SLOVENSKI STANDARD
SIST EN 19694-3:2017

01-julij-2017

Emisije nepremičnih virov - Določevanje emisij toplogrednih plinov (TGP) v energetsko intenzivnih industrijah - 3. del: Proizvodnja cementa

Stationary source emissions - Determination of greenhouse gas (GHG) emissions in energy-intensive industries - Part 3: Cement industry

Emissionen aus stationären Quellen - Bestimmung von Treibhausgasen (THG) aus energieintensiven Industrien - Teil 3: Zementindustrie

Émissions de sources fixes - Détermination des émissions des gaz à effet de serre dans les industries à forte intensité énergétique - Partie 3: Industrie du ciment

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Stationary source emissions - Determination of greenhouse gas (GHG) emissions in energy-intensive industries - Part 3: Cement industry

Émissions de sources fixes - Détermination des émissions de gaz à effet de serre (GES) dans les industries énergo-intensives - Partie 3: Industrie du ciment

Emissionen aus stationären Quellen - Bestimmung von Treibhausgasen (THG) aus energieintensiven Industrien - Teil 3: Zementindustrie

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European foreword

This document (EN 19694-3:2016) has been prepared by Technical Committee CEN/TC 264 “Air quality”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by January 2017, and conflicting national standards shall be withdrawn at the latest by January 2017.

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This document has been prepared under a mandate M/478 given to CEN by the European Commission and the European Free Trade Association.

EN 19694, *Stationary source emissions — Determination of greenhouse gas (GHG) emissions in energy-intensive industries* is a series of standards that consists of the following parts:

— *Part 1: General aspects*

— *Part 2: Iron and steel industry*

— *Part 3: Cement industry*

— *Part 4: Aluminium industry*

— *Part 5: Lime industry*

— *Part 6: Ferroalloy industry*

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Introduction

This European Standard for the cement industry has been based on the WBCSD/CSI and WRI: "CO_2 and Energy Accounting and Reporting Standard for the Cement Industry" [1].

Overview of cement manufacturing process

Cement manufacture includes three main process steps (see Figure 1):

a) preparing of raw materials and fuels;

b) producing clinker, an intermediate, through pyro-processing of raw materials;

c) grinding and blending clinker with other products ("mineral components") to make cement.

There are two main sources of direct CO_2 emissions in the production process: calcination of raw materials in the pyro-processing stage, and combustion of kiln fuels. These two sources are described in more detail below. Other CO_2 sources include direct GHG emissions from non-kiln fuels (e.g. dryers for cement constituents products, room heating, on-site transports and on-site power generation), and indirect GHG emissions from, e.g. external power production and transports. Non-CO_2 greenhouse gases covered by the Kyoto Protocol[1] , apart from carbon monoxide (CO) methane (CH_4) and nitrous oxide (N_2O), are not relevant in the cement context, in the sense that direct GHG emissions of these gases are negligible.

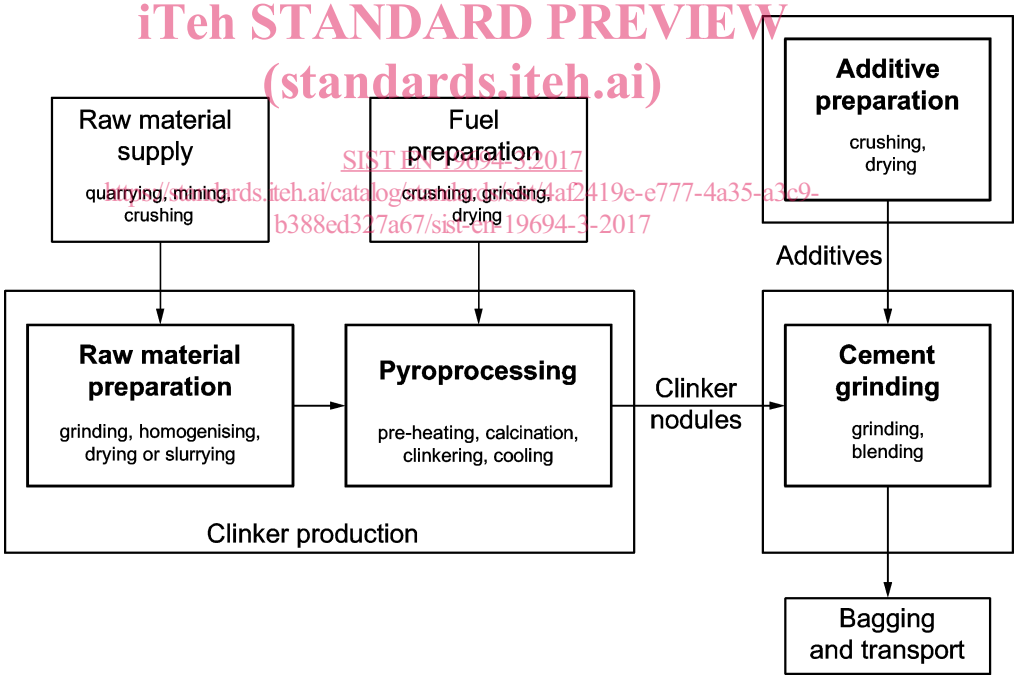

Figure 1 — Process steps in cement manufacture (source: Ellis 2000, based on Ruth et al. 2000)

[1] Methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), partly halogenated fluorohydrogencarbons (HFC) and perfluorated hydrocarbons (PFC)

Table 1 — Overview of input places of materials

Raw meal	**Input place**
Raw materials from natural resources	Raw mill
Alternative raw materials	Raw mill
Raw material flows for clinker production	Input place
Raw meal	Kiln feed
Fuel ashes	Burner or precalciner or fuel dryer
Additional raw materials not part of the kiln feed	Kiln inlet
Fuels flows for clinker and cement production	**Input place**
Fossil fuels	Burner or precalciner or fuel dryer or raw material dryer
Alternative fuels	Burner or precalciner or fuel dryer or raw material dryer
Alternative fossil fuels	Burner or precalciner or fuel dryer or raw material dryer
Mixed fuels	Burner or precalciner or fuel dryer or raw material dryer
Biomass fuels	Burner or precalciner or fuel dryer or raw material dryer
Cement kiln dust	**Output place**
Dust return	Preheater
Filter dust	Precipitator / filter
By pass dust	Bypass filter
Cement constituents based products	**Output place**
Clinker	Kiln (cooler)
Cement	Cement mill
Blast furnace slag	Cement mill or grinding station
Fly ash	Cement mill or grinding station
Gypsum	Cement mill or grinding station
Cooler dust	Cooler, is normally added to the clinker flow to the clinker silo
Cement kiln dust	Preheater or precipitator or filter or bypass filter
Limestone	Cement mill or grinding station
Burnt shale	Cement mill or grinding station
Pozzolana	Cement mill or grinding station
Silica fume	Cement mill or grinding station

CO_2 from calcination of raw materials

In the clinker production process, CO_2 is released due to the chemical decomposition of calcium, magnesium and other carbonates (e.g. from limestone) into lime:

$$CaCO_3 + heat \rightarrow CaO + CO_2$$

$$MgCO_3 + heat \rightarrow MgO + CO_2$$

This process is called "calcining" or "calcination". It results in direct CO_2 emissions through the kiln stack. When considering CO_2 emissions due to calcination, two components may be distinguished:

— CO_2 from raw materials actually used for clinker production, these raw materials are fully calcined in the clinker production process;

— CO_2 from raw materials leaving the kiln system as partly calcined cement kiln dust (CKD), or as normally fully calcined bypass dust.

CO_2 from actual clinker production is proportional to the lime content of the clinker,[2], which in turn varies little in time or between different cement plants. As a result, the CO_2 emission factor per tonne of clinker is fairly stable with a default value in this standard of 525 kg CO_2/t clinker (IPCC default: 510 kg CO_2/t clinker, CSI default: 525 kg CO_2/t clinker [19]).

The amount of kiln dust leaving the kiln system varies greatly with kiln types and cement quality standards, ranging from practically zero to over one hundred kilograms per tonne of clinker. The associated emissions are likely to be relevant in some countries or installations.

CO_2 emissions from calcination of raw materials may be calculated by two methods which are in principle equivalent: Either based on the amount and chemical composition of the products (clinker plus dust leaving the kiln system, output methods B1 and B2), or based on the amount and composition of the raw materials entering the kiln (input methods A1 and A2). See 7.2.1, 7.2.2 for details.

CO_2 from organic carbon in raw materials

The raw materials used for clinker production usually contain a small fraction of organic carbon, which may be expressed as total organic carbon (TOC) content. Organic carbon in the raw meal is converted to CO_2 during pyro-processing. The contribution of this component to the overall CO_2 emissions of a cement plant is typically very small (about 1 % or less). The organic carbon contents of raw materials may, however, vary substantially between locations and between the types of materials used. For example, the resulting emissions may be relevant if a cement company organization (used in this standard) consumes large quantities of certain types of fly ash or shale as raw materials entering the kiln.

CO_2 from fuels for kiln operation

The cement industry traditionally uses various fossil fuels to operate cement kilns, including coal, petroleum coke, fuel oil, and natural gas. Fuels derived from waste materials have become important substitutes for traditional fossil fuels. These alternative fuels (AF) include fossil fuel-derived fractions such as, e.g. waste oil and plastics, as well as biomass-derived fractions such as waste wood and dewatered sludge from wastewater treatment. Furthermore fuels are increasingly used which contain both fossil and biogenic carbon (mixed fuels), like e.g. (pre-treated) municipal and (pre-treated) industrial wastes (containing plastics, textiles, paper etc.) or waste tyres (containing natural and synthetic rubber).

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2 A second, but much smaller factor is the CaO and MgO content of the raw materials and additives used.

Both traditional fossil and alternative fuels result in direct CO_2 emissions through the kiln stack. However, biomass and bioliquids are considered “climate change-neutral“ in accordance with IPCC definitions. Use of alternative (biomass- or fossil-derived) fuels may, in addition, lead to important emission reductions elsewhere, for instance from waste incineration plants or landfills.

Mineral components (MIC) are natural and artificial materials with latent hydraulic properties. Examples of MIC include natural pozzolana, blast furnace slag, and fly ash. In addition, gypsum is within this standard labelled as MIC. MICs are added to clinker to produce blended cement. In some instances, pure MICs are directly added to the concrete by the ready-mix or construction company. Use of MICs leads to an equivalent reduction of direct CO_2 emissions associated with clinker production, both from calcination and fuel combustion. Artificial MICs are waste materials from other production processes such as, e.g. steel and coal-fired power production. Related GHG emissions are monitored and reported by the corresponding industry sector. Utilization of these MICs for clinker or cement substitution does not entail additional GHG emissions at the production site. Consequently, these indirect GHG emissions shall not be included in the cement production inventory.

The basic mass balance methods used in this standard are compatible with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories issued by the Intergovernmental Panel on Climate Change (IPCC) [4], and with the revised WRI / WBCSD Greenhouse Gas Protocol [9]. Default emission factors suggested in these documents are used, except where more recent, industry-specific data has become available.

The 2006 IPCC Guidelines [4] introduced a Tier 3 method for reporting CO_2 emissions from the cement production based on the raw material inputs (Vol. III, Chapter 2.2.1.1, Formula 2.3). However, a large number of raw material inputs and the need to continuously monitor their chemical composition make this approach impractical in many cement plants. The different raw materials are normally homogenized before and during the grinding process in the raw mill. The WRI / WBCSD therefore recommended alternative methods for input-based reporting of CO_2 emissions from raw material calcination in cement plants. They rely on determining the amount of raw meal consumed in the kiln system. In many cement plants the homogenized mass flow of raw meal is routinely monitored including its chemical analysis for the purpose of process and product quality control. The input methods based on the raw meal consumed are already successfully applied in cement plants in different countries and seem to be more practical than Tier 3 of the 2006 IPCC Guidelines [4]. They were included in the Cement CO_2 and Energy Protocol Version 3 (Simple Input Method A1 and Detailed Input Method A2, 7.2.1).

1 Scope

This European Standard specifies a harmonized methodology for calculating GHG emissions from the cement industry, with a view to reporting these emissions for various purposes and by different basis, such as, plant basis, company basis (by country or by region) or even international group basis. It addresses all the following direct and indirect sources of GHG included [1]:

— Direct GHG emissions (scope 1) from sources that are owned or controlled by the organization, such as emissions result from the following sources:

  — process: calcinations of carbonates and combustion of organic carbon contained in raw materials;

  — combustion of kiln fuels (fossil kiln fuels, alternative fossil fuels, mixed fuels with biogenic carbon content, biomass and bioliquids) related to clinker production and/or drying of raw materials and fuels;

  — combustion of non-kiln fuels (fossil fuels, alternative fossil fuels, mixed fuels with biogenic carbon content, biomass and bioliquids) related to equipment and on-site vehicles, room heating/cooling, drying of MIC (e.g. slag or pozzolana);

  — combustion of fuels for on-site power generation;

  — combustion of carbon contained in wastewater.

— Energy indirect GHG emissions (scope 2) from the generation of purchased electricity consumed in the organization's owned or controlled equipment;

— Other indirect GHG emissions (scope 3) from bought clinker. Excluded from this standard are all other scope 3 emissions from the cement industry.

2 Normative references

Not applicable.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
additional raw material
Adrm
additional raw materials are not part of the kiln feed and are fed directly to the calciner or the kiln inlet

3.2
alternative fossil fuel
fossil fuel derived from waste materials without biogenic content and not listed by IPCC

3.3
alternative raw material
Arm
alternative raw materials are raw materials for clinker production derived from artificial resources

3.4
bioliquids
liquid fuel for energy purposes other than for transport, including electricity and heating and cooling, produced from biomass

3.5
bypass dust
discarded dust from the bypass system dedusting unit of suspension preheater, precalciner and grate preheater kilns, normally consisting of kiln feed material which is fully calcined or at least calcined to a high degree

3.6
cement
building material made by grinding clinker together with various mineral components such as gypsum, limestone, blast furnace slag, coal fly ash and natural volcanic material; includes special cements such as the ones based on calcium aluminates

3.7
cement (eq.)
calculated cement production value which is determined from clinker produced on-site in an integrated cement plant applying the plant specific clinker/cement-factor

3.8
cement constituent
main and minor additional constituents of cement plus calcium sulphates and additives in cement

3.9
cement kiln dust
CKD
any discarded dust from dry and wet kiln system dedusting units, consisting of partly calcined kiln feed material which includes bypass dust or any other dust flows coming from the clinker production

3.10
cement constituents based products
all clinker produced for cement making or direct clinker sale, plus mineral components consumed or processed for sale excluding pre-processed mineral components imported from another cement plant

3.11
clinker
intermediate product in cement manufacturing and the main substance in cement; clinker is the result of calcination of limestone in the kiln and subsequent reactions caused through burning (see EN 197-1)

3.12
clinker plant
plant where clinker is produced without having onsite grinding to cement

3.13
concrete addition
finely divided inorganic material with pozzolanic or latent hydraulic properties or nearly inert, used in concrete in order to improve certain properties or to achieve special properties

3.14
fossil direct emissions
total direct emissions of GHGs within the boundaries excluding GHG emissions from biomass fuels or biogenic carbon content of mixed fuels

3.15
dust return
dust arising during clinker manufacture that is ultimately returned to the raw mill or kiln system; this does not include bypass dust

Note 1 to entry: See Figure 6 for an example of mass flows in the clinker production process.

3.16
filter dust leaving the kiln system
cement kiln dust (CKD) leaving the kiln system excluding by pass dust

3.17
fossil fuel
all fossil fuels listed by IPCC

3.18
grinding plant
plant for cement production where cement constituents are ground without having onsite clinker production

3.19
gross emission
fossil direct GHG emissions excluding GHG emissions from on-site power production

3.20
integrated cement plant
plant where clinker is produced and partly or fully ground to cement

3.21
kiln system
tubular heating apparatus used in the production of clinker, including preheater and/or pre-calciner

3.22
kiln feed
raw materials, often processed as raw meal (including recirculated dust), which are fed to a pre-heater or directly into the kiln system

3.23
kiln inlet
kiln hood, or entrance to the tubular heating apparatus for materials

3.24
kiln fuel
fuel fed to the kiln system plus fuels that are used for drying or processing of raw materials for the production of clinker and the preparation of kiln fuels

3.25
mineral components
cement constituents other than clinker plus concrete additions processed in view of changing their properties

3.26
net emission
gross emissions excluding GHG emissions from alternative fossil fuels and comparable benchmark emissions from external heat or energy transfer

3.27
non-kiln fuel
fuels which are not included in the definition of kiln fuels

3.28
petcoke
petroleum coke, a carbon-based solid fuel derived from oil refineries

3.29
raw material
materials used for raw meal preparation for clinker production

3.30
raw material preparation
processes applied for converting raw materials to raw meal

3.31
raw meal
raw meal consists of the ground raw materials for clinker production

3.32
raw meal consumed
part of the raw meal, which is consumed for clinker production and the formation of calcined bypass dust

3.33
recirculated dust
all dust flows that are reused as kiln feed

Note 1 to entry: See Figure 6 for an example of mass flows in the clinker production process.

3.34
total direct GHG emission
all direct emissions of GHGs within the boundaries including GHG emissions from raw materials processing, fossil fuels, biomass and biogenic carbon content of mixed fuels, and CO_2 from waste water combustion

4 Symbols and abbreviated terms

For the purposes of this document, the following symbols and abbreviated terms apply.

Adrm Additional raw material

AF Alternative fuel

AFR	Alternative fuel and alternative raw material
Arm	Alternative raw material
BPD	Bypass dust
cem eq.	cement (eq.)
cem prod.	cement constituents based product
CKD	Cement kiln dust
cli	clinker
CSI	Cement sustainablity initiative of the WBCSD
EF	Emission factor
EU ETS	The CO_2 Emissions Trading Scheme of the European Union
FD	Filter dust
GCV	Gross calorific value (synonym for higher heat value, HHV)
GHG	Greenhouse gas
GWP	Global warming potential
HHV	Higher heat value (synonym for gross calorific value, GCV)
IPCC	Intergovernmental panel on climate change
KF	Kiln feed
KPI	Key performance indicator
LHV	Lower heat value (synonym for net calorific value, NCV)
LOI	Loss on ignition
MIC	Mineral component
m_N^3	normal cubic meters (at 1013 hPa and 0 °C)
NCV	Net calorific value (synonym for lower heat value, LHV)
OPC	Ordinary Portland Cement
RM	raw meal
TC	Total carbon (the sum of TOC and TIC)
TIC	Total inorganic carbon
TOC	Total organic carbon
UNFCCC	United Nations Framework Convention on Climate Change
WBCSD	World Business Council for Sustainable Development
WRI	World Resources Institute

5 Determination of GHGs based on the mass balance method

5.1 General

The volume of GHG emissions may be determined by the mass balance method (see 5.3) or by (continuous) stack emission measurements (see 5.4).