PENTA Engineering Corp.

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Carbon Dioxide

Sources of Emissions and Conventional Control Technology

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Introduction

Carbon dioxide (CO_2) emissions generated from anthropogenic activities are known to be relatively small and in comparison with the gross carbon fluxes from natural systems, they represent only a fraction (about 2%) of total global emissions.

Introduction

Global carbon dioxide emissions
from cement production
have more than doubled since the mid 1970s

and now represent
3.8% of global CO_2 releases from
fossil-fuel burning and cement production

CONVENTIONAL TECHNOLOGIES

In cement plants CO_2 is mainly generated by three means:

- **Calcination of limestone in the clinker making process.**
- **Consumption of thermal energy due to primary use of carbon intensive fuels e.g. coal.**
- **Consumption of electrical energy, because most electricity is generated by thermal power stations, which also use carbon intensive fuels.**

SOURCES OF CO_2

Cement clinker contains five major oxides.

The five major oxides are SiO_2, Al_2O_3, Fe_2O_3, CaO and MgO.

In naturally occurring raw materials, the CaO and MgO occur as carbonates ($CO_3^{=}$)

CaO is formed in the kiln from $CaCO_3$ (limestone) and MgO is formed in the kiln from $MgCO_3$ according to the following chemical reactions:

SOURCES OF CO_2

$CaCO_3$ + heat -------> CaO + CO_2

800 – 900°C

750 kcal/kg CaO

$MgCO_3$ + heat ------> MgO + CO_2

500 – 700°C

600 kcal/kg MgO

SOURCES OF CO_2

With conventional (naturally occurring) raw materials and when producing ASTM Type I or II cement, CO_2 emissions will amount to about

0.55 tons of CO_2 per ton of clinker produced,

not including CO_2 produced by fuel combustion.

SOURCES OF CO_2

Emissions of CO_2 from fuel used

in a rotary kiln producing cement clinker

can range from 0.25 – 0.5 tons of CO_2

per ton of clinker produced.

Description of CO_2 Control Technologies

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Conventional technologies

- Reduction of clinker/cement ratio in cement
- Energy efficiency measures
- Using waste fuels or biomass as fuel
- Using decarbonated (secondary/waste) raw materials

CONVENTIONAL TECHNOLOGIES

Reducing CO_2 by reducing the clinker to cement ratio:

Reducing the amount of clinker used when making finished cement is the most effective current method of reducing CO_2 emissions from the cement manufacturing industry.

The level of clinker replacement by additives depends on the availability of blending materials and on standard requirements

The limits generally range from as low as 2% for silica fume, to about 60% for granulated blast furnace slag.

CONVENTIONAL TECHNOLOGIES

Reducing CO_2 by reducing electrical energy consumption:

- **Electric Motor Retrofit**

Replacing older motors with newer, high efficiency motors can save electrical power and reduce CO_2 emissions at a thermal power plant

- **Variable Frequency Drives (vfd)**

Using variable frequency drives to control airflow through fans or fluid flow in pumps can reduce electrical power and reduce CO_2 emissions at a thermal power plant

CONVENTIONAL TECHNOLOGIES

Reducing CO_2 by reusing waste heat:

- **Cogeneration of Power**

In cement plants with modern technology, it is possible to meet 25 – 30 % of total plant power requirements through cogeneration.

- **Sea Water Desalination**

Exhaust air from the clinker cooler vent on a 6,000mt/d kiln was used to produce steam in a boiler which is then used in a multiple effect desalination (MED) plant to produce desalinated water

CONVENTIONAL TECHNOLOGIES

Reducing CO_2 by using waste fuels :

- Rotary kilns producing cement clinker are uniquely suited for using waste materials as fuels.
- It is possible to substitute more than 50% of a cement kiln's fuel requirements with waste fuels
- The use of a flammable waste reduces the use of conventional fossil fuels
- There is a net reduction of CO_2 emissions if wastes are used as a fuel rather than incinerated.

CONVENTIONAL TECHNOLOGIES

Reducing CO_2 by using decarbonated raw material:

Steel Slag

Crystalline slags may be used as a partial substitute for raw materials in cement kiln feed.

These slags typically have chemical analyses similar to cement clinker; however, the CaO component is not a carbonate.

The use of slag as a component in kiln feed has the potential to reduce CO_2 emissions per ton of clinker

Thank You