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The Greenhouse Gas Emissions Produced by Cement Production and Its Impact on Environment: A Review of Global Cement Processing

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ABSTRACT:
The purpose of this study is to investigate and explain the review of cement processing and its impact on cement manufacturing emissions on the environment. For instance, the cement industry is contributing in global warming and climate change in the world. The processes of cement manufacturing are extremely energy intensive which utilize high fuel consumption and finally it results in the emissions. The cement industry is major cause of global warming and it stands at the third biggest industrial source of pollution. It emits more than 500,000 tons per year of sulfur dioxide, nitrogen oxide, and carbon monoxide. The paper highlights the overview of cement processes and contribution of cement industry in causing the emissions and their impact on the environment and health.

KEYWORDS:
Cement Processing; Emissions; Environmental impact; Health impact; Climate Change; NO_2; SO_2; CO_2; Pollution

INTRODUCTION

The most important and major industry for greenhouse gas emission is cement industry which contributes almost 6% of the world global warming and anthropogenically conservatory gases emanations (Zhang et al., 2014). Therefore, to address the global warming and imperativeness of environmental changes, International Agency modeling suggests that CO_2 releases should be cut down 50% by year 2050 (Gao et al.). Hence, as a result of these world decline in emissions of CO_2 the IEAGHGT has projected according to current situation of today's strategies and predicted marketplace expansions, the cement manufacturing essentially requires to cut down by around 35% from 2.34 Gt to 1.55GT (Xu, Fleiter, Fan, & Eichhammer, 2014). In the meanwhile, greenhouse gas emissions and environmental issues caused by cement industry has been controlled and reduced

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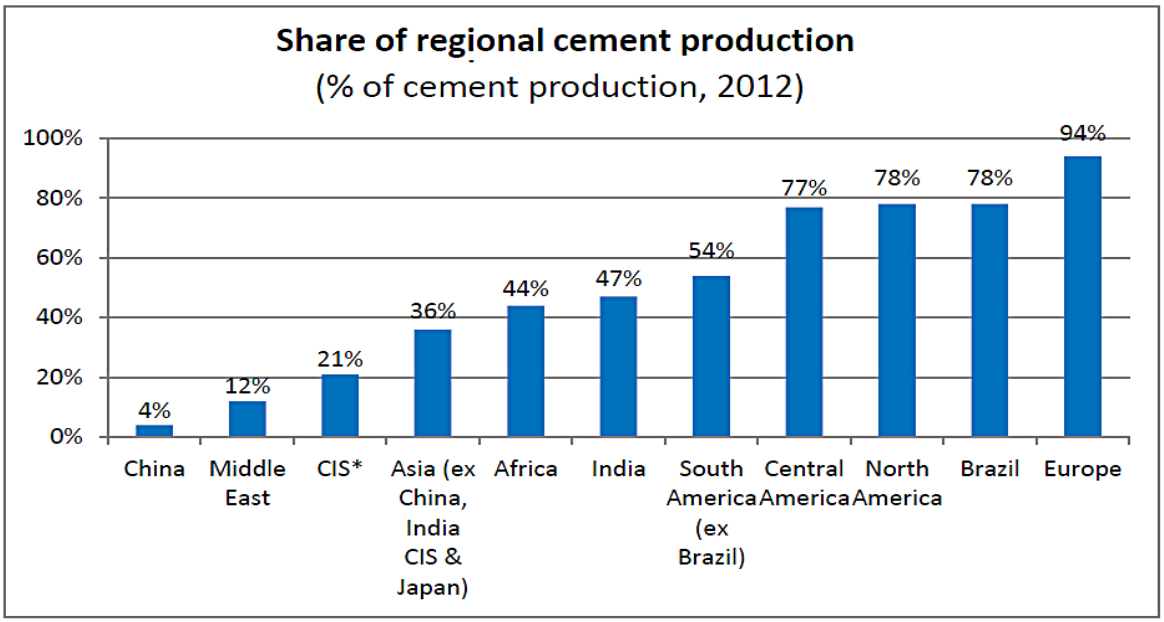
during the last decades by adopting various strategies and resources (Sjølie, 2012). For instance, substitute raw materials, switching and utilizing substitute fuels and reducing the clinker in cement ratio (Song & Chen, 2014). Cement industry has introduced modern and efficient plants to reduce carbon caption which is the best available technology to achieve the future goals of global change (Hendriks et al., 1999). The process of cement production releases CO_2 emissions which cannot be avoided to eliminate the emissions and greenhouse gas to the environment as the raw materials particularly limestone utilized in cement manufacturing is releasing around 65% CO_2 and causing global warming (Noor ul, 2012). Cement is among the important industries of Pakistan and it has been as one of the most important industries during the last two decades (Wen, Chen, & Meng, 2015). The main raw materials for cement production are Limestone and Gypsum and these available in abundance in Pakistan (Gardezi, Manarvi, & Gardezi, 2014). The good supply of Natural gas is great potential for the country to produce cement domestic use as well as for exports to generate foreign reserves for the country. Pakistan cement industry is fulfilling local market and also is exporting cement to neighborhood countries including Russia, Iraq, Sri Lanka, India, Afghanistan and United Arab Emirates. At present, Pakistan is also exporting cement to some African countries (Nayyar, Zaigham, & Qadeer, 2014). The cement industry is one of important industries of the world which plays a pivotal role in the economic development.

It is a highly important construction material which is used for the construction of housing sector and infrastructure activities. It is a key to economic growth of any country. The demand of cement is directly linked with the economic growth of any country("C," 1968)(Shen et al., 2014). Many developing countries are focusing their concentration on the development of infrastructure which results in the growing demand of cement in the global market. The cement industry benefits the economy by contributing in the economic development of any country. It contributes in the Gross Development Product of the country, creates employment opportunities for a large number of people and creates multiple benefits for the economy. The cement industry also benefits its allied industries. Despite of all the development, growth and profitability the cement industry faces huge challenges due to environmental and pollution issues (Shen et al., 2014).



Source: http://www.wbcsdcement.org/index.php/key-issues/climate-protection/gnr-database

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While the remaining 35% emissions is usually caused by the combustion of fossil fuels to generate heat for limestone decomposition process during cement production ($CaCO_3$ → $CaO + CO_2$) (Wang, Zhu, & Geng, 2013). Henceforth, the purpose of evaluation of the practicality in positioning to capture CO_2 to alleviate the impact on environment, it is required to test the emissions produced by cement industry. Usually, in cement plant, post combustion capture techniques is among the most preferred methods to capture CO_2(Rahman & Khondaker, 2012). Such methods are verified and authentic in some industries but this is not pertinent in cement plants in current situation as a capturing technology to alleviate CO_2 discharge.

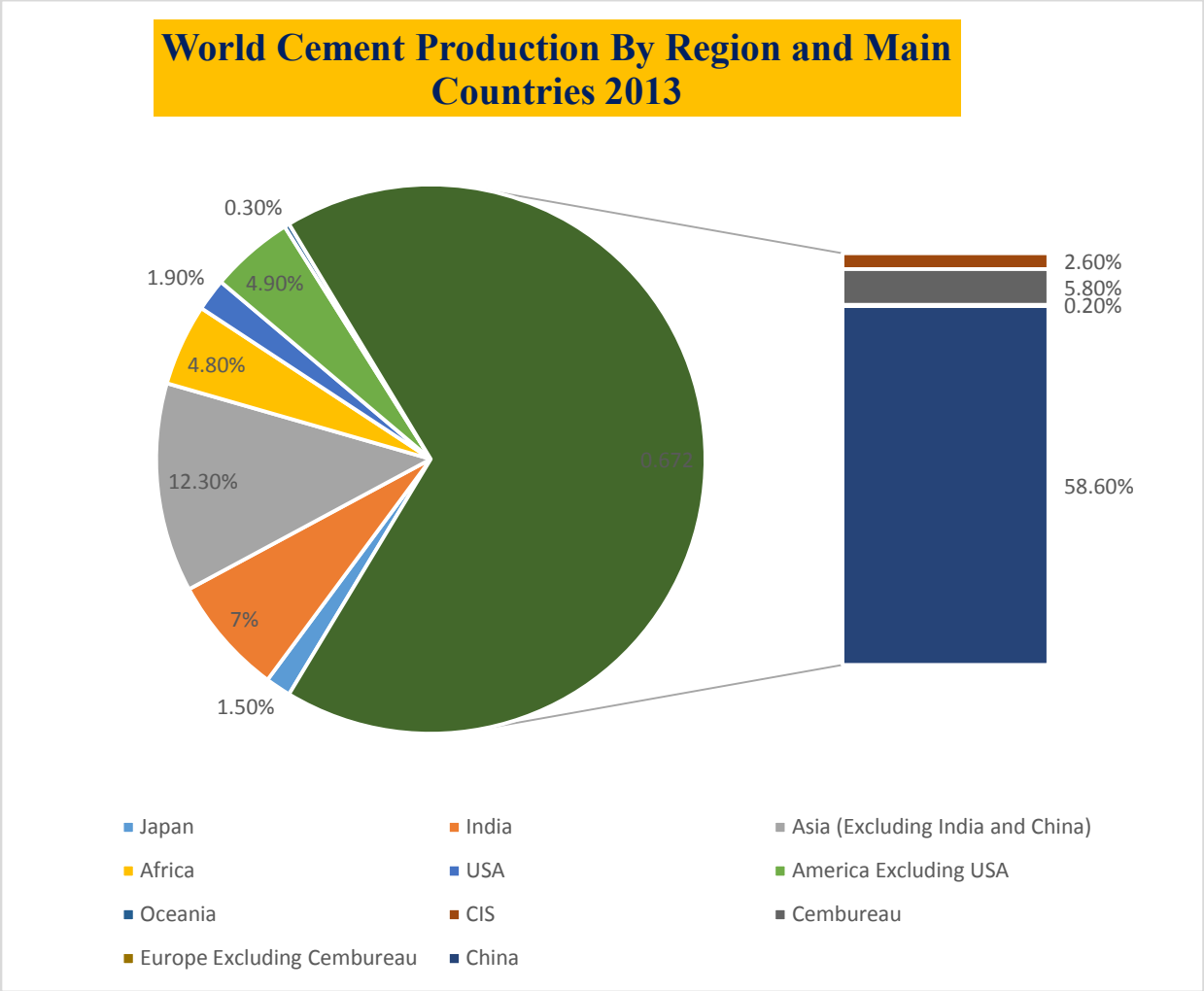

Figure 2

Source: http://www.cembureau.be/sites/default/files/World2.JPG

2. LITERATURE REVIEW

2.1 Cement Processing

Cement Processing is a special kind of technique in which raw materials limestone and clay are mixed and heated together for specific time period on a specific temperature (Buttress, Jones, & Kingman, 2015). The raw materials clay and limestone are mixed together and

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heated the mixture until it changes into a fine powder. The silicates and aluminates present in the cement undertake a chemical reaction when they are mixed together with the water (Yang, Xue, & Huang, 2014).

Cement Processing Plant

The result of this chemical reaction gives a solid mass. Mining of raw materials is the first stage of cement production. The raw materials are crushed and mixed together in a specific proportion. The raw materials like limestone and clay are combined together and the mixture is changed in a definite from powder to solid at 1400 to 1500 °C in a kiln (Tonoli et al., 2013). Then the product clinker is produced. The silos are then used for the shipment of cement in bags. All the processes of cement manufacturing require a certain level of energy and it consumes sufficient energy. During processing of cement thermal energy is used while grinding of raw materials of cement and clinker utilize electrical energy (Lamas, Palau, & Camargo, 2013). As the cost of energy constitutes a huge part of the cost of production of cement. Approximately 90 liters of oil is required to produce one ton of clinker (Li, Wang, Zhang, Wang, & Ouyang, 2012). In case of natural gas hundred cubic meters of gas is required for the same amount of production. Approximately 180 kg of coal is required for production of one ton of clinker (Lecompte, Perrot, Subrianto, Le Duigou, & Ausias, 2015).

2.2 BRIEF DESCRIPTION OF PROCESSING OF CEMENT AND RAW MATERIALS

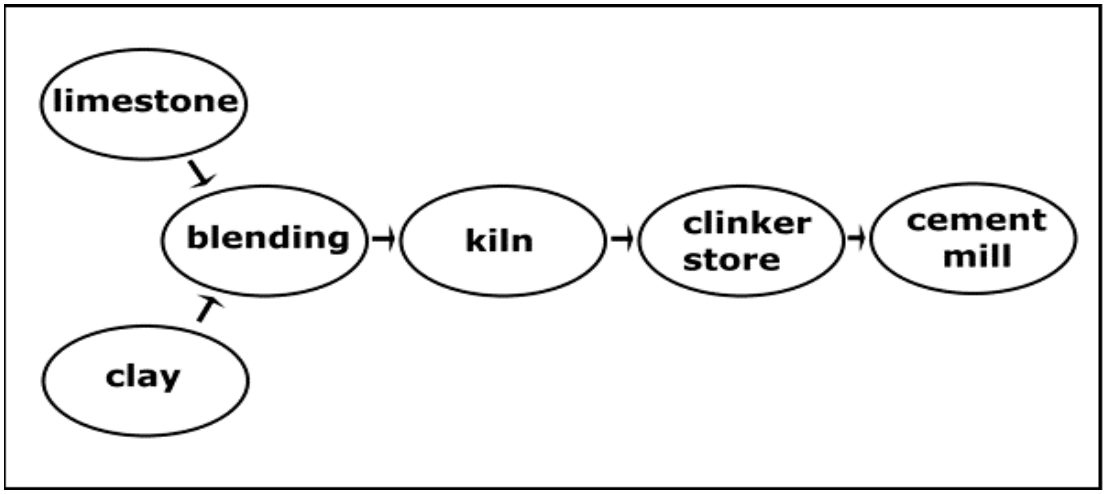

Figure 3

Following is the detail of Cement Processing and Raw Materials.

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2.2.1 LIME STONE

It is an important raw material of cement and it can be utilized as a building material as well. The composition of lime stone constitutes mostly of calcium carbonate. Calcite and aragonite are the crystals which compose lime stone. There are skeletal fragments of marine organisms on the structure of lime stone such as coral. In structure it is very hard sedimentary rock which is also considered as a building material.

Approximately 10 percent of the total sedimentary rocks are limes stones and according to this quantity of lime stones, they are sufficient in nature. The solubility of limestone in water and weak acid solutions makes karts landscapes, in which water erodes the limestone over thousands and millions of years. The limestone bedrock makes majority of the cave systems. It can be used in many ways. It is used as building material and also used in the construction of roads. Limestone is used as filler in products like painting materials and toothpastes.

2.2.2 CLAY (SHALE)

Clay or shale is like a soil which is the mixture metal oxides and organic matters. The deposits of clay on the earth are made up of phyllosilicate minerals. These phyllosilicate minerals are made up of different amount of water trapped in the structure of minerals. In physical nature the clay is quite different from various other kinds of grained soil. They differ in size and mineralogy. The kind of grained soil is silts which is larger in size than the shale or clay. There are some characteristics and properties which are common in the natural deposits of clay shale and silts.The formation of clay usually takes a longer time in nature and it is the result of gradual chemical weathering of rocks. There is another process through which clay minerals are formed like hydrothermal activity. The clay minerals can be composed in place as residual deposits in soil. On the other hand secondary sedimentary process of deposition results in the composition of thick deposits of clay minerals. The deposits of clay are associated naturally with a significant little energy depositional environments such as marine basins and huge lakes.

2.2.3 SILICA SAND

The uses of Silica sand are very vast all over the world. It is found in almost all parts of the earth. So it is recognized as the most common among the kinds of sand in the world. It is available all over the world and it is commonly used in the processing of industry. Glass is made by using silica sand. It is also used in creating molds and castings. *Silica sand is found in different types all over the world. Every kind of silica sand carries different properties and characteristics.* Every variety of silica sand differs from others. Some silica sands are mainly composed of limestone which is

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broken down but some silica sands contain magnetite and these are volcanic in nature. Some silica sands carry lofty amounts of iron in them and are rich in nature while their color is yellow.

2.2.4 IRON ORE

It is a type of rock which gives rise to metallic iron. There are economic methods to extract metallic iron from iron ore. So it is a very useful mineral.These are the minerals which have rich oxide sand. Their color is different from each other. The shape of iron can be found like magnetite and hematite. Some iron ores are found in the shape of goethite and limonite. Some ores contain hematite and magnetite in a huge quantity. This type of ores is known as natural ore and they are transferred in to blast furnaces directly for iron making. It is used in the composition of pig iron which is further processed to compose steel with other raw materials. In composition of steel approximately 98 percent of iron ore is utilized. Iron ore is very important mineral or commodity not only for the country but also for the whole world.

2.2.5 GYPSUM

Gypsum is used in the construction and decoration activities for a long time. It is a common mineral which is found on the surface of earth. In construction and decoration it is used in the shape of plaster and alabaster. Gypsum can be used in different ways. Catal Huyuk was the place of Asia where plaster had been discovered first. In Israel it was discovered in 700 B.C. In construction of the Cheops Pyramid Gypsum was used as mortar. The plaster was used by the artists and decorators in the middle ages for their work. After that the activities related to that are increasing time to time. In bread and dough and Gypsum is mixed for calcium and baking aid. Gypsum works as filler and fire retardant particularly in products of product.Gypsum can be used in Portland cement for setting and expansion control. Gypsum is used as a source of calcium and sulphate sulphur for the growth of plant. It can be used in patching compound as an ingredient. Gypsum can be used for many purposes.

2.2.6 NEEDS FOR RAW MATERIAL

For the production of about one ton of Portland cement approximately 1500 kg of raw materials are required. Beside these approximately 1.2 tons of limestone and marl are required. Lime stone and marl are chalky

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materials. The required quantity of clay is approximately 0.4 ton. Clay is shale like material. Gypsum which is either natural or synthetic is also required for cement production and about 0.05 tons of gypsum is utilized in manufacturing of one ton of cement.

2.2.7 PREPARATION OF RAW MATERIALS

The preparation of raw materials starts from the mining of limestone. Lime stone go under the process of blasting as well as drilling during mining. So this requires a modern technology and equipments in order to control noise and dust. The modern machinery is helpful in keeping all the emissions at minimum level which are harmful for environment and health. The materials produced from blasting are usually in different sizes. Some materials are produced in large sizes while some materials are produced in the shape of smaller particles.

2.2.8 Capacity of Crusher / Quarry Equipment

Normally the manufacturing plant works for the shift of eight hours and there may be a single shift or double shift. The quarry and crushing plant is designed to work in approximately 75 percent of the available time. There are some interruptions in the operations which usually come in the way of supply of material.

2.2.9 RAW GRINDING

The process of raw grinding is a unique one where all raw materials are kept in a specific proportion for a chemical composition in the wet process. The raw materials are further converted into the smaller even they as small as 75 microns or sometimes more smaller according to the need. The slurry materials are those which are departed from the mill. The slurry material is flown and pushed to the blending tanks where chemical composition takes place in the exact manner. The process is called homogenization.

The materials produced are loaded in the trucks from the blasting area and they are taken to the plant where they are crushed. The crushing changes the lime stone into a smaller size or the size which is required. The decreased size of limestone after crushing may be less than the size of 100 mm. After that the lime stones are kept in the storage until they are used. According to the size of the material, it is used in the production of the cement. Some small materials like shale, sand and clay are crushed or some are not crushed before storage. Almost all the raw materials are made productive after the process of blasting and crushing. The crushing can take place in primary, secondary and final stage in order to change them to the required size.

After this process the material is ready for the storage before its usage. All the raw materials are set to an accurate proportion for a chemical decomposition in the dry process. In this process a revolving ball mill is required or a vertical roll mill can also be used. After that all the inputs means raw materials are dried up with the help of waste process gases and the raw materials are changed to the smaller sizes even less than the size of 75 microns.

In the dry process the materials which are taken away from the mill are called kiln. Kiln can be exit from both types of mills like revolving ball mill or vertical roll mill. After that the kiln is set for the chemical composition and the process of homogenization takes place and then the kiln is set for storage before its usage.

2.2.10 PYRO-PROCESSING

In both processes of cement processes whether it is dry process or wet, they are quite related. Because the chemical reactions taken place in the result of these both process are

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similar. The chemical reaction can be evaporation of moisture. It can be reaction of raw materials like iron, sand, clay and shale with calcium oxide. The chemical reaction can be taken place to produce calcium oxide from limestone. All these chemical reaction finally results in the composition of clinker. The clinker is a black and nodular product with all desired hydraulic properties. The slurry which is thin liquid cement is kept in a rotary kiln during the wet process. The diameter of slurry may be approximately 5m. The length of the slurry may be approximately 165 m. In the manufacturing of rotary kiln is specially designed to protect it from high temperatures. Steel and special refractory material is used for this purpose because temperature during the process of clinker making can be reached to the extent of 1450 degree C. On the other hand the dry process is different from the wet process in which pre-heater tower. The pre-heater tower is higher to the extent of 150 meters. So before feeding the material to the rotary kiln, it is fed to the pre-heater kiln. After that the material is fed to a rotary kiln which is also practiced in the wet. The diameter of the material can be same or it can be shorter as well. The kiln used in the dry process is same as in the wet process because the manufacturing of rotary kiln is specially designed to protect it from high temperatures. Steel and special refractory material is used for this purpose because temperature during the process of clinker making can be reached to the extent of 1450 degree C. Apart from of the process, the rotary kiln and the pre-heater tower are equipped fully with the firing. The red hot clinker is discharged from the rotary kiln. It is discharged to a clinker cooler in intense flame. The heat is then removed from the clinker in the clinker cooler and it get backs to the Pyro-processing and results in reduction of fuel consumption. It also results in improvement of energy efficiency. The clinker cooler makes the cooler as conducive as it can be handled on the standing handing over equipment.

2.2.11 FINISHING AND GRINDING

When the clinker is ready for usage it is stored in silos before its usage in the production of cement. The clinker is one of the inputs of cement but gypsum and other raw materials are added for the final production of cement. In ball mills clinker and other raw materials are added to give cement a final shape. So the amount and proportion of addition of raw materials is very important in the making the cement a final product.

XI. PACKING OF CEMENT

Packing of cement is also an important part of the manufacturing of cement. From the storage towers the cement is gone through the packing machines which help to pack the cement bags and sacks. There are two types of machines used in cement packing. The in liner packer is called stationary machine. It contains 4 to 6 filling spouts. The second kind of packing machine is called rotary packing machine. It has 6 to 16 spouts. The spouts are mounted on the bottom of a cylindrical container. Bags are set on all spouts by the machine operator and he opens the valve of the spout into the cement bags. There is a weighing machine for automatic weighing of cement before the packing is done. So the filling operation is controlled through this system.

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2.2.12 DISTRIBUTION

The distribution of cement is the important process through which it is supplied to the consumers. The cement is basically stored in different bulks. These bulks are distributed in the market according to the need. Railway can be used for the distribution of cement which is comparatively cheaper in cost than trucks. Trucks are also used for the distribution of cement. Sea route is also an important source for the cement distribution.

3. METHODOLOGY

The strategy of the study includes the traditional steps used in historical research which consists of defining the problem of the study, locating sources of data and all documents relevant to the study, summarizing and evaluating the data and then finally interpreting the data by means of content analysis.

4. ENVIRONMENTAL AND HEALTH IMPACT OF EMISSIONS

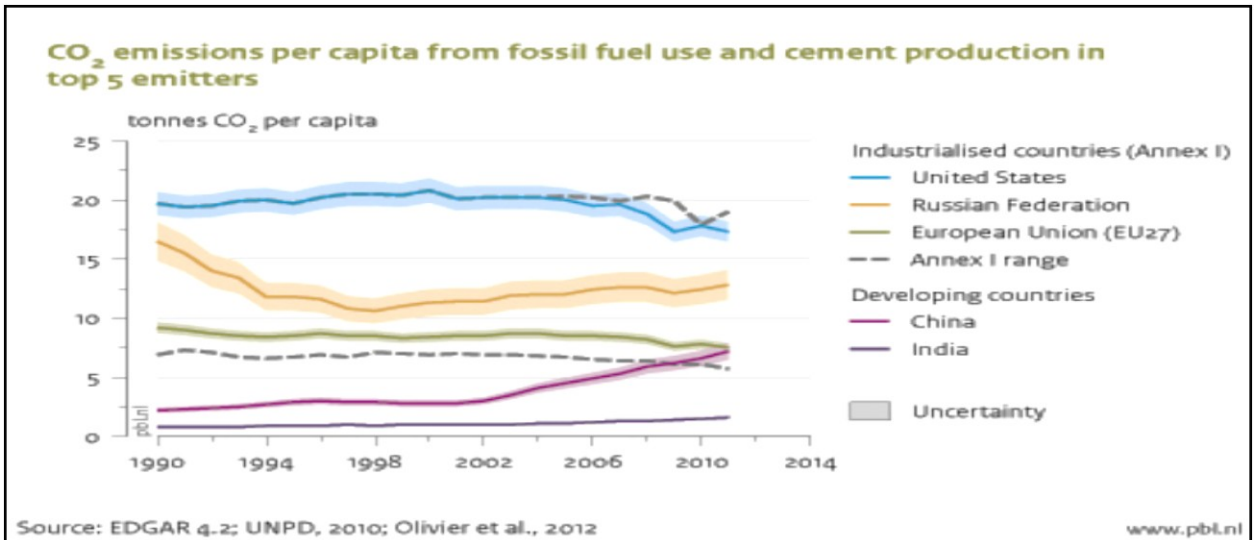

Figure 4

Cement plants are a significant source of sulfur dioxide, nitrogen oxide and carbon monoxide, which are associated with the following health and environmental impacts. Nitrogen oxide (NO_x) can cause or contribute to a variety of health problems and adverse environmental impacts, such as ground-level ozone, acid rain, global warming, water quality deterioration, and visual impairment. Affected populations include children, people with lung diseases such as asthma, and exposure to these conditions can cause damage to lung tissue for people who work or exercise outside.

Sulfur dioxide (SO_2) in high concentrations can affect breathing and may aggravate existing respiratory and cardiovascular disease.

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Sensitive populations include asthmatics, individuals with bronchitis or emphysema, children, and the elderly. SO_2 is also a primary contributor to acid deposition, or acid rain. Carbon monoxide (CO) can cause harmful health effects by reducing oxygen delivery to the body's organs and tissues, as well as adverse effects on the cardiovascular and central nervous systems. CO also contributes to the formation of smog (ground-level ozone), which can cause respiratory problems.

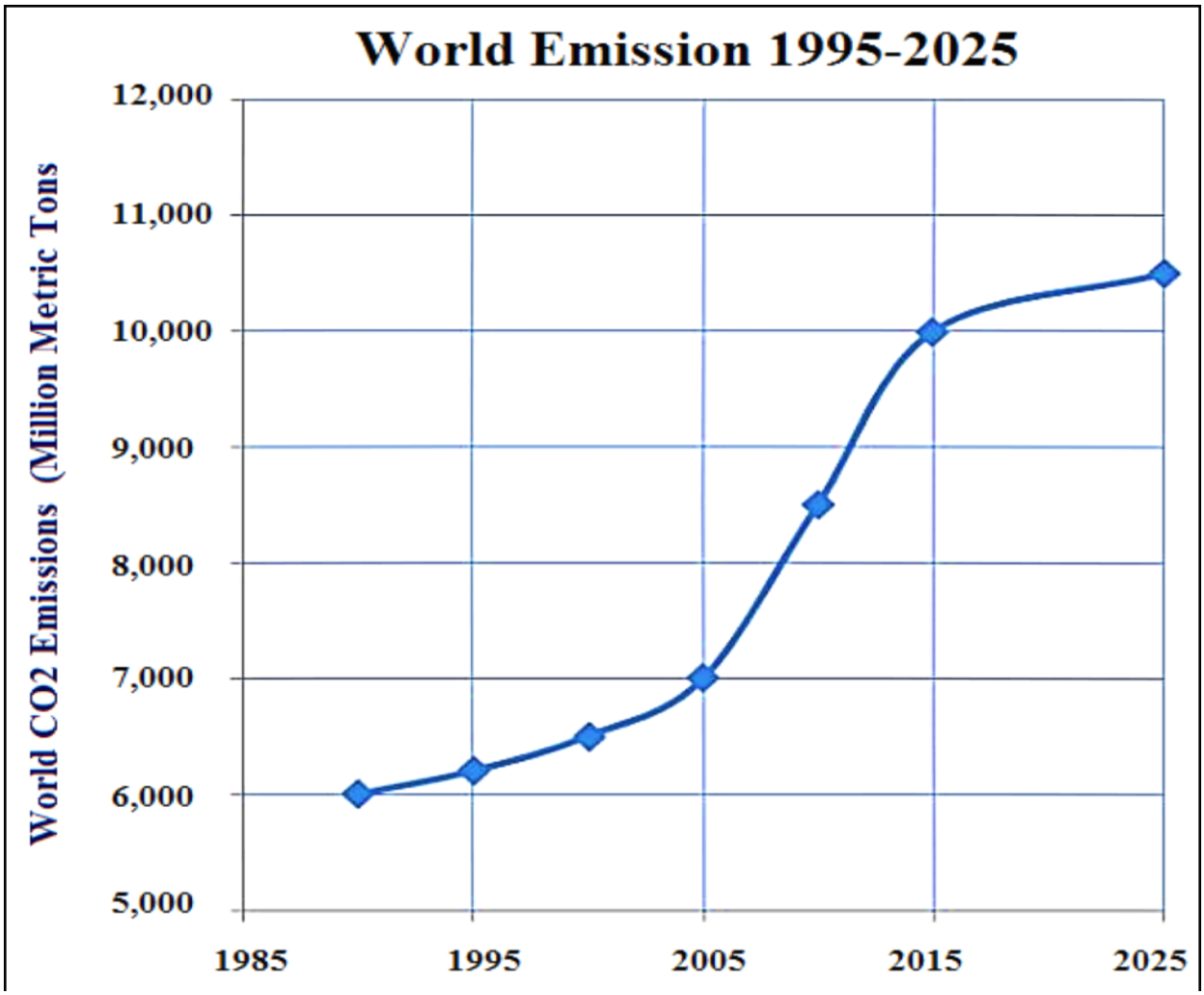

Figure 5

5. CONCLUSION

Cement Processing is energy intensive method which requires high level of energy consumption. The process of cement manufacturing also creates environmental and health issues for human beings. At present, we are witnessing significant development and infrastructure activities which is the major reason to increase the demand of cement production at large scale to fulfill domestic and international demand during the last couple of years. Despite of all the developments made by this sector, environmental and health issues are also created

all over the world. The emissions from the cement manufacturing processes are degrading the quality of air and it results in the environmental pollution. The review of literature shows the cement processing and its impact of emissions on the environment change in detail. Henceforward, it is concluded from the study that the emissions from cement manufacturing processing causes environmental and health issues and its very harmful to human beings and causes global warming. Therefore, it is strongly recommended that better equipment's should be utilized in the process of cement manufacturing to minimize the global warming and environmental issues.

REFERENCES

[1.] Buttress, A., Jones, A., & Kingman, S. (2015). Microwave processing of cement and concrete materials – towards an industrial reality? *Cement and Concrete Research, 68*(0), 112-123. doi: http://dx.doi.org/10.1016/j.cemconres.2014.11.002

[2.] . C. (1968) *Recent Publications in the Social and Behavioral Sciences* (pp. 37-47): Pergamon.

[3.] Gao, T., Shen, L., Shen, M., Chen, F., Liu, L., & Gao, L. Analysis on differences of carbon dioxide emission from cement production and their major determinants. *Journal of Cleaner Production*(0). doi: http://dx.doi.org/10.1016/j.jclepro.2014.11.026

[4.] Gardezi, S. S. S., Manarvi, I. A., & Gardezi, S. J. S. (2014). Time Extension Factors in Construction Industry of Pakistan. *Procedia Engineering, 77*(0), 196-204. doi: http://dx.doi.org/10.1016/j.proeng.2014.07.022

[5.] Hendriks, C. A., Worrell, E., Price, L., Martin, N., Ozawa Meida, L., de Jager, D., & Riemer, P. (1999). - Emission reduction of greenhouse gases from the cement industry *Greenhouse Gas Control Technologies 4* (pp. 939-944). Oxford: Elsevier Science Ltd.

[6.] Lamas, W. d. Q., Palau, J. C. F., & Camargo, J. R. d. (2013). Waste materials co-processing in cement industry: Ecological efficiency of waste reuse. *Renewable and Sustainable Energy Reviews, 19*(0), 200-207. doi: http://dx.doi.org/10.1016/j.rser.2012.11.015

[7.] Lecompte, T., Perrot, A., Subrianto, A., Le Duigou, A., & Ausias, G. (2015). A novel pull-out device used to study the influence of pressure during processing of cement-based material reinforced with coir. *Construction and Building Materials, 78*(0), 224-233. doi: http://dx.doi.org/10.1016/j.conbuildmat.2014.12.119

[8.] Li, Y., Wang, H., Zhang, J., Wang, J., & Ouyang, L. (2012). The Industrial Practice of Co-Processing Sewage Sludge in Cement Kiln. *Procedia Environmental Sciences, 16*(0), 628-632. doi: http://dx.doi.org/10.1016/j.proenv.2012.10.086

[9.] Nayyar, Z. A., Zaigham, N. A., & Qadeer, A. (2014). Assessment of present conventional and non-conventional energy scenario of Pakistan. *Renewable and Sustainable Energy Reviews, 31*(0), 543-553. doi: http://dx.doi.org/10.1016/j.rser.2013.12.049

[10.] Noor ul, A. (2012). Use of clay as a cement replacement in mortar and its chemical activation to reduce the cost and emission of greenhouse gases. *Construction and Building Materials, 34*(0), 381-384. doi: http://dx.doi.org/10.1016/j.conbuildmat.2012.02.022

[11.] Rahman, S. M., & Khondaker,

A. N. (2012). Mitigation measures to reduce greenhouse gas emissions and enhance carbon capture and storage in Saudi Arabia. *Renewable and Sustainable Energy Reviews, 16*(5), 2446-2460. doi: http://dx.doi.org/10.1016/j.rser.2011.12.003

[12.] Shen, L., Gao, T., Zhao, J., Wang, L., Wang, L., Liu, L., . . . Xue, J. (2014). Factory-level measurements on CO2 emission factors of cement production in China. *Renewable and Sustainable Energy Reviews, 34*(0), 337-349. doi: http://dx.doi.org/10.1016/j.rser.2014.03.025

[13.] Sjølie, H. K. (2012). Reducing greenhouse gas emissions from households and industry by the use of charcoal from sawmill residues in Tanzania. *Journal of Cleaner Production, 27*(0), 109-117. doi: http://dx.doi.org/10.1016/j.jclepro.2012.01.008

[14.] Song, D., & Chen, B. (2014). A Life Cycle Modeling Framework for Greenhouse Gas Emissions of Cement Industry. *Energy Procedia, 61*(0), 2649-2653. doi: http://dx.doi.org/10.1016/j.egypro.2014.12.267

[15.] Tonoli, G. H. D., Belgacem, M. N., Siqueira, G., Bras, J., Savastano Jr, H., & Rocco Lahr, F. A. (2013). Processing and dimensional changes of cement based composites reinforced with surface-treated cellulose fibres. *Cement and Concrete Composites, 37*(0), 68-75. doi: http://dx.doi.org/10.1016/j.cemconcomp.2012.12.004

[16.] Wang, Y., Zhu, Q., & Geng, Y. (2013). Trajectory and driving factors for GHG emissions in the Chinese cement industry. *Journal of Cleaner Production, 53*(0), 252-260. doi: http://dx.doi.org/10.1016/j.jclepro.2013.04.001

[17.] Wen, Z., Chen, M., & Meng, F. (2015). Evaluation of energy saving potential in China's cement industry using the Asian-Pacific Integrated Model and the technology promotion policy analysis. *Energy Policy, 77*(0), 227-237. doi: http://dx.doi.org/10.1016/j.enpol.2014.11.030

[18.] Xu, J.-H., Fleiter, T., Fan, Y., & Eichhammer, W. (2014). CO2 emissions reduction potential in China's cement industry compared to IEA's Cement Technology Roadmap up to 2050. *Applied Energy, 130*(0), 592-602. doi: http://dx.doi.org/10.1016/j.apenergy.2014.03.004

[19.] Yang, Y., Xue, J., & Huang, Q. (2014). Studies on the solidification mechanisms of Ni and Cd in cement clinker during cement kiln co-processing of hazardous wastes. *Construction and Building Materials, 57*(0), 138-143. doi: http://dx.doi.org/10.1016/j.conbuildmat.2013.12.081

[20.] Zhang, J., Liu, G., Chen, B., Song, D., Qi, J., & Liu, X. (2014). Analysis of CO2 Emission for the Cement Manufacturing with Alternative Raw Materials: A LCA-based Framework. *Energy Procedia, 61*(0), 2541-2545. doi: http://dx.doi.org/10.1016/j.egypro.2014.12.041

[21.] Cheng-yi, H. & Feldman, F. (1985). Properties of Portland Cement-Silica Fume Pastes Cement and Concrete Research. Vol. 15. Ottawa, Canada,: Copyright (c) 1985 Pergamon Press, Ltd. Pp. 943-952.

[22.] Cement Manufacturing Enforcement Initiative, Environment protection Agency report, Online

availableat:http://www2.epa.gov /enforcement/cementmanufacturing-enforcement initiative

[23.] Cristian Dincă, Călin-Cristian Cormoş, Horia Necula, Environmental Impact Assessment of GHG Emissions Generated by Coal Life Cycle and Solutions for Reducing CO2, 2013

[24.] Environmental Assessment of the Amran Cement Plant, US Agency for International Development, 2005

[25.] Feng, L., M. Ross, and S. Wang, 1995. Energy Efficiency of Chinas Cement Industry, Energy, the International Journal 7 20 pp669-681 (1995).

[26.] Huhta, R.S., 1992. Operating Costs of U.S. Cement Plants, Rock Products, November 1992, pp.30-34.

[27.] Hendrik G. van Oss and Amy C. Padovani, Cement Manufacture and the Environment Part II: Environmental Challenges and Opportunities, 2003

[28.] Health Effects of Regulated Air Pollutants from Toxic Waste Burning Cement Kilns, Online available at: http://www.groundwork.org.za/Cement

[29.] Marland, G., Boden, T. and Brenkert, A. 1998 Revised Global CO2 Emissions from Fossil Fuel Burning, Cement Manufacture, and Gas Flaring, 1751-1995

[30.] Mark Z. Jacobson, on the causal link between carbon dioxide and air pollution mortality, 2008

[31.] Manjula R., R. Praveena, Rashmi R. Clevin, C. H. Ghattargi, A. S. Dorle, D. H. Lalitha, Effects of occupational dust exposure on the health status of portland cement factory workers, 2014.

[32.] M.A.Darweesh1, M.K.El-Sayed, The Effect of Cement Dust Pollution on the Zygophyllum Coccinum Plant, 2014.

[33.] Marlowe Ian and Mansfield David, Toward a Sustainable Cement Industry Substudy 10: Environment, Health & Safety Performance Improvement, December 2002, an Independent Study Commissioned by WBCSD

[34.] Marchwinska-Wyrwal E., Dziubanek G., Hajo I., Rusin M., Oleksiuk K. and Kubasiak M., Impact of Air Pollution on Public Health, (2011).

[35.] Mehraj.S, Bhat G.A., Balkhi. H.M, Cement Factories and Human Health, 2013

[36.] Oak Ridge, TN: Carbon Dioxide Information and Analysis Center, Oak Ridge National Laboratory.

[37.] Peikang, R., C. Yuanshen, Z. Yuhui, and Z. Qingshan, 1997. Chinas Cement Industry in 1996 and Development Prospects for 1997, World Cement 6 28 pp.5-8 (1997).

[38.] Potgieter Johannes H. An Overview of Cement production: How “green” and sustainable is the industry?, 2012.

[39.] Pariyar Suman K, Das Tapash, Ferdous Tanima, Environment And Health Impact For Brick Kilns In Kathmandu Valley, 2013.

[40.] Pollution Prevention and Abatement Handbook 1998 toward Cleaner Production, World Bank Group, International Finance Corporation, Washington D.C., 1999.

[41.] Sustainable Cement Production, Co-Processing Of Alternative Fuels And Raw Materials In The European Cement Industry Chembureau , 2009.

[42.] Sharma Kuldeep, Treatment of Waste Generated From Cement Industry And Their Treatment- A Review.