WASTE TIRE AS AN ALTERNATIVE FUEL OF CEMENT PRODUCTION PROCESS IN IRAN

[1]MOHAMMAD MALEKIHA, [2]MEHDI HAJIAHMADI

[1,2]R&D Department, Foolad Technic International Engineering Company, Isfahan, Iran
E-mail: Mohammadmalekiha@yahoo.com

Abstract- From the beginning of the 21st century human society encountered with global environmental problems. It would be necessary that the industries find effective solutions for such problems. One of these problems is emission of greenhouse gases which cause to global warming. The cement plants are the most important reason of emitting greenhouse gases and carbon dioxide in the world. Cement industries lonely produce 5 percent of Carbon dioxide in the world which its portion is more than the whole world air transportation industries. So the Kyoto protocols which is about decreasing the emission of greenhouse gases in way of Clean Development Mechanism by using alternative cleaner fuels and improvement of energy consumption and saving has been established in 1997. On the other hand, In recent years, the volume of non-recyclable polymers such as waste tires, plastics in municipal wastes increased rapidly, so improvement of recycling process is an important duty of industries. According to the statistics in industrial countries one tire is used per citizen a year. It means that 9 Kg tire is used per person. According to available statistics in Iran 10 million tires are used per year which equal to 200.000 Tons of tires annually. In Iran only 20 percent of Waste Tires are recycled and 80 percent sent to land fields. Disposal of tires is a hard duty because waste tires have high volume versus their weight. In this study combustion of old tires in cement production process as an alternative Fuel and related environmental benefits was investigated.

Keywords- Recycling, Waste Tire, Cement Process, Alternative Fuel, Energy

I. INTRODUCTION

As We know from the beginning of 21st century human beings encountered with environmental problems It would be necessary that the industries find a proper solution by using natural resources and recycling process for these problems. In recent years the volume of non-recyclable polymers such as waste tires, plastics in municipal wastes which incinerated sharply increased, therefore industries should find suitable solution for this problem. Cement production process requires huge amount of energy and they are the most important Emitters of greenhouse gases and carbon dioxide in the world with 5 percent of greenhouse gases emitting. This carbon dioxide sourced from two resources: first, decomposition of Limestone process during cement production and second burning fossil fuels in cement kilns [1-3].

So applying waste tires as an alternative fuel lead to energy saving and economical benefits. Because of long length, high temperature and materials long retention time in cement kilns, they could be an appropriate environment for combusting waste tires as an alternative fuel. Raw materials of cement production could be mixed with waste tires combustion ash without decreasing cement quality and properties. Tires contain zinc and ferrous materials in their composition both of them increase chemical properties and quality of cement [4-6].
Fortunately while utilizing waste tires as an alternative fuel there is no need basic changes in Material handling equipment in cement plants, In addition according to EPA reports incineration of waste tires in cement kilns generally didn't emission major environmental contaminates [6, 8]. Waste tires have already caused environmental difficulties for the urban services organization in Iran. According to predictions using of tires in 2026 will reach to 800.000 Tons annually [8, 9].
Today the amount of using tires reported 350.000 Tons per year which could be used as an alternative fuel in cement industry [10]. In this study application of waste tires in cement plants, environmental benefits and its effects on producing clinker has been investigated.

II. DETAILS EXPERIMENTAL

2.1. Cement Production Process in Iran

Required raw materials in cement industry are: Clay, Quartz, Gypsum, Iron ore and Limestone. These materials are mixed with a specific ratio: limestone 75 %, clay 13% and additives 12 %.modifiers and fluxes consist of zinc, magnesium, iron and aluminum compounds which are used as mixing and melting agents.

In this process limestone is broken in 25 mm size particle in crusher then the ratio of raw materials for mixing in kiln is determined by laboratory. Other consisting cement materials are mixed with crushed limestone in preheating kiln. The raw materials in powder form are injected from the top of the preheating kiln and flame is blown from the bottom of the kiln. Raw materials slowly pass the kiln path, during this process the temperature is increased from 100 c to 800 these materials are transferred to cement kiln. In this stage temperature is increased up to 1500 c and clinker formed. Finally clinker gets cooled and 2 % gypsum is added for accelerating adherence and sent to mill to produce cement powder [11, 12].

2.2. Application of Waste Tires in Cement Process

The chemical compositions of various tires are very identical and Rubber is the main part of the tire, so this characteristic facilitates using of tires as an alternative fuel in cement production industries. Waste tires are identified as a compact fuel with low humidity which consists of 90 % of hydrogen, carbon and oxygen with thermal value 32 MJ/Kg. Table 1 shows the chemical composition, thermal value of waste tires and main fuels used in Iran cement industry. According to EPA (Environment Protection Agency of USA) previous reports of 60 cement plants in USA used 53.000.000 waste tires as alternative fuel [11-13].

Table1. Chemical Composition and Thermal Value [14-17]

Composition	Natural gas %	Fuel Oil %	Tire %
Humidity	0.2	1	0
Carbon	80.1	83.8	78.2
Hydrogen	14.3	11.2	7.1
Sulfur	4.5 ppm	3.9	1.6
Nitrogen	5.3	0.1	0.2
Zinc Oxide	0	0	0.9
Steel	0	0	12
Thermal Value	36.6 (Mj/Nm^3)	41.7 (Mj/Kg)	37.6 (Mj/Kg)

The thermal value of waste tires differ depending upon type and amount of consisting fiber and steel materials. Also the very low amount of contaminating elements such as nitrogen and sulfur is another advantage of using waste tires as an alternative fuel in cement production process. According to the recent studies waste tires burn fast at the temperature range of 300 c to 350 c then by increasing temperature to 400 c the carbon part of tires start to burn and finally at the temperature of 650 c burning process of carbon is completed. As a theoretical calculation the thermal value of 1 kg tire is equivalent to 0.86 liter of oil [7, 8, 18, 19]

2.3. Effects on Clinker Production Quality

Cement kilns are suitable environment for burning alternative fuel. Because cement kiln have long length and high temperature around 1500 C with long retention time Figure 1 shows the cement kiln use waste tire as alternative fuel.

Depending on the kiln system, the following rules should take to consider regarding to chip size and potential for substitution to ensure success: Smaller the chips size provides more substitution rate and produced more efficiency. The best chips size in short kiln size is about 25 x 25 mm chip size or smaller. Premixing the chips with cement raw materials recommended in preheating kilns because for complete combustion of chips and breaking strong organic bond in hydrocarbon chain via main flame in main rotary kiln. For long kilns without pre heating, the chips need to be blown to the back of the burning zone. Ideally, the injection pipe should be located above the main burner, at a 5-10 degree angle, so the main flame can carry the chips further and start the volatilization prior to the chips striking the load [12, 13, 20-22]. Finally, impact of raw materials on SO2, CO, VOC, D/F's needs to be fully understood and tracked, prior to co-processing any chips on the other hand [4, 20]. Application of waste tire affect on produced clinker. It would be necessary to study the effect of elements such as inorganic elements such as Sulfur, Iron and Zinc on produced cement.

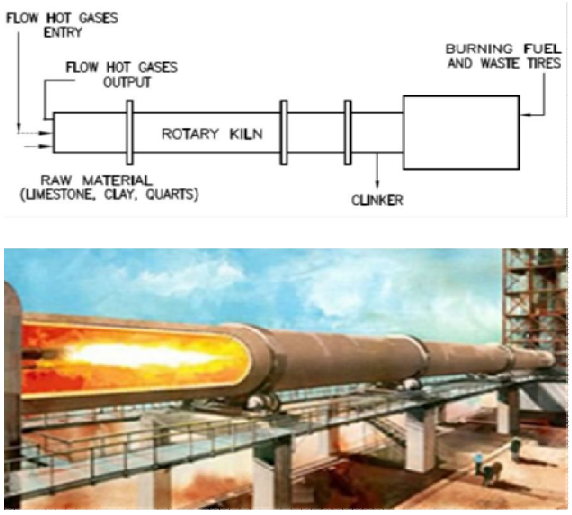


Fig1. Cement kiln use waste tire as alternative fuel

Sulfur: According to high concentration of sulfur in tire composition, and tendency of production of volatile alkaline salts in this environment, Solid layer form in inlet and outlet of cement kiln [4].

Iron: Iron contained in tire melts and reacts with aluminum in cement kiln. This results in decreasing concentration of aluminum in cement composition. So it would be necessary to add aluminum compounds to the raw materials [5].

Zinc: Zinc presents with high concentration in tires. 1 to 2 percent of tire weight is zinc oxide. If the concentration of zinc in clinker is lower than 500 ppm it would not affect on cement properties. Substitution rate of waste tire in cement industry is 25% of total required energy. If rate of substitution is more than 25%, time of production of clinker will greatly increase [5]

2.4. Environmental and Energy Consumption Impacts

One of the most important environmental effects of cement production plants is emitting carbon dioxide. According to the statistics 5 percent of greenhouse gases in the world produced in these plants. This carbon dioxide sourced from two resources: first, decomposition of Limestone. In this process for production of 0.8 tons of cement, 1 ton of carbon dioxide released and second burning fossil fuels in cement kilns. Iran ranks in the 7th place of producing greenhouse gases after China, USA, India, Russia, Japan and Germany in the world. The amount of

carbon dioxide produced in Iran cement industries in year 2012 is equal 28,017,652.5 which mean 4.2 percent of all Iran greenhouse gases [4, 5, 23, 11]. Figure 2 shows the global distribution of carbon dioxide emission in the world.

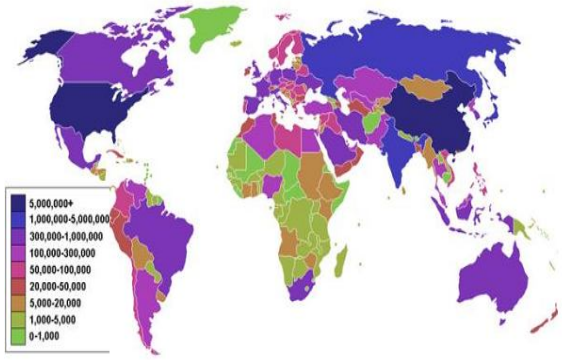


Fig. 2. Countries by carbon dioxide emissions world map

After Iran's accession to the Kyoto Protocol in 2005 starting an effort to finding alternative fuels such as waste tires in cement industries. Based on statistics of Iran Cement Association the amount of cement production was 105 million tons in year 2013. According to the previous studies for producing 1 ton cement in Iran, averagely 95 liters of heavy oil consumed. Based on previous prospects, the amount of energy consumption in cement industry is equal to 38.9 million barrel of oils per year which by substituting 20 percent of traditional fuels by waste tires it will be possible to saving 7.8 million barrel of oils annually [1, 11-13, 25, 26].

On the other hand there are Environmental concerns about using waste tires as an alternative fuel in cement industries existing till now. It is proved that burning tires in open area has harm full effects on environment and human health. Burning tires emit toxic and dangerous compounds such as volatile organic compounds like benzene, metals such as lead, polycyclic aromatic hydrocarbons such as benzopyrene, and synthetic rubber components such as butadiene and styrene. Additionally, the chlorine content in tires leads to the production of dioxins and furans that are extremely toxic. Environmental effects of burning tires in cement kiln depend on traditional fuels substituted for tires and thermal input provided by incineration of tires.

Recent experiences show that it can be safe to substitute 25% up to 30% of common fuel such as natural gas, Fuel Oil and coal in cement kiln for waste tire. To prevent dispersion of toxic metals like Zinc and Chromium it is suggested to use tires in chips forms. Using waste tires in cement kiln as an alternative fuel decreases the emission of nitrogen oxide, saves energy and environmental costs. The amount of emitted sulfur and sulfur compounds from cement stack could be decreased by using waste tires instead of coal and Fuel Oil as fuel [6, 7, 18, 22].

III. RESULTS AND DISCUSSION

Application of alternative fuels could be a competitive challenge in cement plant energy saving and costs. This results in decreasing the disposal cost of environmental contaminations and solid wastes. However in a developing country like Iran it can be very hard to substitute waste tires for traditional fuels without legal and environmental supports because traditional fuel in Iran like natural gas and oil are not expensive, so investment for using alternative fuel in cement industry is not favorable. So the developing countries such as Iran would play an effective role in decreasing emission of carbon dioxide by using alternative fuels and carbon credit as an encouragement in way of receiving international financial grants such as United Nation Industrial Development Organization, Global Environmental Funds and Clean Development Management. In conclusion the amount of using tires in Iran reported 350.000 Tons per year which could be used as an alternative fuel in Iran cement plants. So complete burning tires in cement kilns do not emit environmental contaminates. Because organic contents completely burn in cement kilns and heavy metals are trapped inside final products. These advantages cause saving 842 million US dollars which is equal 7.8 million barrel of oils annually for the next generation, in addition to environmental benefits.

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