International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 4 Issue 4, June 2020 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Waste Disposal through Portable Incinerator

Shareq Wajih, Purab Verma, Vivek Chauhan, Neeraj, Sahil Yadav

B. Tech (Mechanical Engineering), ABES Engineering College, Ghaziabad, Uttar Pradesh, India

ABSTRACT
In order to meet the worldwide demand for a clean environment, various national, regional, state, or local regulations or guidelines have been proposed and enforced. Incineration of solid wastes is usually considered to be the most effective in volume reduction of the solid waste, thereby reducing the burden of landfill. Incineration can remain a viable option when it ensures pollution minimization.

KEYWORDS: *Incinerator, Waste disposal, Solid waste, Flue gas*

How to cite this paper: Shareq Wajih | Purab Verma | Vivek Chauhan | Neeraj | Sahil Yadav "Waste Disposal through Portable Incinerator" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-4 | Issue-4, June 2020, pp.262-267, URL: www.ijtsrd.com/papers/ijtsrd30881.pdf

IJTSRD30881

I. INTRODUCTION

Solid waste disposal by combustion (incineration) is now and will continue to be an important part of our national solid waste management programme. Treatment of solid wastes (municipal, hospital, industrial etc.) has become one of the main concerns of many urban and rural communities. Adequate management of the wastes through reduction of the waste production from households by recycling and reuse should be given the highest priority. However, some portions of these wastes are buried underground, i.e. landfill. In order to meet the worldwide demand for a clean environment, various national, regional, state, or local regulations or guidelines have been proposed and enforced. Incineration of solid wastes is usually considered to be the most effective in volume reduction of the solid waste, thereby reducing the burden of landfill. Incineration can remain a viable option when it ensures pollution minimization. The need for a quick, reliable, and environmentally friendly method of waste disposal generated from households, hospitals, markets, industries etc., has brought attention to the design and construction of a specialty incinerator to suit both rural and urban purposes. Incineration is a method of waste destruction in a furnace by controlled burning at high temperatures [1]. Incineration of waste materials converts the waste into ash, flue gases and heat. The ash is mostly formed by inorganic constituents of the waste, and may take the form of solid lumps or particulate matter carried by the flue gas. Incineration has frequently been preferred to other waste treatment or disposal alternatives due to advantages such as; the volume and mass of the solid waste is reduced to a fraction of its original size by 85-90% volume, the waste reduction is immediate and not dependent on long biological breakdown reaction times. The public health impact associated with emissions from solid wastes (municipal, hospital etc,) has become and continue to be a major subject of concern because of the following points: (i) Some materials are not supposed to be incinerated as they are more valuable if recycled, they are non-combustible or their by-product may give rise to harmful emissions (ii) Poor operating practice and the presence of chlorine in the waste may lead to emissions containing highly toxic dioxins and furans (iii) The control of metal emissions may be difficult for inorganic wastes containing heavy metals, such as arsenic, cadmium, chromium, copper, lead, mercury, nickel, etc. (iv) Incinerators require high capital costs and trained operators leading to moderately high operating costs (v) Supplementary fuels are sometimes required to achieve the necessary high temperatures (vi) Residual disposal (fly ash and bottom ash) presents a variety of aesthetic, water pollution, and worker health related problems that require attention in system design and operation (vii) Process analysis of combustors is very difficult, changes in waste character are common due to seasonal variations in municipal waste or product changes in industrial waste.

II. LITERATURE REVIEW

1. **Title-** 'Design Aspects of a Low Emission, Two-Stage Incinerator' By J. A. English II

Description-
The paper intended to present a rational and practical design procedure for a low emission, two-stage, starved air

incinerator, based both on the theory of combustion and incineration and on the results of experimental studies.

Conclusion-

A. Through extensive study of this paper we gained an understanding of incinerator principles and combustion theory.
B. It enabled us to eliminate most of the experimental work needed to design and specify an incinerator.
C. Once the experimental evidence has been obtained for a given incinerator, we can specify units of different sizes by applying the relationships presented herein.

2. **Title-** 'Conceptual Design of a Multipurpose Mobile Smokeless Incinerator' By Abdul Talib Din, Syaiful Bahari Ahammed, Siti Norehan Rosli

Description- This paper investigates the problem of existing conventional incinerators, proposing a solution, prioritizing requirements, designing and producing an ideal incinerator for domestic users. The air pollution control device, APCD was used to overcome the problem of air pollution due to incineration process. Quality Function Deployment (QFD) was performed to get the ideal design of the incinerator. The assumption of the retail price of the fully functioning small, multipurpose, mobile and smokeless incinerator was estimated.

Conclusion-

A. Tests were conducted to show how the incinerator was functioning well and the data from the observations was recorded.
B. From the particulate emission experiment, the incinerator only emitted a very small amount of smoke that literally can be said to be smokeless.
C. No flying ash or particulate matter came out from the incinerator compared to external open burning that results in a lot of smoke and flying ash produced from the burning.
D. Both the APCDs installed in the incinerator were functioning well and the air pollution could be reduced using this incinerator.
E. Time taken for the waste material to completely burn in the incinerator was recorded to be shorter than the external open burning.
F. The use of APCDS and castor wheel has granted the incinerator the capability to be a multipurpose, mobile and smokeless incinerator.

3. **Title-** 'Design of a Smokeless and Non-Pollutant Emitting Incineration System' By Obuka Nnaemeka SP, Ozioko, Emeka R

Description-

This research was intended for the designing and construction of a smokeless and non-pollutant emitting incineration system prototype with two-chambers (primary and secondary) each equipped with a burner, with an overfire air jet. A wet scrubber was retrofitted to the incinerator to completely remove the remaining flue gases and particulate matter released from the incinerator through a wash down and absorption mechanism. The water for the spray tower was designed to be mixed with slaked lime to help in absorption of acidic gases in the smoke from the incinerator.

Conclusion-

A. The incinerator was designed as a double chambered system to be double walled and lagged with a fibreglass system.
B. The incinerator has two burners at each of the primary and secondary chamber, producing a burning temperature of 800 0C at the primary chamber and 10000C in the secondary chamber.
C. The critical insulation thickness of the incinerator chambers was carefully and successfully evaluated, and there was reduced heat transfer to the surrounding with double walled and lagged body.
D. The flue gas and particulate matters leaving the incinerator are not allowed into the environment but channeled into a wet scrubbing unit designed as a vertical spay tower with water mixed with slaked lime flowing counter currently to the incoming gas and particulate matters.
E. This scrubber system successfully performed the last phase of acid gases and particulate matters removal and allowed for a non-pollutant emission.

4. **Title-** 'An Overview of Hazardous/Toxic Waste Incineration' By C. C. Lee , George L. Huffman & Donald A. Oberacker

Description- This paper provided an overview of hazardous/toxic waste incineration. It was intended for those who are not involved in actual incineration management or operations, to enable them to easily understand the status of and the prospects for incineration. It describes current regulatory requirements and provides an overview of hazardous waste incineration. Data on the performance of and emission levels associated with incinerators are not provided in this paper because they have been made available in other recent EPA publications.

Conclusion-

A. It was found that by far the best demonstrated available technology for waste destruction is incineration.
B. Based on current advancements, it may emit unwanted products of incomplete combustion or trace metals.
C. The PICs could conceivably be equally or more hazardous than the original compounds in the waste fed to the units.
D. The amounts of the PICs in the exhaust are generally at least two orders of magnitude less than the original compounds in the feed.
E. Both PIC and trace metal emissions are very complicated problems and thus, a considerable amount of research needs to be done in order to ensure that they can be adequately controlled.

5. **Title-** 'Incineration of Hazardous Waste: A Critical Review Update, Air Waste' By Clyde R. Dempsey & E. Timothy Oppelt

Description- In response to the increase of waste at an unprecedented rate, there has been a significant modification of waste management practices. The more traditional and lowest-cost methods of direct landfilling, storage in surface impoundments and deep-well injection are being replaced in large measure by waste minimization at the source of generation, waste reuse, physicochemical/biological treatment, incineration and chemical stabilization/solidification methods. Of all of the "permanent" treatment technologies, properly designed incineration systems are capable of the highest overall degree of destruction and control for the broadest range of hazardous waste streams. Substantial design and operational experience exists in this area and a wide variety of commercial systems are available. Consequently, significant growth is anticipated in the use of incineration and other thermal destruction methods. The objective of this research was to examine the current state of knowledge regarding hazardous waste incineration in an effort to put these technological and environmental issues into perspective.

Conclusion-

A. The research draws up a number of conclusions on the status of incineration technology, current practice, monitoring methods, emissions, performance, and public health risks.
B. Considerable design experience exists, and design and operating guidelines are available covering the engineering aspects of these systems.
C. The most common incinerator designs incorporate one of four major combustion chamber designs: liquid injection, rotary kiln, fixed hearth or fluidized bed.
D. The most common air pollution control system involves combustion gas quenching followed by a venturi scrubber (for waste removal), a packed tower absorber (for acid gas removal) and a mist eliminator.
E. Newer systems have incorporated more efficient air pollution control devices, however, such as wet electrostatic precipitators, ionizing wet scrubbers, spray dryer absorbers, fabric filters and proprietary systems.

6. **Title-** 'A review of municipal solid waste environmental standards with a focus on incinerator residues' By Alec Liu, Fei Ren, Wenlin Yvonne Lin, Jing-Yuan Wang

Description- This research establishes the relevance of environmental regulations and standards as they maintain a balance among competing resources and help protect human health and the environment. One important environmental standard is related to municipal solid waste (MSW). The sustainability of landfills is also of concern as increasing volumes of MSW consume finite landfill space. The incineration of MSW and the reuse of incinerated residues help alleviate the burden on landfill space. However, the reuse of MSW incinerator residues must be regulated because they may expose the environment to toxic heavy metal elements. The study of environmental standards from different countries applicable to MSW is not widely published, much less those for incinerated MSW residue reuse. This paper compares extant waste classification and reuse standards pertinent to MSW, and explores the unique recent history and policy evolution in some countries exhibiting high environmental regard and rapid changes, so that policy makers can propose new or revise current MSW standards in other countries.

Conclusion-

A. Countries with limited natural resources should have a greater interest in resource reuse.
B. Between developed and developing economies, more developed ones tend to have greater environmental concerns, and waste management focus priorities in developing economies generally follow similar paths as those in developed ones.
C. Standard setting is a science that takes into account the natural environment setting that needs protection, the transport phenomena of contaminants through different media, and the contamination source.
D. These generalizations may serve as implications that will help decision makers in governments that are looking to begin to set MSW leaching criteria standards initiate proposals.
E. Increasing popular support for standards in general propagated by social media and open innovation, increasing demand for sustainable technology brought on by the dwindling and rising cost of resources, and aligning business interests with waste and energy cost reduction goals may increase standards importance and availability.

7. **Title-** 'Characteristics and application potential of municipal solid waste incineration (MSWI) bottom ashes from two waste-to-energy plants', P. Tang, M. V. A. Florea, P. Spiesz, H. J. H. Brouwers

Description- This study focuses on municipal solid waste incineration (MSWI) bottom ash characteristics, its heterogeneity, environmental properties, and their stability in time. The physical and chemical characteristics of bottom ashes from two plants were determined over time; results showed that their properties are very stable and similar to each other. As an exploratory study, bottom ash was applied in mortars without further treatment, in order to identify the limit conditions of its use as replacement material. Results showed that bottom ash fines have a detrimental effect on cement hydration and strength of the mortars.

Conclusion-

A. The physical and chemical properties of the bottom ashes from both waste-to-energy plants were stable over time and were very similar to each other, despite different production processes. The coarse bottom ash particles (4–32 mm) had higher water absorption than natural aggregate and recycled concrete aggregate.
B. The dominant oxides found in the bottom ashes are SiO_2, CaO, Al_2O_3 and Fe_2O_3. Based on the calculations of relevant parameters, these bottom ashes could possibly be used as correction material for clinker production.
C. The calorimetric results confirmed that the bottom ashes had very low hydraulic activity and their addition to cement led to the retardation of cement hydration. The addition of bottom ashes contributes to the total heat release of cement hydration.
D. The MSWI bottom ash has a high amount of fine particles (<125 μm) which leads to higher water absorption and eventually reduces the amount of water available to react with cement and metallic aluminium in mortar. Hence, the bottom ashes fines (<2 mm) used as sand replacement reduce the strength of mortars, but with no visible cracks on the mortar.
E. The leaching behaviour of bottom ashes was very stable over time. The leaching contaminants which exceed the legislative limit were copper, antimony, chloride and sulphate. Thus, a future study will be focused on the reduction of these specific contaminants from the investigated bottom ashes

8. Title- 'Review on Technologies of Removal of Dioxins and Furans from Incinerator Flue Gas' By A. Mukherjee, B. Debnath, Sadhan Kumar Ghosh

Description- This review deals with the most serious drawback of incineration waste disposal process, the emission of dioxins and furans in flue gas. Dioxins and Furans are regarded as very harmful chemicals which can have serious health effects causing cancer, reducing immunity. Various techniques are available for the treatment of flue gas emission depending upon the type of feed stocks. Some popular and effective methods are using sulphur compounds namely $(NH4)2SO4$, pyrite ($FeS2$), changing the operating conditions of incinerations etc. The main aim of this paper is to suggest a cost effective, efficient and a long lasting method to treat the flue gas so that the concentration of dioxins and furans can be reduced effectively as well as to eradicate the challenges associated with the process. The present review discusses the current views on methods to minimize dioxins and benzo-furans, namely polychlorinated dibenzo-dioxins (PCDDs) and dibenzo-furans (PCDFs), formation in different types of incineration systems. Municipal solid waste incineration system, hazardous solid waste incineration system and Bio medical waste incineration system has been considered in this case. The findings of this paper will help the stakeholders in the decision making process in establishing a sustainable future of waste management and will set future directions for better and innovative research addressing the problems.

Conclusion-

A. A review has been presented discussing different technologies associated with removal of dioxins and furans evolved during incineration of wastes.
B. Precursor of formation, mechanism of formation, Sources of dioxins, congeners has been discussed in detail.
C. The methods established in the past twenty years have been reviewed and it's been found that, among the existing techniques, each and every one has some problems.
D. End of pipe treatment options have shown good potential. Hybridization of good combustion practice and end of life pipe treatment has been suggested which will not only improve the process efficiency from the operational aspect but also from the economical aspect.
E. Injection of sulphur compounds is suggested which will prevent the formation and hence is a good option. Thus, the hybrid method will no doubt secure a sustainable future for the incinerators and dioxin removal technologies. This paper will help the stakeholders, researchers and practitioners for better decision making and future research pathways.

9. Title- 'A systematic review on biomonitoring of individuals living near or working at solid waste incinerator plants' By

Description- A systematic review of peer-reviewed literature on human biological monitoring of exposure and effect following potential exposure to SWI pollutants (Solid waste incinerators (SWI) emit several pollutants among which polychloro dibenzo dioxins and furans (PCDD/Fs), polychlorobiphenyls, metals, monocyclic and polycyclic aromatic hydrocarbons (PAHs)) to bring together evidence and to highlight strengths and deficiencies of the studies conducted so far. Relevant studies on biomonitoring of individuals living near or working at SWIs were selected through three steps: (1) A literature search in the Medline, CAplus, and Embase database; (2) The retrieved abstracts were screened by four independent reviewers; (3) The full text of the relevant papers were read,papers were pooled in studies, and then analyzed to highlight strengths and weaknesses. Studies with the strongest epidemiological design and/or the largest sample size were identified as reference studies. Most studies presented methodological pitfalls; reference studies showed no or limited evidence of the impact of SWI on exposure and effect biomarkers.

Conclusion-

A. Several biological monitoring studies were studied, the majority of them were performed in the decade 2001-2010, with a decreasing number in the following years.
B. The levels of the studied biomarkers in the general population living near modern SWI were, in most studies, in the range of the reference values, showing no or very scarce impact of SWI emissions on the internal dose of the considered pollutants and on their effects.
C. Similarly, in SWI workers biomarkers of exposure and effect seldom exceeded the reference values and were always within the biological limit values for occupational settings.
D. Overall, the results suggest a low contribution, if any, from SWI to the internal dose/early-biological effects of the investigated toxicants.
E. However, it is necessary to highlight that several pitfalls affected many of the reviewed studies. Therefore, future investigations in the field need to address issues associated with a proper recruitment of study subjects, a careful collection of individual characteristics and a thoughtful personal exposure assessment.

10. Title- 'Energy Recovery from Waste Incineration: The Importance of Technology Data and System Boundaries on CO2 Emissions' By Ola Eriksson and Göran Finnveden

Description- This research paper recognizes that in previous studies of the relationship between energy and waste disposal, it has not been shown explicitly which key parameters are most crucial, how much each parameter affects results and conclusions and how different aspects depend on each other. The interconnection between waste incineration and the energy system is elaborated by testing parameters potentially crucial to the result: design of the incineration plant, avoided energy generation, degree of efficiency, electricity efficiency in combined heat and power plants (CHP), avoided fuel, emission level of the avoided electricity generation and avoided waste management. $CO2$ emissions have been calculated for incineration of 1 kWh mixed combustible waste. The results indicate that one of the most important factors is the electricity efficiency in CHP plants in combination with the emission level of the avoided electricity generation. Since waste incineration typically has lower power to fuel ratios, this has implications for further analyses of waste incineration compared to other waste management practises and heat and power production technologies. Electricity generation must not be lost, as it has to be compensated for by electricity production affecting the overall results.

Conclusion-

A. This study provides quantitative results on the implications of different technological data for waste incineration and competing technologies for heat and power production.
B. Results from this assessment show the power-to-fuel ratio in combination with the emission level of the avoided electricity generation and the avoided waste management are identified as the most important factors.
C. If current waste incineration is replaced, the most inefficient plants should be substituted. In case there is a surplus of waste, due to the higher efficiency as described above, it should not be subject to landfill disposal but recycled. New efficient waste incineration should primarily substitute current inefficient CHP production
D. It is also noted that the emission factor for material recycling (which is an average value for a mix of recycling processes) are negative since recycling includes avoided virgin production and constitutes a saving in emissions.
E. All these arguments are in favour of exporting waste from countries where waste is subject to landfill disposal, to be efficiently incinerated in CHP plants in countries with district heating systems, especially if it can avoid the use of fossil fuels.
F. A novel aspect of this study is the plant-by-plant comparison showing how different electricity efficiencies associated with different types of fuels and plants influence results. Since waste incineration typically has lower power to fuel ratios, this has implications for further analyses of waste incineration compared to other waste management practises and heat and power production technologies.

11. **Title-** 'Waste To Energy By Incineration' By Avinash A. Patil, Amol A.Kulkarni, Balasaheb B. Patil

Description- Incineration is the main waste-to-energy form of treatment. It is a treatment technology involving destruction of solid waste by controlled burning at high temperatures. It is accompanied by the release of heat. This heat from combustion can be converted into energy. Incineration is a high-quality treatment for Municipal Solid Waste (MSW), very useful in big or crowded cities, because it reduces the quantity and volume of waste to be landfilled. It can be localised in an urbanised zone, and offers the opportunity of recovering energy. However, it should be taken into account that the economic investment needed is high. The environmental conditions of the incineration process must be very precise to make it environmentally safe. The larger portion of the investment required is due to environmental measures such as emissions control. When choosing incineration as an alternative, the following issues should be considered: volume/quantity of waste produced, heat of combustion of waste, site location, dimensions of the facility, operation and maintenance costs and investment.

Inference-

The left-over waste at the dumping yards generally contains a high percentage of inert (>40%) and of putrescible organic matter (30-60%). It is common practice to add road sweepings to the dust bins. Papers and plastics are mostly picked up and only such a fraction which is in an unrecoverable form remains in the refuse. Paper normally constitutes 3-7% of refuse while the plastic content is normally less than 1%. The calorific value on a dry weight basis (High Calorific Value) varies between 800-1100 kcal/kg. Self-sustaining combustion cannot be obtained for such waste and auxiliary fuel will be required. Incineration, therefore, has not been preferred in India so far. The only incineration plant installed in India at Timarpur, Delhi way back in the year 1990 has been lying inoperative due to mismatch between the available waste quality and plant design. However, with the growing problems of waste management in the urban areas and the increasing awareness about the ill effects of the existing waste management practices on the public health, the urgent need for improving the overall waste management system and adoption of advanced, scientific methods of waste disposal, including incineration is imperative.

III. CONCLUSION

Through the study of the various research papers that we reviewed, the following conclusions were derived: Solid waste disposal by combustion (incineration) is now and will continue to be an important part of our national solid waste management programme. Treatment of solid wastes (municipal, hospital, industrial etc.) has become one of the main concerns of many urban and rural communities. Adequate management of the wastes through reduction of the waste production from households by recycling and reuse should be given the highest priority. However, some portions of these wastes are buried underground, i.e. landfill. In order to meet the worldwide demand for a clean environment, various national, regional, state, or local regulations or guidelines have been proposed and enforced. Incineration of solid wastes is usually considered to be the most effective in volume reduction of the solid waste, thereby reducing the burden of landfill. Incineration can remain a viable option when it ensures pollution minimization. The need for a quick, reliable, and environmentally friendly method of waste disposal generated from households, hospitals, markets, industries etc., has brought attention to the design and construction of a specialty incinerator to suit both rural and urban purposes. Incineration is a method of waste destruction in a furnace by controlled burning at high temperatures [1]. Incineration of waste materials converts the waste into ash, flue gases and heat. The ash is mostly formed by inorganic constituents of the waste, and may take the form of solid lumps or particulate matters carried by the flue gas. Incineration has frequently been preferred to other waste treatment or disposal alternatives due to advantages such as; the volume and mass of the solid waste is reduced to a fraction of its original size by 85-90% volume, the waste reduction is immediate and not dependent on long biological breakdown reaction times. The public health impact associated with emissions from solid wastes (municipal, hospital etc,) has become and continue to be a major subject of concern because of the following points: (i) Some materials are not supposed to be incinerated as they are more valuable if recycled, they are non-combustible or their by-product may give rise to harmful emissions (ii) Poor operating practice and the presence of chlorine in the waste may lead to emissions containing highly toxic dioxins and furans (iii) The control of metal emissions may be difficult for inorganic wastes containing heavy metals, such as arsenic, cadmium, chromium, copper, lead, mercury, nickel, etc. (iv) incinerators require high capital costs and trained operators leading to moderately high operating costs (v)Supplementary fuels are sometimes required to achieve the necessary high temperatures (vi) Residual disposal (fly ash and bottom ash) presents a variety of aesthetic, water pollution, and worker health related problems that require attention in system design and operation (vii) Process analysis of combustors is very difficult, changes in waste character are common due to seasonal variations in municipal waste or product changes in industrial waste.

ACKNOWLEDGEMENT

The team would like to credit all the academics of the respective research mentioned in our review, who were responsible for the experimental work done in the field around the globe. We'd also like to extend our deepest gratitude to the Department of Mechanical Engineering, ABES Engineering College for supporting the project. Namely, Dr. Rajendra Kumar Shukla (HOD), Ms. Gaganpreet Kaur (Project In-charge) and Mr. Vijay Kumar Gupta (Project Guide).

REFERENCES

[1] J. A. English II, '*Design Aspects of a Low Emission, Two-Stage Incinerator*', Ecological Science Corporation, Miami, Florida, USA: National Incinerator Conference, 1974

[2] Obuka Nnaemeka SP, Ozioko, Emeka R, *Engineering 'Design of a Smokeless and Non-Pollutant Emitting Incineration System'*, Department of Mechanical/Production Engineering, Enugu State University of Science and Technology, Enugu, Nigeria: Scholars Journal of Engineering and Technology (SJET), 2018

[3] Abdul Talib Din, Syaiful Bahari Ahammed, Siti Norehan Rosli, *'Conceptual Design of a Multipurpose Mobile Smokeless Incinerator'*, Faculty of Mechanical Engineering, Universiti Teknikal Malaysia Melaka, Melaka, Malaysia: Proceedings of Mechanical Engineering Research Day, 2018

[4] C. C. Lee , George L. Huffman & Donald A. Oberacker, *'An Overview of Hazardous/Toxic Waste Incineration'*: Journal of the Air Pollution Control Association, U. S. Environmental Protection Agency Cincinnati, Ohio, 8th March 2012

[5] Clyde R. Dempsey & E. Timothy Oppelt, '*Incineration of Hazardous Waste: A Critical Review Update, Air Waste*', Risk Reduction Engineering Laboratory U.S. Environmental Protection Agency Cincinnati, Ohio, 6th January 2015

[6] Alec Liu, Fei Ren, Wenlin Yvonne Lin, Jing-Yuan Wang *'A review of municipal solid waste environmental standards with a focus on incinerator residues'*, School of Civil and Environmental Engineering, Nanyang Technological University, 50 Nanyang Avenue, Singapore 639798; Singapore Residues and Resource Reclamation Centre (R3C), Nanyang Environment and Water Research Institute, Nanyang Technological University, 1 Cleantech Loop, CleanTech One, Singapore 637141, Singapore, 1st November 2015

[7] P. Tang, M. V. A. Florea, P. Spiesz, H. J. H. Brouwers, *'Characteristics and application potential of municipal solid waste incineration (MSWI) bottom ashes from two waste-to-energy plants'*, Department of the Built Environment, Eindhoven University of Technology, P.O. Box 513, 5600 MB Eindhoven, The Netherlands; ENCI Heidelberg Cement Benelux, The Netherlands, 13th March 2015: Construction and Building Materials Volume 83, 15 May 2015, Pages 77-94

[8] A. Mukherjee, B. Debnath, Sadhan Kumar Ghosh, *'A Review on Technologies of Removal of Dioxins and Furans from Incinerator Flue Gas',* P.G. Scholar, Department of Chemical Engineering, University of Calcutta, Kolkata, India; Research Scholar, International Society of Waste Management, Air and Water, Kolkata, India; Professor, Department of Mechanical Engineering, Jadavpur University, Kolkata, India: International Conference on Solid Waste Management, 5IconSWM 2015

[9] Laura Campo, Petra Bechtold, Lucia Borsari & Silvia Fustinoni, *'A systematic review on biomonitoring of individuals living near or working at solid waste incinerator plants'*, Environmental and Industrial Toxicology Unit, Fondazione IRCCS Ca Granda, Ospedale Maggiore Policlinico, Milan, Italy; Department of Public Health, Local Health Unit, Modena, Italy; Department of Biomedical, Metabolic and Neural Sciences, University of Modena and Reggio Emilia, Modena, Italy; Department of Clinical Sciences and Community Health, Università degli Studi di Milano, Milan, Italy: Critical Reviews In Toxicology 2019, Vol. 49, No. 6, 479–519

[10] Ola Eriksson, and Göran Finnveden, *'Energy Recovery from Waste Incineration—The Importance of Technology Data and System Boundaries on CO2 Emissions'*, Faculty of Engineering and Sustainable Development, Department of Building, Energy and Environmental Engineering, University of Gävle, SE 801 76 Gävle, Sweden; Division of Environmental Strategies Research–fms, Department of Sustainable Development, Environmental Sciences and Engineering (SEED), School of Architecture and the Built Environment, KTH Royal Institute of Technology, SE 100 44 Stockholm, Sweden: Journal Energies (ISSN 1996-1073; CODEN: ENERGA)

[11] Avinash A. Patit, Amol A.Kulkarni, Balasaheb B. Patil, '*Waste To Energy By Incineration*', Environmental Science & Technology Department, Department Of Technology, Shivaji University, Kolhapur, India