that can reduce the waste by the amount that recycling and incineration can, these should be considered as some of the top options for garbage disposal.

**Advantages of Incineration**

The main advantage of incineration over all other methods is the volume reduction. This is important in small cities where space is scarce and landfill plots are not available.

Incineration plants can also be located close to the area of service which makes it more cost effective than other methods where the garbage must be transported long distances before ultimate disposal.

Incineration plants can be in operation 24 hours a day which allows for increased net garbage disposal per day. They also can operate in any type of weather unlike other methods where bad weather can shut down the operation.

The by-product of incineration is the ash of the garbage that was burnt. The ash produced is in a stable form and consists mainly of inorganic material. The types of refuse that are used in a landfill are numerous. All refuse can be burnt in an incinerator with few exceptions.

Unlike landfills, incinerators do not take up large plots of land which make it a good option for small cities.

The odours and rodents that are present in other methods are not a problem when using incineration as a garbage disposal method. Finally, money can be made that can help to pay for the cost of the incinerator.

If steam is a marketable item to produce hot water, electricity, or other things, some incinerators can recycle the steam and money can be made.

As this discussion has proven, incineration solves many of the problems so common to other methods of municipal garbage disposal. As can be seen from the discussion that will follow, incineration poses other problems that are still being studied and are not fully understood.

**Disadvantages of Incineration**

Incineration poses environmental problems and other possible problems as well. The large stacks that emit the excess heat and gases from the waste contribute to the greenhouse effect. As the greenhouse effect is better understood in the coming years, the use of incineration as a method of garbage disposal could dwindle.

The emissions coming from the stacks of incineration plants consist of other potentially harmful substances that pollute the air. These emissions can be distributed through other media such as plants, water, soil, and in animals. The emissions can thus become a part of the food chain which can lead to further exposure. The emissions will be discussed later on.

The initial cost of building an incinerator plant can be very high and thus may not be reasonable solution in some places where another method is cheaper. Once the facility is built, problems can also occur. Although the process of incineration is simple, the machinery that drives the process is not. If something goes wrong with the incinerator and maintenance is required, repairs can become very costly.

Since incineration is still a relatively new mode of disposal, the machinery is still in its developmental stages and is being improved and will continue to be improved in the future.

An incinerator requires fewer employees to operate it than a municipal landfill would but the employees that run an incinerator facility must also be trained and are usually paid more than employees at a landfill.

A key disadvantage to incineration is that all the waste stream is burned including materials that could possibly be recycled. Thus incineration can cancel out the benefits that recycling produces.

All trash that is brought to an incinerator does not all disappear. The ash that is left over after incineration is usually 1/5 to 1/10 the volume of the waste that was incinerated. The ash contains toxic materials that must be dealt with and usually are taken to a landfill. Ash that is left over is called bottom ash. Ash then escapes the plant and is released through the stack is called fly ash and poses other problems. The health implications of both types of ashes will be discussed later. The stack also releases toxic trace metals that can lead to respiratory problems if ingested.

Though many disadvantages exist when using an incinerator, many ways of dealing with these problems also exist

# Chapter-5

# INDIAN SCENARIO

### 5.1 Other Garbage Disposal Methods

Various methods exist to deal with the mountains of garbage produced in the world. Dumping is the most basic form of garbage disposal and requires the least amount of work. The garbage is simply dumped on the land. This method is inexpensive and the most offensive because insects and rodents flock to the area. Bad odours also exist as the garbage is not covered with any sort of ground cover. Open burning is similar to dumping. Garbage is dumped on the land and then it is burned. The same problems exist as before but volume is reduced and less land is required for the garbage. This method raises obvious health problems related to air pollution of the surrounding areas. A more sound and accepted method is the sanitary landfill. The garbage is buried in the ground in a sanitary manner. The landfill is lined with different layers of impervious materials that prevent contamination of the groundwater. Because the garbage is covered with layers of soil, rodents are not a problem. This method requires more land than the previous two methods. Other problems include dust, odours, leaching, and formation of explosive gases in the area of the landfill that is decomposing. Leachate poses a significant threat when water seeps down through the landfill. If hazardous contaminants exist in the landfill, the water runoff can transport those contaminants in a liquid phase to the groundwater. Composting is the process of degrading organic material into a harmless and sanitary form. This is commonly done with yard wastes and is a sound method. The products can be used as fertilizer at a later stage. The disadvantage of this method is that it only deals with organic wastes. Another way to dispose of garbage is to dump it at sea. This method has many drawbacks though. The garbage may not stay at the bottom of the sea and furthermore the garbage can have ill effects on the marine life. Swine feeding is the last method that will be discussed. Cooked food wastes are fed to the swine and thus part of the waste stream is eliminated. Problems with this mode of disposal include only partial disposal of the waste stream and possible adverse health effects to the swine. Some cities manage their garbage by paying other cities to landfill their garbage as the city of Islip, New York did while other cities simply transport the garbage out to some remote area like a desert and dispose of it there. As can be seen from this discussion on the various methods of disposing garbage, each has distinct disadvantages. Incineration solves many of the problems of the previously discussed garbage disposal methods. It also has its drawbacks and some of them are still being studied as incineration is still in its infancy as a way to manage garbage.

**Source: MPCB, March 2008**

Table#5.1: Status of Disposal of Solid waste in Municipal Corporations

**Future in India:**

**Budget 2013: Waste-to-energy gets fund boost**

With the government throwing its weight behind waste-to-energy (WTE) plants in this year's Budget, a debate has started on the need for, and suitability of, such projects. Waste management across most parts of the country is in a mess and in cities like Delhi, where a WTE plant has been operating for more than a year, municipal agencies say it is the best way to manage waste. However, environmentalists say incineration is not a suitable technology for India.

For the first time, the government has made a budgetary provision to encourage setting up of WTE plants. In his Budget speech, finance minister P.

# Chapter-6

# Conclusion

It may also be assumed that too little is known of the effects of incineration to adequately conclude whether or not they are safe. More time and testing is needed to conclude for sure if these facilities are harmful to the health of the communities around them. The pollutants of the incineration process are known to be harmful. Furans and dioxins are known to be carcinogenic but it is not sure what amounts will cause cancer. The trace metals are known to cause respiratory problems and studies seem to indicate that people living around an incinerator plant will have more respiratory problems. The concept of bio-concentration is also an important factor to consider because some of these pollutants do not pass through the body like most other harmful pollutants. They can concentrate themselves in the body’s fatty tissue and thus accumulate until harmful levels are reached. A solution to part of this problem is the use of scrubbers and bag-houses to collect some of the harmful fly ash that carries these pollutants. These mechanisms have been shown to effectively reduce the amount of pollutants and thus the risk of exposure. Incineration is not the only source of these harmful pollutants. Background exposure is the main source of these pollutants and the amount of pollutants produced by the incineration process is a fraction of that observed naturally. This should be a cause for concern because the source of the natural exposure is not known. The interaction of incineration with the recycling process is an important one to consider also. As the world continues to grow and more and more resources are used, it will be important to conserve and reuse these resources. Incineration burns many resources that could be recycled and reused. The process also requires a continuous waste stream and recycling can reduce the waste needed to keep an incinerator operating. The two could supplement each other, the incinerator plant made an effort to recycle some of the waste prior to burning it. Reduction of paper and other recyclable materials could greatly reduce the harmful stack emissions. The best solution to the garbage problem seems to be a combination of recycling and incineration. These two methods will reduce the volume of garbage more than any other methods. Overall, incineration solves many problems that are inherent to other waste disposal processes. Volume reduction is the most important but other advantages are also important. An incinerator plant will not have rodent problems, produce bad odours, require large plots of land, or require many employees. It will also be close to the garbage collection area and is capable of operating 24 hours a day. An incinerator does cause some problems, as has been discussed, but it seems that the advantages outweigh the disadvantages and that incineration is a relatively effective method for garbage disposal. Mainly in India, being the second most populated country, non-serious consumption of resources & products produces large piles of indisposable waste, hence incineration plants are to be seen as the only possible solution. As more data become available, the effectiveness of incineration will become more evident.

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