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The Process

Incineration refers to the process of destroying something through setting ablaze. Trash incineration is the process of destroying trash or waste through burning. It is also said to be a waste treatment technique that integrates the combustion of the waste material for recovering energy. The process is among the numerous societal uses of combustion. A typical incineration of waste facility includes various operations (Gille, 2007). First, it includes waste storage and feed provision which is followed by burning in a furnace, generating hot gases, and ash residue at the bottom for disposal. The process also includes reduction in gas temperature which often entails recovery of heat through steam generation. It is followed by the treatment of air-conditioned gas to remove the air pollutants and dumping of residuals (Roberts & Chen, 2006). Lastly, the process includes dispersion of the treated gas to the air via induced-draft stack and fan. Note that these processes are a single unit operations used in most facilities but several others exist that can be used as well.

In the process of incineration an application, waste is used as the main source of fuel while the source of oxygen is air. The burning process generates numerous stable end products irrespective of whether the material set on fire is coal, natural gas, gasoline, wood, medical waste, municipal solid waste, or hazardous waste (Roberts & Chen, 2006). The flame area of a well-developed incinerator is adequately hot to reduce all organic and inorganic molecules into ashes to permit reactions between several unstable waste components and nitrogen (N_2) and oxygen in air. The main reactions are between oxygen and carbon (C) which results in carbon dioxide (CO_2), and between oxygen and hydrogen (H) to generate water vapor (H_2O) (Gille, 2007). Partial burning of the organic compounds present in waste feed stream generates some

carbon monoxide (CO) as well as carbon-containing particles. At the same time, oxygen acts in response to organically-bound chlorine to generate hydrogen chloride (HCl).

Furthermore, numerous reactions take place and generate sulfur oxides (SO_x) from sulfur compounds, metal oxides from compounds of metals, nitrogen oxide (NO_x) from nitrogen compounds, and metal vapors from other unspecified compounds. The furnace is often modeled in a way that it generates proper mixture of the combustion air, vapors from the burning waste and gases in a process called sampling which will be discussed later. However, in other sections of the furnace where combustion is partial (for instance, near the furnace walls), flammable components of various organic compounds get consumed and leave the partial compounds called fly ash entrained in the flue gas while the residual or incombustible particulate matter is left behind as the bottom ash.

Nonetheless, the process of trash incineration receives numerous criticisms from the environmentalists because it is not the best way of managing waste. Incineration is the most polluting and expensive means of making energy as a waste management system (Gille, 2007). It generates the least jobs in comparison to recycling, reuse, and composing the waste materials. Moreover, it is the dirtiest way to manage waste as it is perceived to be a more pollutant than even landfills and burning coal. Consequently, this process has massive risks both to the environment and wellbeing of individuals.

Applications of Incineration

The array of waste treatment methods available in the globe today may seem overwhelming. While there is no doubting the range of waste treatment alternatives at the disposal of various nations today, incineration has been heralded by many to be one of the most efficient methods of waste management. Indeed, judging by the various societal processes that

continue to put incineration into use, the near indispensability of this method of waste treatment becomes more lucid. The health sector relates to one societal realm that continues to reap the rewards of incineration (Rosenthal, 2010). The treatment of clinical wastes through incineration continues to be praised due to the efficacy with which the process is associated. Without a doubt, the handling of biomedical waste has to be afforded elevated scrutiny given the risk they pose to human health. The fact that biomedical waste comes in various forms means that proper measures to ensure their disposal have to be taken at all times. Such waste is usually generated from medical and biological processes, as well as the activities to which they are linked (Blackman Jr., 2016). Disposal of biomedical waste has been one of the primary environmental concerns for a long time since the majority of medical wastes are categorized as biohazardous or infectious. As such, wastes have the potential to result in the spread of various infectious conditions. The number one danger for human beings relates to the infection, which can also affect other living organisms where such waste is inappropriately disposed. As stated by particular incisive reports, being exposed to the waste (landfill) daily results in the buildup of dangerous substances in the individual's body. To that end, incineration offers a workable solution that satisfactorily addresses the concerns that are connected with biomedical waste.

Chemical multi-product plants are another area that continues to benefit from the invaluable contributions of incineration. As is often the case, chemical plants usually generate a vast range of products, a significant proportion of which poses a great risk to the environment. Just to mention an instance, certain chemical plants usually have different toxic or highly toxic streams of wastewater. Because of this, it is not possible to route such waste to typical wastewater treatment plants (Blackman Jr., 2016). Under such circumstances, incineration comes in handy as it has the capability to convert the toxic waste generated by chemical plants into

harmless/useful products. The pathogens and toxins in these hazardous wastes can be rendered harmless following their subjection to high temperatures. Succinctly, the application of incineration in chemical multi-product plants continues to be justified as it works toward the elimination of a vast repertoire of toxic waste that would not be efficiently eliminated through other means.

Finally, incineration continues to find regular application in the elimination of municipal solid waste. Municipal solid waste relates to a form of waste that is made up of everyday commodities, which are thrown away by the public (FANG, ZHOU, & YAN, 2010). The makeup of municipal solid waste tends to vary from one municipality to another and transforms considerably with time. Since municipal solid waste usually comes in bulk, appropriate measures to manage them continue to be one of the primary focuses of various municipalities. The typical incineration plant employed in tackling such issues relates to the moving grate incinerator. This type of incinerator is highly valued due to its efficacy in dealing with different forms of waste. Incineration continues to be applied in various facets of the society because the form of waste management is associated with wide-ranging benefits.

Chemicals Associated with Incineration

Incinerators have become a common aspect of people's living in the contemporary world. With these technological advancements gaining popularity with each passing day, intense apprehensions as regards the emissions of certain chemicals from such machines continue to grow. Indeed, the greatest concern from environmentalists when it comes to matters in incineration revolves around fears that such processes generate considerable amounts of furan and dioxin (PCDDs) emissions. The two emissions are regarded by many to pose the greatest health hazard. Dioxins typically come about as by-products in the production of particular

organochlorides during the incineration of materials that contain chlorides, for instance, PVC (polyvinyl chloride) (Vilavert et al., 2014). On the other hand, furan relates to a heterocyclic organic compound that is made up of an aromatic ring with five members (one oxygen and four carbon atoms). Just as dioxins, furan continues to be categorized among the injurious chemical emissions that result from the process of incineration. Apart from these two major incineration concerns, heavy metals, PAH, PCDFs, and PCBs remain a worry for many.

Further, gaseous emissions (particularly carbon dioxide) represent other products whose emissions through the process of incineration remain an issue of concern. Sulfur dioxide, nitrogen oxides, heavy metals, hydrochloric acid, as well as fine particles, also make up the list of harmful chemicals with which incineration is associated. Mercury represents the greatest concern of the heavy metals owing to its elevated volatility and toxicity (Buekens & Cen, 2011). Thus, while incineration plays an undeniably huge role in the management of waste, concerns surrounding the chemicals emitted through such processes represent one of the few blots on its growing reputation. With various studies pointing to the validity of these apprehensions, adopting fitting measures to tackle them is of the essence.

Health Hazards Associated with the Chemicals

Trash incineration is a waste management technology that has been the subject of extensive argument on social, environmental, and political circles. This is because the technology has hazardous effects to the environment and human beings. With respect to the environment, the trash incineration process generates two kinds of ashes (Roberts & Chen, 2006). The bottom ash comes from the furnace and is blended with slag while fly ash originates from the stack and contains elements that are dangerous. In large trash incinerators, bottom ash is about 10 percent in terms of volume and about 20 to 35 percent by weight of the initial solid

trash input (Zafar, 2016). On the other hand, the volume and weights are much lower with less than 10 percent of the initial waste input. As observed earlier, the emissions from the furnace can include furans, dioxins, and heavy metals, which may exist in the waste ash, water, or gases. Metals and plastics are the main sources of the fattening value of the waste (Roberts & Chen, 2006). Burning of plastics such as polyvinyl chloride (PVC) leads to an extremely toxic pollutants.

Toxics are developed at differing stages of the thermal technology as opposed to only at the end of the hoard. The toxics can be created in the stack pipes, during the combustion process, scrubber water and filters, as residues in ash, and even in air plumes that come out of the stack. Unfortunately, as far as incineration process is concerned, there is no strategy or means to prevent the production of the toxics or destroy them (Zafar, 2016). At best, they may be trapped at extreme cost in the ash or in complex filters. At the same time, the eventual release of these toxics from the furnace is unavoidable, and if trapped in filters or ash, they become hazardous wastes on their own. Therefore, the trach incineration project is generally hazardous to the environment because no matter what process is involved, the residues come out and affect water, food, air, and land.

Moreover, trach incineration process causes extreme health effects. As observed earlier, the incineration systems often generate large amounts of pollutants to the surrounding. The outcome is massive health effects on the human beings and animals present in the environment (Roberts & Chen, 2006). The systems are costly and do not sufficiently control or eliminate the toxic emissions in the chemically complicated solid waste. The problem is that even newly acquired incinerators generate toxic dioxins, metals, and acid gases to the surrounding (Zafar, 2016). Dioxins are the most dangerous Persistent Organic Pollutants (POPs) which leads to

irreversible environmental outcomes. The most affected individuals are those who work in these incinerator systems, those who live near them, and the people who live in the wider region.

Through breathing the air from the incineration systems, people get affected extensively as they are likely to develop lung complications and cancer, and heart conditions among others.

In addition, through eating locally generate foods or water contaminated by the dioxins from the incinerator also leads to other health complications such as disruption of reproductive systems, neurological damage, and thyroid systems. The noise from the incinerator system causes sleep disturbances and stress especially to the people who work in these systems (Zafar, 2016). At the same time, the heat generated from the furnace is often extreme and affects the workers extensively. The heat wave from the furnace leads to health problems such as dizziness, headaches, fainting, and in more severe cases, people might develop heat stroke (Roberts & Chen, 2006).

Lastly, through eating wildlife and fish that have been polluted by the air emissions may also result in more health complications. It indicates that the workers and people living within localities with incineration systems are exposed to massive health dangers and there is need for bodies such as OSHA to intervene and manage the situation.

What about the health hazards of the chemicals listed before?
Regulatory Requirements for Waste Incineration

OSHA has put in place various regulatory measures to see to it that industrial hygiene is maintained at the most appropriate levels. The particular site safety and health plan (SAHP) needs to have procedure for the execution and application of safety and health laws for everyone on site (OSHA, 2017).



Employers need to ensure that they provide proper and continuous training to the workers on matters relating to trash incineration. This is to ensure that minimum harm occurs on the

employees due to lack of proper training.



Employers need to ensure that they develop waste incineration procedure/guidelines to ensure minimum harm is committed on the employees. However, employers need to ensure that they have provided their employees with the right protective clothing during waste incineration. This special clothing (full-body suits, booties, gloves and respirators) should ensure that the entire body of the employees are well protected from any harm. (Alvarez, 2009, p, 207). Besides this, the incinerator need to be of high quality and adhere to the set standards to ensure it does harm cause harm to the workers. Employers need to have medical emergency plans in place to ensure that in case any accident happens, the workers are able to receive immediate medical attention. This goes a long way in ensuring that minimum harm/damage is caused on the patient as they wait to be moved to the hospital.

Industrial hygienists are given thorough training to anticipate, distinguish, assess, and to come up with recommendations as regards control for physical and environmental hazards that have the potential to have a detrimental effect on employees' health and well-being. Indeed, industrial hygienists play an equally crucial role in the development and issuance of OSHA standards for the protection of employees from various health hazards that may arise in various processes including the incineration of waste. Such hazards usually include biological hazards, toxic chemicals, as well as physical agents. Through OSHA's relationship with industrial hygienists, regulations that seek to improve the safety of workers are in place. Industrial hygienists are tasked with the analysis, identification, and measurement of workplace hazards or stressors that have the potential to bring about impaired health, sickness, or considerable

uneasiness in employees through biological, chemical, ergonomic, or physical exposures.

Through OSHA's regulatory requirements, these conditions can be spotted, hence allowing for their elimination and control through proper measures.

Control Measures

Process control entails adjusting the way jobs or process is done with the aim of minimizing risk. Industrial hygienists believe that engineering, work practices, and administrative control act as the main ways to which employees might be protected from exposure to occupational hazards (OSHA, 2017). Engineering controls entail the removal of toxic chemicals and replacing the harmful toxic materials with the less dangerous ones, confining work operation, and having a ventilation system. Some important and quickly executed work practice controls are (1) adhering to procedures which reduce exposure while operating production and control equipment. (2) Examining and sustaining processes and control equipment regularly and offering good supervision. (3) Lowering the temperature of a process hence minimal fewer vapors is released: (4) Using automation - the fewer workers have to handle or use the materials, the less potential there is for exposure. (5) Use of personal protective equipment like gloves, goggles, helmets, safety shoes, and protective attires should be put on by the employees when working (OSHA, 2017).

Exposure measurements



OSHA has pointed out that there are no "best" measurement methods for all circumstances.

However, certain aspects which need to be considered when developing a strategy are:

- (1) Availability and expenses of sampling tools
- (2) Availability and expenses of analytic facility

- (3) Availability and expenses of personnel to take samples
- (4) Location of staff and work operation (Council, 2011)
- (5) Intraday and interday difference in the procedure
- (6) Precision and accuracy of sampling and analytic strategies
- (7) Some samples needed.

→ Air sampling method is used by OSHA to measure the exposure of an industry. It entails the collection of airborne contaminant using a mechanical device like a pump to determine air/contaminant mixture through the sampling tool. Workplace Material Survey is another method used and which is done to establish whether formaldehyde is used in the industry and the conditions under which it is used. Workplace Observations is the other method and whose intention is to offer an indication as to the degree of potentially exposed workers (OSHA, 2017).

OSHA regulation on Biological waste

→ OSHA requires that exposure to blood-borne pathogens be minimized owing to the assumption that they are infectious. Majority of the actions taken to lower exposure are under cross-contamination protocols, that give particular actions that needs to be taken to lower further spreading the contamination throughout otherwise clean areas. OSHA also requires that biological waste should be put in a well labeled container with the universal biohazard symbol (OSHA, 2017).

OSHA regulation on Mold noise ?

→ OSHA requires that when information shows that the workers would be exposed to equal or exceed an 8-hour time-weighted average of 85 decibels, they should establish and execute a monitoring program. This program should be developed to identify workers for inclusion in the

hearing conservation program and make it possible for the right selection of hearing protectors (OSHA, 2017).

OSHA regulation on Heat

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(1) Employers should allow their employees to take water at liberty: Minimally one pint of water in every hour (per worker)

(2) Employers need to have provision for a work/rest regimen so as to lower exposure time to high temperatures. They should also provide shade/air conditioning and water during these breaks.

Sampling Method and Parameter

[The sampling strategy used by industries seeks to determine the need for exposure measurements.] *which strategy?* In effect, the employer has to establish whether workers may be exposed to concentrations of a given harmful product of incineration beyond the action level. This establishment becomes the initial step in a worker exposure monitoring initiative that reduces employer sampling burdens while offering sufficient worker protection (Takala et al., 2010). If workers may be exposed more than the action level, the employer has to gauge exposure. Otherwise, an objective establishment that worker exposure is low offers sufficient proof that the potential of exposure has been checked.

The employer needs to check every available relevant information, for instance, trade association information, insurance company, as well as data from suppliers. Of equal importance, information gathered from similar operations should be examined by the employer in determining exposure. Further, the employer may also make use of previously carried out

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sampling such as area monitoring. The employer has to make an ascertainment relevant to every operation. If the employer can show convincingly that no worker is exposed more than the action level, they do not need to go ahead with worker exposure monitoring until a change in conditions become evident, hence rendering determination invalid (Takala et al., 2010). On the other hand, if the employer is unable to establish that worker exposure is below the action level, worker exposure monitoring has to be carried out. Through this sampling method, an employer is afforded the opportunity to gauge exposure levels in every employee. As long as every requirement of the sampling strategy is followed alongside approved analytical methods, accurate findings are usually bound to be accrued.

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Air sampling method is the most predominant technique used to evaluate the exposure for the industry but Workplace Material Survey also works effectively. The latter method is often used to determine whether formaldehyde is undertaken in the industry or not as well as assess the conditions under which it is employed if it exists. Another method is the workplace observation which provides indication to the extent of the potentially exposed employees (OSHA, 2017). Their health is assessed from time to time and observed keenly to note any changes that might be caused by the noise, heat or dioxin emissions from the furnace. In case of any slight change, medical action is taken immediately and OSHA is allowed to evaluate the situation further.

Certainly, this sampling strategy offers various benefits, in particular, it enables employers to measure exposure levels in every employee and to take appropriate measures.

Not detailed enough

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