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Calculation method of carbon dioxide emission intensity from iron and steel production —

Part 3: Steel plant with electric arc furnace (EAF) and coal-based or gas-based direct reduction iron (DRI) facility

Méthode de calcul de l'intensité de l'émission de dioxyde de carbone de la production de la fonte et de l'acier —

Partie 3: Usine de fabrication d'acier dans des fours électriques à arc (FEA) et installations de production de minerais de fer préréduits avec procédés au charbon ou au gaz

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ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

Contents

Page

Foreword

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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 on 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 the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 17, *Steel*.

A list of all the parts in the ISO 14404 series can be found on the ISO website.

Introduction

The steel industry recognizes there is an urgent need to take actions concerning climate change. Slowing and halting global warming requires reductions in GHG emissions on a global scale. To play a role in achieving these reductions, it is necessary for steel plants to determine the amount of CO_2 emitted during the production of steel products, in order to identify further CO_2 reduction opportunities.

The steel production process involves complex chemical reactions, several heating cycles and the cycling of various by-products. This variety of imports, including raw materials, reactive agents, fuel and heat sources, are transformed into a wide range of steel products, by-products, waste materials and waste heat.

Steel plants manufacture various products including: flat items, long items, pipes, tubes and many others. In addition, they produce unique specialty-grade steel products with high performance. These are achieved using a number of sub-processes including micro-alloying and applying surface treatments like galvanizing and coating, which require additional heat treatments. The variety of products produced and processes used means there are not two identical steel plants in the world.

Climate regulations in each country require steel companies to devise methods to lower CO_2 emissions while continuing to produce steel products by these diverse and complex steelmaking processes. To accomplish this, it is desirable to have universally common indicators for determining steel plant CO_2 emissions.

There are many methods for calculating CO_2 emission intensity from steel plants and specific processes. Each method was created to meet the objectives of a particular country or region. In some cases, a single country can have several calculation methods in order to fulfil different objectives. Each one of these methods reflects the unique local characteristics of a particular country or region. Therefore, these methods cannot be used for comparisons of CO_2 emission intensity from steel plants located in different countries and regions.

The World Steel Association (worldsteel), which consists of more than 161 major steel companies in 60 countries and regions of the world, has been working on the development of a calculation method for CO_2 emission intensity to facilitate the improvement of steel plant CO_2 emissions. The calculation method is based on an objective comparison of CO_2 emissions intensity among the member steel companies located in different places in the world. An agreement was reached among members and worldsteel issued the method as "CO_2 Emissions Data Collection User Guide". Actual data collection among worldsteel members based upon the guide started in 2007. Furthermore, worldsteel is encouraging non-member steel companies to begin using the guide to calculate CO_2 emission intensity of their steel plants.

The calculation method establishes clear boundaries for the collection of CO_2 emissions data. The net CO_2 emissions and production from a steel plant are calculated using all the parameters within the boundaries. The CO_2 emission intensity is calculated by the net CO_2 emission from the plant using the boundaries divided by the amount of crude steel production of that plant. With this methodology, the CO_2 emission intensity of steel plants is calculated irrespective of the type of process used, products manufactured and geographic characteristics.

This calculation method only uses basic imports and exports that are commonly measured and recorded by the plants; thus, the method requires neither the measurement of the specific efficiency of individual equipment or processes nor dedicated measurements of the complex flow and recycling of materials and waste heat. In this way, the calculation method ensures its simplicity and universal applicability without requiring steel plants to install additional dedicated measuring devices or to collect additional dedicated data other than those commonly used in the plant management. However, since different regions have different energy sources and raw materials available to them, the resulting calculations cannot be used to determine a benchmark or best in class across regions.

With this method, a steel company can calculate a single figure for the CO_2 emissions intensity of a site as a whole. Most steel plants manufacture a vast range of products with various shapes and specifications. This calculation method is simple and universally applicable because it is not affected

by the differences in the various product production processes and it handles CO_2 data in a way that allows a comparison with CO_2 intensities of production processes that are operated inside the site.

Calculation method of carbon dioxide emission intensity from iron and steel production —

Part 3:
Steel plant with electric arc furnace (EAF) and coal-based or gas-based direct reduction iron (DRI) facility

1 Scope

This document specifies calculation methods applicable to those companies using an electric arc furnace (EAF) to produce steel and having direct reduced iron (DRI) facilities within their premises. It can be used to evaluate the total annual carbon dioxide (CO_2) emissions and the emission factor of CO_2 per unit of steel production of the entire steel production process. This document is applicable to plants producing mainly carbon steel.

It includes boundary definition, material and energy flow definition and emission factor of CO_2. Besides direct source import to the boundary, upstream and credit concept is applied to exhibit the plant CO_2 intensity.

This document supports the steel producer to establish CO_2 emissions attributable to a site. This document cannot be used to calculate benchmarks or to compare CO_2 intensities of production processes that are operated inside the site.

Conversion to energy consumption and to consumption efficiency can be obtained using Annex A.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at www.iso.org/obp

— IEC Electropedia: available at www.electropedia.org

3.1 Emissions

3.1.1
emission source
process emitting CO_2 during the production of steel products

Note 1 to entry: There are three categories of CO_2 emission sources: direct, upstream and credit. Examples of emission sources that are subject to this document are given in 3.1.2, 3.1.3 and 3.1.4.

3.1.2
direct CO_2 emission
CO_2 emissions from steel production activity inside the boundary

Note 1 to entry: Direct CO_2 emission is categorized as “direct GHG emissions” in ISO 14064-1.

3.1.3
upstream CO_2 emission
CO_2 emissions from imported material related to outsourced steel production activities outside the boundary and from imported electricity and steam into the boundary

Note 1 to entry: CO_2 emissions from imported material in this term are categorized as “other indirect GHG emissions” in ISO 14064-1.

Note 2 to entry: CO_2 emissions from imported electricity and steam in this term are categorized as “energy indirect GHG emissions” in ISO 14064-1.

3.1.4
credit CO_2 emission
CO_2 emission that corresponds to exported material and electricity or steam

Note 1 to entry: Credit CO_2 emission is categorized as “direct GHG emissions” in ISO 14064-1.

3.2 Gas fuel

3.2.1
natural gas
mixture of gaseous hydrocarbons, primarily methane, naturally occurring in the earth and used principally as a fuel

3.2.2
town gas
fuel gas manufactured for domestic and industrial use

3.3 Liquid fuel

3.3.1
heavy oil
No. 4 to No. 6 fuel oil defined by ASTM

Note 1 to entry: ASTM: American Society for Testing and Materials.

3.3.2
light oil
No. 2 to No. 3 fuel oil defined by ASTM

3.3.3
kerosene
paraffin (oil)

3.4 Solid fuel

3.4.1
EAF coal
coal used for an electric arc furnace (EAF), including anthracite

3.4.2
steam coal
boiler coal for producing electricity and steam, including anthracite

3.4.3
coke
solid carbonaceous material

3.4.4
charcoal
devolatilized or coked carbon neutral materials

EXAMPLE Trees, plants.

3.4.5
SR/DRI coal
coal used for smelting reduction (SR)/ direct reduction iron (DRI), including anthracite

3.5 Auxiliary material

3.5.1
limestone
calcium carbonate, $CaCO_3$

3.5.2
burnt lime
CaO

3.5.3
crude dolomite
calcium magnesium carbonate, $CaMg(CO_3)_2$

3.5.4
burnt dolomite
$CaMgO_2$

3.5.5
electric arc furnace graphite electrodes
EAF graphite electrodes
net use of EAF graphite electrodes or attrition loss

3.5.6
nitrogen
N_2
inert gas separated from air at an oxygen plant, imported from outside the boundary or exported to outside the boundary

3.5.7
argon
Ar
inert gas separated from air at an oxygen plant, imported from outside the boundary or exported to outside the boundary

3.5.8
oxygen
O_2
gas separated from air at an oxygen plant, imported from outside the boundary or exported to outside the boundary

3.6 Energy carriers

3.6.1
electricity
electricity imported from outside the boundary or exported to outside the boundary

3.6.2
steam
pressurized water vapour imported from/exported to outside the boundary

3.7 Ferrous containing materials

3.7.1
pellets
agglomerated spherical iron ore calcinated by rotary kiln

3.7.2
hot metal
intermediate liquid iron products containing 3 % to 5 % by mass carbon produced by smelting iron ore with equipment such as blast furnace

3.7.3
cold iron
solidified hot metal as an intermediate solid iron product

3.7.4
scrap
used steel available for reprocessing

3.7.5
gas-based DRI
direct reduced iron (DRI) reduced by a reducing gas such as reformed natural gas

3.7.6
coal-based DRI
direct reduced iron (DRI) reduced by coal

3.8 Alloys

3.8.1
ferro-nickel
alloy of iron and nickel

3.8.2
ferro-chromium
alloy of iron and chromium

3.8.3
ferro-molybdenum
alloy of iron and molybdenum

3.9 Product and by-product

3.9.1
CO_2 for external use
CO_2 exported to outside the boundary

3.10 Others

3.10.1
other emission source
other related emission sources such as plastics, scraps, desulfurization additives, alloys, fluxes for secondary metallurgy, dust, sludge, etc.

3.10.2
boundary
limit of activity used to calculate CO_2 emissions intensity for steel production activities

Note 1 to entry: Generally, the boundary is set to be the same as the site boundary.

3.10.3
EAF
electric arc furnace
furnace that melts and refines iron-bearing material into steel

3.10.4
casting
pouring steel directly from a ladle through a tundish into a mould shaped to form billets, blooms or slabs, or pouring steel from a ladle into a mould shaped to form ingots

3.10.5
lime kiln
kiln used to produce *burnt lime* (3.5.2) by the calcination of limestone (calcium carbonate)

3.10.6
oxygen plant
cryogenic air separator to produce high-purity oxygen

3.10.7
steam boiler
boiler for production of steam

3.10.8
power plant
plant that generates electricity

3.10.9
hot rolling
rolling at elevated temperature

3.10.10
cold rolling
rolling at room temperature

3.10.11
coating
covering steel with another material (tin, chrome, zinc, etc.), primarily for corrosion resistance

Note 1 to entry: Coating materials may include tin, chrome, zinc, etc.

4 Symbols

For the purposes of this document, the symbols given in Table 1 apply.

Table 1 — Symbols

Symbols	Unit	Description
$E_{d,CO2}$	Tons (or tonnes) of CO_2	Direct CO_2 emissions
$E_{u,CO2}$	Tons (or tonnes) of CO_2	Upstream CO_2 emissions
$E_{c,CO2}$	Tons (or tonnes) of CO_2	Credit CO_2 emissions
$E_{CO2,annual}$	Tons (or tonnes) of CO_2	Annual CO_2 emissions
I_{CO2}	Tons (or tonnes) of CO_2 per ton	CO_2 intensity factor