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Emissioner fra stationære kilder – Bestemmelse af emission af drivhusgasser (DHG) i energiintensive industrier – Del 6: Ferrolegerings- og silikoneindustri

Stationary source emissions – Determination of
greenhouse gas emissions in energy-intensive
industries – Part 6: Ferroalloys and silicon industry

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Stationary source emissions — Determination of greenhouse gas emissions in energy-intensive industries —

Part 6: Ferroalloys and silicon industry

*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 et du silicium



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Contents

Page

Foreword	v
Introduction	vi
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Abbreviated terms	3
5 Determination of GHGs — Principles	4
5.1 Introduction	4
5.2 General	4
5.3 Determination based on mass balance	4
5.4 Use of waste gas/heat recovery	4
6 Boundaries	4
6.1 General	4
6.2 Operational boundaries	5
6.3 Organizational boundaries	5
7 Direct emissions and their determination	6
7.1 General	6
7.2 Mass balance approach	6
7.2.1 Generic approach	6
7.2.2 Sampling	7
7.2.3 Alternate approach.....	7
7.3 Process emissions.....	9
7.3.1 Overview.....	9
7.3.2 Methods.....	9
7.4 Combustion emissions	10
7.4.1 Overview.....	10
7.4.2 Methods.....	11
7.4.3 Calculation of the quantity of fuel.....	12
7.4.4 Determination of the lower calorific value and the emission factor.....	12
7.4.5 Determination of the oxidation factor	12
7.5 Combustion of biomass fuels.....	12
8 Indirect emissions	12
8.1 General	12
8.2 CO ₂ from external electricity production.....	13
8.2.1 General.....	13
8.2.2 GHG from heat transfer.....	13
9 Baselines, acquisitions and disinvestments	13
10 Reporting	14
10.1 General	14
10.2 Reporting periods.....	15
10.3 Performance indicators.....	15
10.3.1 General.....	15
10.3.2 Denominator for specific, unit-based emissions	15
10.3.3 Denominator for other ratio indicators.....	15
10.3.4 Key performance indicators	15
10.3.5 Recovery of waste gas and waste heat.....	15
11 Uncertainty of GHG inventories	16
11.1 Introduction to uncertainty assessment.....	16
11.1.1 Basic considerations	16
11.1.2 Materiality thresholds.....	17

This is a preview of "DS/ISO 19694-6:2023". [Click here to purchase the full version from the ANSI store.](#)

11.2	Uncertainty of activity data	17
11.2.1	Measuring instruments for the determination of fuel and material quantities.....	17
11.2.2	Aggregated uncertainties in case of mass balances	18
11.3	Uncertainties of fuel and material parameters.....	18
11.4	Evaluation of the overall uncertainty of an GHG inventory.....	18
Annex A (normative) Tier 1 emission factors.....		19
Annex B (normative) Minimum frequency of analyses		22
Annex C (normative) Country-wise emission factors for electricity.....		23
Bibliography		27

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 146, *Air quality*, Subcommittee SC 1, *Stationary source emissions*.

A list of all parts in the [ISO 19694 series](#) can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

0.1 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.

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 can be open, semi-closed or closed. Submerged electric arc furnaces with graphite electrodes or self-baking Søderberg electrodes are used (see [Figure 1](#)).

The reduction process is the main source of direct CO₂ emissions. Other CO₂ 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, for example, external power production.

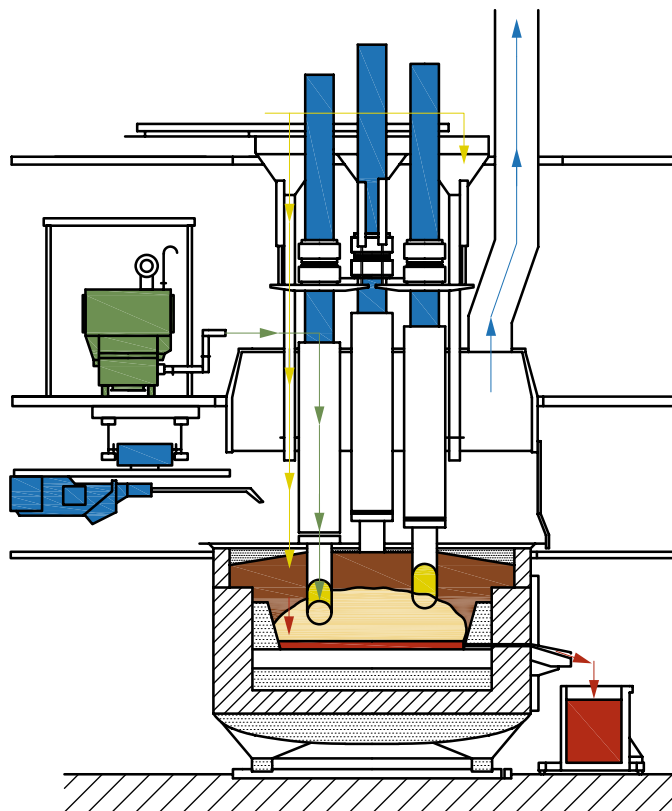


Figure 1 — Submerged electric arc furnace

0.2 CO₂ from the smelting of raw materials

In the smelting process, CO₂ 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 CO₂ (in different ways depending on the process), and the ores are reduced to molten base metals. For the calculation, the assumption is that all CO is assumed to be converted in the furnace to CO₂.

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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 depends on 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	Söderberg paste
Coke from coal	Composite electrode
Wood	—
Calcinated wood	—
Charcoal	—
Graphite powder	—
Anthracite	—

CO₂ emissions are estimated with and calculated from the consumption of the reducing agents and electrodes, their carbon content, and the carbon content of the final products.

NOTE The basic calculation methods used in this document are compatible with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories issued by the Intergovernmental Panel on Climate Change (IPCC)^[1].

Ores and reducing agent react to form ferro-alloys or metal, CO₂ and dust and other 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.

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Part 6: Ferroalloys and silicon industry

1 Scope

This document provides a harmonized methodology for calculating GHG emissions from the ferroalloys industry based on the mass balance approach. This document also provides key performance indicators over time for ferro-alloys plants. This document covers the following direct and indirect sources of GHG:

- direct GHG emissions [see ISO 14064-1:2018, 5.2.4 a)] from sources that are owned or controlled by the company, such as emissions resulting 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.);
- indirect GHG emissions [see ISO 14064-1:2018, 5.2.4 b)] from the generation of purchased electricity consumed in the company's owned or controlled equipment.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

[ISO 14064-1:2018](#), *Greenhouse gases — Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals*

[ISO/IEC 17025](#), 2005, *General requirements for the competence of testing and calibration laboratories*

[ISO 19694-1:2021](#), *Stationary source emissions — Determination of greenhouse gas emissions in energy-intensive industries — Part 1: General aspects*