SLOVENSKI STANDARD
SIST EN 19694-6:2017

01-julij-2017

Emisije nepremičnih virov - Določevanje emisij toplogrednih plinov (TGP) v energetsko intenzivnih industrijah - 6. del: Proizvodnja ferozlitin

Stationary source emissions - Determination of greenhouse gas (GHG) emissions in energy-intensive industries - Part 6: Ferroalloy industry

Emissionen aus stationären Quellen - Bestimmung von Treibhausgasen (THG) aus energieintensiven Industrien - Teil 6: Ferrolegierungsindustrie

Émissions de sources fixes - Détermination des émissions des gaz à effet de serre dans les industries à forte intensité énergétique - Partie 6: Industrie des ferro-alliages

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Stationary source emissions - Determination of greenhouse gas (GHG) emissions in energy-intensive industries - Part 6: Ferroalloy industry

Émissions de sources fixes - Détermination des émissions de gaz à effet de serre (GES) dans les industries énergo-intensives - Partie 6: Industrie des ferro-alliages

Emissionen aus stationären Quellen - Bestimmung von Treibhausgasen (THG) aus energieintensiven Industrien - Teil 6: Ferrolegierungsindustrie

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European foreword

This document (EN 19694-6:2016) 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of an identical text or by endorsement, at the latest by January 2017, and conflicting national standards shall be withdrawn at the latest by January 2017.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

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*

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

Overview of the ferro-alloy manufacturing process

Ferroalloy production involves a metallurgical reduction process that results in significant carbon dioxide emissions. These emissions are the results of a carbothermic reaction which is intrinsic to the process. In ferroalloy production, ore, carbon materials and slag forming materials are mixed and heated to high temperatures for smelting.

Submerged Electric Arc Furnaces (SEAF) with graphite electrodes, self- baking Søderberg or composite electrodes is the main process to produce ferro-alloys in Europe (see Figure 1). Smelting in an electric arc furnace is accomplished by conversion of electrical energy to heat. An alternating current applied to the electrodes creates current to flow through the charge between the electrode tips. The heat is produced by the electric arcs and by the resistance in the charge materials. Emissions from the smelting process are therefore not to combustion emissions. The furnaces may be open, semi-closed or closed.

The reduction process is the main source of direct CO_2 emissions. Other CO_2 sources include direct emissions from calcination of calcium, magnesium and other carbonates (e.g. limestone) in some processes and from non-smelting fuels (e.g. dryers for ladles and refractory linings, room heating), and indirect emissions from, e.g. external power production.

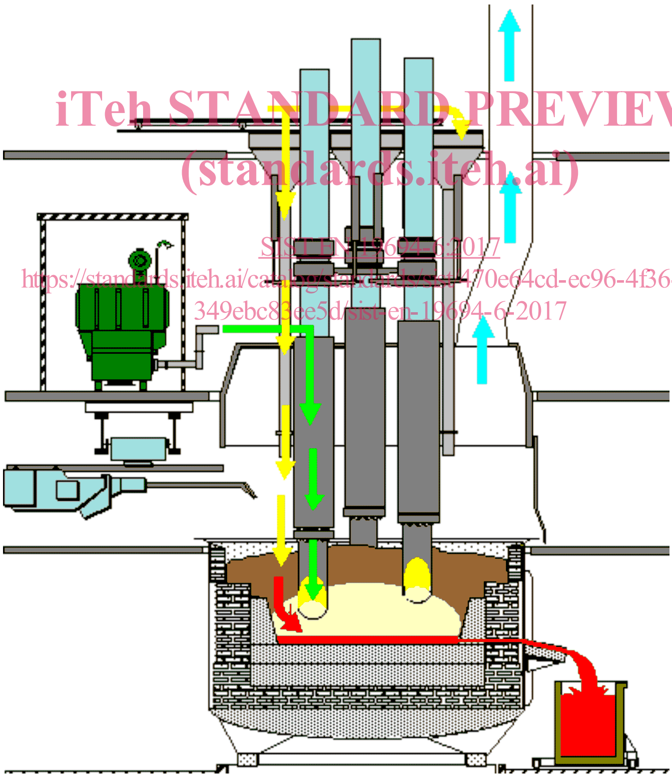

Figure 1 — Submerged Electric Arc Furnace (SEAF)

CO_2 from the smelting of raw materials

<u>CO_2 emissions from reducing agents and electrode use</u>

In the smelting process, CO_2 is released due to the carbothermic reduction of the metallic oxides occurring with the consumption of both carbonaceous reductants and carbon based electrodes. The carbon in the reductants reacts with oxygen from the metal oxides to form CO and then CO_2 (in different ways depending on the process), and the ores are reduced to molten base metals. For calculation, the assumption is that all CO is assumed to be converted in the furnace to CO_2.

The reductant carbon is used in the form of coke, coal, pet coke, anthracite, charcoal and wood-chips. The first four are fossil based and the charcoal and wood-chips are bio-carbon.

In the carbothermic process, only the fixed carbon content is used as a reducing agent, which means that volatile matter, ashes and moisture mostly leave the furnace with the off-gas and slag.

The nature of reducing agents, price and electrodes is depending of the localization of the plant, the raw material availability and it is presented in Table 1. It is variable from one site to another and from one year to another and also from one ferro-alloy to another.

Table 1 — Type of reducing agents and electrodes used in the electrometallurgy Sector

Reducing agents	Electrodes
Crude petroleum coke	Graphite electrode
Calcinated petroleum coke	Prebaked electrodes
Coal coke	Södeberg paste
Coke from coal	Composite electrode
Wood	
Calcinated wood	
Charcoal	
Graphite powder	
Anthracite	

CO_2 emissions are estimated with/calculated from the consumption of the reducing agents and electrodes, their carbon content and the carbon content of the final products[1].

ores + reducing agent → ferro-alloys/metal* + CO_2 + dust/by-product (i.e. slags)*

* amount of carbon can be found in the products

Default emission factors suggested in these documents are used, except where more recent, industry-specific data has become available.

[1] The basic calculation 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), and with the Regulation 601/2012 but the objectives of this standards are of different nature implying that the data gathered can cover a broader (or reduced) boundaries as compared to the objectives of the Regulation.

1 Scope

This European Standard provides a harmonized methodology for calculating GHG emissions from the ferro-alloys industry based on the mass balance approach[2]. It also provides key performance indicators over time of ferro-alloys plants. It addresses the following direct and indirect sources of GHG:

— Scope 1 – Direct GHG emissions from sources that are owned or controlled by the company, such as emissions result from the following sources:

  — smelting (reduction) process;

  — decomposition of carbonates inside the furnace;

  — auxiliaries operation related to the smelting operation (i.e. aggregates, drying processes, heating of ladles, etc.).

— Scope 2 – Indirect GHG emissions from:

  — the generation of purchased electricity consumed in the company's owned or controlled equipment.

This European Standard is to be used in conjunction with EN 19694-1, which contains generic, overall requirements, definitions and rules applicable to the determination of GHG emissions for all energy-intensive sectors, provides common methodological issues and defines the details for applying the rules. The application of this standard to the sector-specific standards ensures accuracy, precision and reproducibility of the results and is for this reason a normative reference standard. The requirements of these standards do not supersede legislative requirements.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 19694-1:2016, *Stationary source emissions — Determination of greenhouse gas (GHG) emissions in energy intensive industries — Part 1: General aspects*

3 Terms and definitions

For the purposes of this document, the terms and definitions in EN 19694-1 and the following apply.

3.1
auxiliaries
equipment consuming electricity/power related to the smelting process: fans, pumps, gas abatement systems (filter bags, venture scrubbers, etc.)

3.2
silica fume
amorphous silicon dioxide particles from the volatilization and vaporization of furnace feed materials in the manufacture of ferrosilicon and silicon, the process off-gas that contains silica fumes beings cleaned in a baghouse using fabric filters of the open or semi-closed SEAF

[2] Based on European Commission Regulation 601/2012.

3.3
ferro-alloy
term used to describe concentrated alloys of iron and one or more metals such as silicon, manganese, chromium, molybdenum, vanadium or tungsten

3.4
silicon
metalloid produced by carbo-thermic reduction of quartz in an electric submerged arc furnace

3.5
smelting
industrial process where one or more ores or ore concentrates are heated and reduced (i.e. chemically modified) by, e.g. aluminino-carbo-silico thermic reduction –to manufacture and mix the metals in one step

EXAMPLE Examples of smelted alloys are ferro-alloys.

3.6
Submerged Electric Arc Furnace
SEAF
electric arc-heating furnace in which the arcs are completely submerged under the charge. The arc forms between the electrode (graphite electrodes or self- baking Søderberg electrodes) and metal surface or bottom lining. The heat being produced by the electric arcs and by the resistance in the charge materials *initiates* the reduction process. The furnaces may be open, semi-closed or closed, which can depend upon the ferro-alloy to be produced. A commonly used technology is the submerged-arc (electric) furnace (SEAF).

3.7
fossil fuels
all fossil fuels listed by IPCC or any fuel which contains organic and inorganic carbon that is not biomass

3.8
biomass fuels
fuels with only biogenic carbon

3.9
Petcoke
petroleum coke, a carbon-based solid fuel derived from oil refineries

3.10
sintering/sinter
process to form a coherent mass by heating without melting

3.11
Søderberg electrodes
continuously self-baking carbon electrode used in electro-metallurgical furnaces for production of ferroalloys and silicon (the “Søderberg paste” is a preparation of coal tar pitch and carbonaceous dry aggregate)

3.12
composite electrodes
in composite electrodes the core is composed of graphite while the exterior is a self-baking carbon paste (which is a “Søderberg paste”)

3.13
pre-baked electrodes
carbonaceous paste (a mixing of coal tar pitch with a dry carbonaceous aggregate) is baked so as to carbonize coal tar pitch in order to form a solid pitch coke binder phase

4 Symbols and abbreviations

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

AF alternative fuels

CO carbon monoxide

CO_2 carbon dioxide

EF emission factor

EU ETS The CO_2 Emissions Trading Scheme of the European Union

FA ferro-alloys

FABP ferro-alloys and related by-products

GHG greenhouse gases

GJ giga joule

IPCC Intergovernmental Panel on Climate Change

KPI key performance indicator

LHV lower heat value (synonym for net calorific value)

m_n^3 normal m^3 (at 0 ºC and at a pressure of 1 atmosphere)

MIC mineral components

SEAF submerged electric arc furnace

TC total carbon (the sum of TOC and TIC)

TIC total inorganic carbon

TOC total organic carbon

t tonne (1.000 kg)

UNFCCC United Nations Framework Convention on Climate Change

5 Determination of GHGs – Principles

5.1 General

The determination of CO_2 emissions can be in principle done either through calculation (mass balance method) or through stack emission measurement.

The methodology described in this standard for GHG emissions determination is based on the mass balance method (7.2).

NOTE Industry have demonstrated that the mass balance method is more accurate than stack emission measurements with a lower level of uncertainty. Additionally, the mass balance method is much more cost effective. This has been clearly demonstrated during the field tests performed to develop this standard.

5.2 Major GHG in ferro-alloys

CO_2 is the only GHG relevant for the ferro-alloys industry.

5.3 Determination based on mass balance

In installations where carbon stemming from input materials used remains in the products or other outputs of the production, e.g. for the reduction of metal ores, a mass balance approach is applied. In installations where this is not the case, combustion emissions and process emissions are calculated separately.

Emissions from source streams are calculated from input or production data, obtained by means of measurement systems, and additional parameters from laboratory analyses including calorific factor, carbon content and biomass content. Standard factors may also be used; references to these factors are provided in the General Aspects Standard (see normative references).

The methodologies for determining emission factors in the mass balance approach are referred to as tiers. The increasing numbering of tiers from one (standard factors) upwards (specific factors) reflects increasing levels of accuracy, from Tier 1 as the International reference for emission factors (IPCC data) to Tier 3 as Industry specific (site-specific) reference.

5.4 Use of waste gas/heat recovery

Direct GHG emissions related to waste gas and heat recovery will be reported as scope 1 emissions. Waste gas including CO and CO_2 can be subtracted from the direct emission, when exported outside the boundaries of the location, as a negative carbon flow in the mass balance (for example when exporting waste gas to another installation).

6 Boundaries

6.1 General

Drawing appropriate boundaries is one of the key tasks in an emissions inventory process.

6.2 Operational boundaries

Operational boundaries refer to the types of sources covered by an inventory. A key distinction is between direct and indirect emissions related to the smelting process:

a) **Direct emissions** are emissions from sources that are owned or controlled by the reporting company. For example, emissions from smelting are direct emissions of the company owning (or controlling) the furnace.

b) **Indirect emissions** are emissions that result as a consequence of the activities of the reporting company but occur at sources owned or controlled by another company. For example, emissions from the generation of grid electricity consumed by a ferro-alloy company will qualify as indirect.

Clause 7 of this standard provides detailed guidance on the different sources of direct emissions occurring in ferro-alloys plants. Indirect emissions are addressed in Clause 8.

Companies shall use the operational boundaries outlined in Table 2 and the relevant process steps in Table 3, for the determination of the GHG emissions for the smelting/carbo-thermic reduction operations part of the ferro-alloy plant. Any deviation from these boundaries shall be reported and explained.

Table 2 — Operational boundaries

Included within boundaries	Excluded
Smelting (carbo-thermic reduction) Electrodes Reducing agents Non furnace fuels	**Mobile transport**
Electricity consumption for whole production process **Onsite power production** Waste heat recovery	**Room heating / cooling (negligible)** **Mobile transport in plant**
Stock inventories carbon materials	

Table 3 — Process steps

Process Step	**Scope**	**Inclusion?**
Smelting	Scope 1	Yes
Electricity consumption for whole production process	Scope 2	Yes
Onsite power production	Scope 1	Yes
Waste heat recovery	Scope 1	Yes
Room heating / cooling	Scope 1. Scope 2 when the used equipment is electrically powered	Yes, but negligible
Stock changes	Scope 1	Yes

6.3 Organizational boundaries

The major source of GHG emissions in the ferroalloys sector is the process-related emissions from the Submerged Electric Arc Furnaces operations, the reduction of the metallic oxides and the consumption