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Energy Conservation Measures In Kiln For Clinker Production

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Abstract:*This study was aim to identify and explain the energy conservation measures in kiln for clinker production. For better energy efficiency in kiln, requires the implementation of energy conservation measures in kiln in order for optimum performance and energy saving of kiln. The cement process, have three stages and detail discussed, also energy in kiln system and heat transfer is explained. However table 2.0 combined rotary kiln burner technical data, which comprises burner fuel capacity, fuel oil temperature and normal acceptable fuel oil viscosity and fuel pressure at set point for better and saving fuel consumption 1.0 and 3.0 is also the energy utilization in clinker production and burner basic air adjustment for kiln fuel using at SokotoCement Plant. The energy conservation measure were also identified and explained. However the chart of stoppages and downtime of kiln explained how, the stoppages affect the kiln fuel consumption and clinker production.*

Keywords: *Energy; Clinker; Conservation;Kiln; Consumption.*

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I. Introduction

Cement manufacturing is an energy intensive and heavy pollutant emissions process. Industrial sector accounts to 30-70% of the total global energy consumption of which cement industry is one of most energy intensive industries in the world [12]. The energy use associated with mining and quarrying raw materials for cement production are not typically included in the cement sector, but rather are accounted for in mining sector. As such the cement sector energy consumption is comprised of energy used for raw material preparation, clinker production and finish grinding. With the cement kiln, it requires about 40-50% of total thermal energy to complete the complex chemical reactions of clinker formation [9]. However energy consumption by a cement industry is estimated at about 2% of the global primary energy consumption (or) which is almost 5% of total global industrial energy consumption [10]. Within the cement kiln, it require about 40-50% of total thermal energy to complete the complex chemical reactions of clinker formation.Energy use associated with mining and quarrying raw materials for cement production are not typically included in the cement sector. As such the cement sector energy consumption is comprised of energy used for raw material preparation, clinker production and finish grinding. Raw material preparation is an electricity intensive production step requiring generally about 23-32kwh/short ton [10].

1.1 Objective

To identify and explain the energy conservation measures in kiln for clinker production, for better energy efficiency and saving in kiln.

2. Cement manufacturing process

The cement manufacturing processes involves three key fundamental stages of production, these are:

- preparation of raw meal
- production of clinker
- grinding of cement

2.1 Preparation of raw meal

This is the stage where the main material (to the kiln) is prepared. And which is also known as raw mix or raw meal. Raw material preparation by whatever preparation cement is to be manufactured consists of the following main processing areas. These are: quarrying, crushing, stockpiling and solid blending, grinding, raw meal blending, homogenization and finally storage. The raw material for the cement production is the mixture (as fine powder in the dry process) of minerals containing calcium oxide, silicon oxide, aluminium oxide, ferrite oxide, and magnesium oxide [13].

2.2 Production of clinker

The rotary kiln is the of the cement manufacturing unit and is the stage at which finely grounded and well blended raw materials undergo a chemical transformation to form a new compound called clinker[9].

2.3 Grinding of cement
This is the main product achieved at any cement mill in any cement plant around the globe. It is a ground grayish power formed by grinding. The cooled clinkers are discharged from the clinker silos where it falls on a belt conveyor. As the clinker is conveying on the belt conveyor, gypsum and limestone are being added to it at a point before it enters into the cement mill. Limestone addition is possible only if the clinker is highly reactive and the product is called cement II type [9]

3. Energy in the kiln system
Producing clinker used large amount of heat energy. About 420kcal of energy is theoretically needed to produce a kilogram of clinker from typical dry kiln feed materials. However much more energy than this is needed in the kiln system to make each kilogram of clinker because energy is also lost with evaporating feed moisture, exhaust gases from the kiln and cooler, clinker and process dust (HeidelbergCementGroup, 2003).

4. Heat Transfer
The heat is transmitted from the flame and combustion products through radiation. The heat from the flame is absorbed by the kiln lining and the feed charge some of the heat absorbed by the kiln refractory lining is lost as radiant heat through the shell to the kiln exterior. However heat loss is reduced in some kiln by using insulating refractories although some heat loss from the kiln is needed for coating formation [9]. The amount of radiant heat transmitted from depends on the composition of the gases and particles in the flame especially soot. For this reason coal and oil fuels give much better heat transfer than natural gas.
Heat Loss
Heat losses from kiln shell, cyclones, Air leaks through Radiation, convection and conduction

Table1.0 Energy Utilization in Clinker Production

Electrical Energy Demands	Thermal Energy Demands
Kiln main and auxiliary drive	LPFO fan kiln and hot gas generator
Transport system	Rice husk for kiln fuel
Mill drive	Diesel for oil pre-heater
ESP	
WT fan/EP fan/Mill fan	

Table 1.0 is the table shows how the power demanding at cement company of northern Nigeria plc sokoto. They used electrical power on transport system, electrostatic precipitator (ESP), WT fan. For the thermal energy they used LPFO oil for kiln fan, hot gas generator, rice husk for kiln fuel, and diesel for oil preheater.

Table2.0 Combined Rotary Kiln Burner Technical Data

Burner Performance	**64 Gcal/hr (74MW)**
Burner capacity/ fuel oil	6600kg/hr
Fuel oil temperature	130^0C
Fuel oil viscosity	10/15 cSt
Fuel oil pressure	35/36 bar (g)
Rice Husk	
Solid secondary fuel (max)	6000kg/hr
Conveying air (variable speed control)	$1200m^3$/hr(+/-20% adjustable)

The table above is the method practice of combined rotary kiln burner, comprises burner fuel capacity, fuel oil temperature and normal acceptable fuel oil viscosity and fuel pressure at set point for better and saving fuel consumption.

5. Energy-Efficiency Measures for Clinker Production in Cement Industry
As noted earlier, each of the process steps has specific energy requirements and consumption patterns, as well as various energy efficiency measures that can be applied to reduce energy use and increase productivity depending on how it been applying and conditions of the cement factory. This section is measures that are applicable to the Cement Company of Northern Nigeria.

1. Identified Energy Conserving Methods: this includes, improving raw mix design, fuel monitoring (for quality and quantity), reducing kiln stoppages, operating at optimum capacity, flame shape regulation, andregular maintenance and tuning of kiln equipment.

2.Improving Raw Mix And Raw Meal Design: A good design of raw meal include, proper raw mix from quarry should be ensured, ensuring accurate mixing of LG and HG limestone (with corr. Material if necessary to give good design), grinding of limestone to specification sieve residue, and minimizing moisture content of raw meal to as low as possible (hot gas generator is always necessary.

3.Fuel monitoring: This is to ensure good quality fuel is burnt (for instance avoiding water in LPFO, sand in rice husk), preheating LPFO to about 130^0C (as per the design) is necessary**,** pumping the oil to the burner at high pressure 30-35bar, and more CO is likely to occur if the fuel oil is not preheated to the right temperature and pressure. (CCNN, 2016).

4. Reducing kiln stoppages: Fuel is burnt to resume steady operation after any stoppage, the cost of frequent unplanned stoppages is fuel consumption for returning to normal kiln temperature without any clinker production, operators should notify maintenance personnel where equipment failure is speculated.

5. Operating at Optimum Capacity: These measures include design capacity of the kiln at cement company of northern Nigeria sokoto is 1600 clk tpd (apprx. 114t/h raw meal).At optimum capacity, the kiln is neither under-fed nor over-fed with material and overfeeding may lead to exposing the kiln to work beyond its capability and may also lead to dumping/flushing because the material may not have reacted all. However underfeeding in kiln operation may lead to flushing of material and waste of fuel since no clinker is produced.

6. Flame Shape Regulation: This measure include; Short hot flames are better than long flames for better fuel efficiency, however short flames are detrimental to brick life, and also the flame shape should be adjusted accordingly with direction from HOS/Master burner. (Cement company of northern Nigeria sokoto).

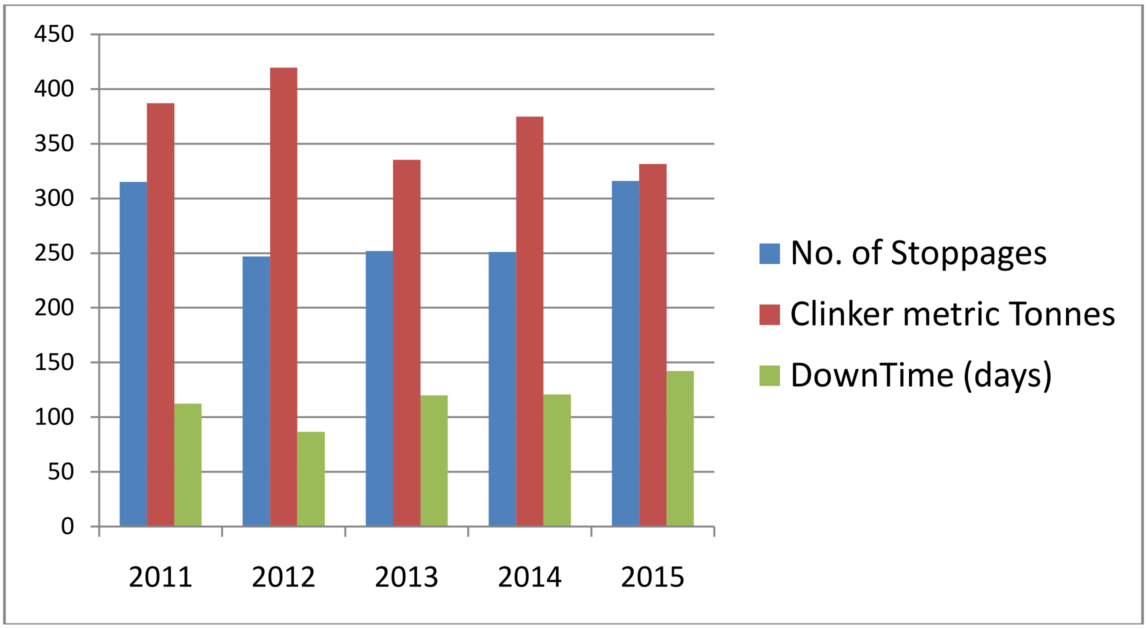
7. Other Methods: These include employing operation practices that reduce wear of refractories and reduce heat losses such as: Avoiding high temperature in the kiln, using a short flame with high kiln speed, operating at the appropriate kiln speed and replacing refractories at optimum wear.

Table3.0 Burner and Basic Air Adjustment for Kiln Fuel

Operations	Flame	Pressure of MAS (mbar)	MAS swirl number(setting on scale)	Pressure of central air (mbar)
LPFO only	Standard	100	3-5	40-150
	Long flame	70-100	2-3	40-150
	Short flame	180-220	6-7	40-150
LPFO+Rice Husk	Standard	100-140	4-8	40-150
	Long flame	100-120	3-4	40-150
	Short flame	180-220	6-8	40-150

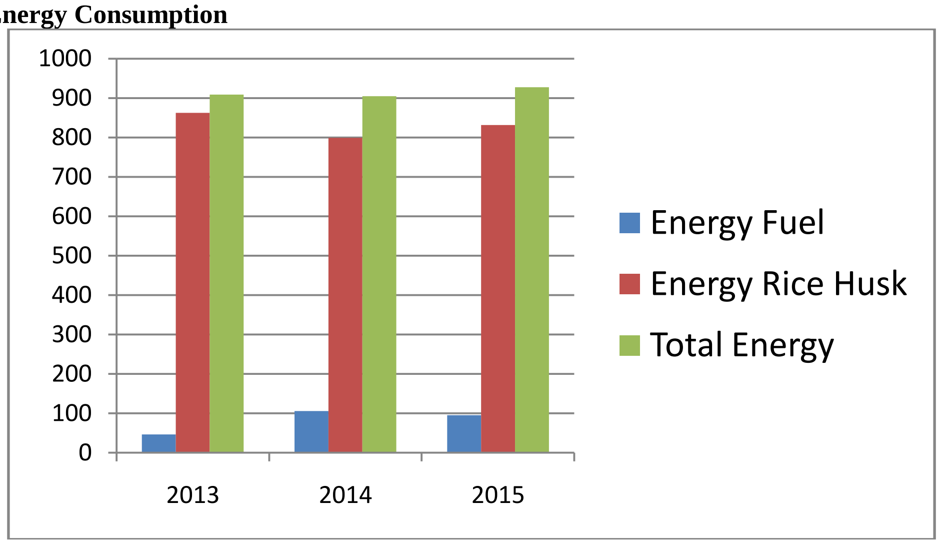
Table 3.0 above is the methodpractices of burner and basic air adjustment for kiln fuel using at cement factory, which includes operation of LPFOonly and also when LPFO plus Rice Husk.

Chart 1.0 of Stoppages, Downtime of Kiln



The chart above shows that there were decreased of clinker metric tonnes production in the year of 2015, due to the increased of number of stoppages. However there were deviations of clinker metric tonnes production in the year of 2011, 2013 and 2014, even though their number of stoppages is the same. And also in 2012 there is better increased of clinker metric tonnes production than all the years mentioned, this is because there were small number of stoppages of kiln.

Chart 2.0 Energy Consumption



The energy consumption chart, shows how the energy were been consumed for some years ago at cement company of northern Nigeria plc sokoto. By implementing the energy conservation measures all this consumption can be reduced for better saving and profitability production.

II. Conclusion

Finally in this research, it is found that the effective way to improve the energy efficiency by the implementation of energy conservation measures in kiln for clinker production. However chart above shows the effects of stoppages of the kiln, usually more fuel is burnt to resume steady operation after any stoppage, and more cost of frequent unplanned stoppages is fuel consumption for returning to normal kiln temperature without any clinker production, and operators should notify maintenance personnel where equipment failure is speculated.

III. Recommendation

For better energy conservation efficiency in kiln, these energy conservation measures should be focus and implement. And however the subsequent research should focuses on exergy and energy analysis of kiln for better energy efficiency around the kiln.

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