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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 sidérurgique avec four électrique à arc (FEA) et installation de réduction directe de la fonte (DRI) à base de charbon ou de gaz

Reference number
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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 document 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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This document was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 21, *Environment related to climate change in the iron and steel industry*.

This second edition cancels and replaces the first edition (ISO 14404-3:2017), which has been technically revised.

The main changes are as follows:

— revision of Introduction, Terms and Definitions, and default emission factors;

— addition and revision of some emissions sources;

— clarification of the difference between "Boundary" and "Site boundary";

— addition a new informative annex, Annex D on “Decarbonization strategies and its impact in CO_2 Calculation Method” to give guidance on future relevant emission source categories as new materials and processes become widely applicable at industrial level.

A list of all the parts in the ISO 14404 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

The steel industry recognizes the 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 part in achieving these reductions, it is necessary for steel plants to identify the amount of CO_2 emitted during the production of steel products, in order to identify next opportunities for reduction of CO_2 on their pathway to decarbonization.

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

Steel plants manufacture a vast range of products with various shapes and specifications 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 manufactured, and processes used means there are not two identical steel plants in the world.

Additionally, there are other aspects related to the heterogeneity nature of steel industry around the globe other than assets characteristics, that should be taken into account (inputs availability; market and business environment, innovation), when looking for commonalities in calculation methodologies to ensure consistency and comprehensiveness.

Climate regulations in each country require steel companies to devise methods to lower CO_2 emissions from steel plants 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.

To overcome this methodological fragmentation, the World Steel Association (worldsteel), has developed a calculation method for CO_2 emission intensity of steel plants. This calculation method was developed to facilitate the improvement of steel plant CO_2 emissions. It helps members keep track of their CO_2 emissions intensity relative to the other member steel companies located in different places in the world. An agreement was reached among members, and worldsteel has issued the method as a guideline called “CO_2 Emissions Data Collection User Guide.” Actual data collection among worldsteel members based upon the guide started in 2007. Furthermore, worldsteel is encouraging even non-member steel companies to begin using the guide to calculate CO_2 emission intensity of their steel plants.

The present ISO 14404-3 revision is based on worldsteel’s CO_2 Data Collection Users Guide, version 11[4], reviewed in 2022, and follows ISO14404-4.

This calculation method establishes clear boundaries for collection of CO_2 emissions data. The net CO_2 emissions and production from a steel plant are calculated using all parameters within the boundaries. The CO_2 emission intensity of the steel plant is calculated by the net CO_2 emission from the plant using the boundaries divided by the amount of crude steel production of the plant. With this methodology, the CO_2 emission intensity of steel plants is calculated irrespective of the variance in 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 data in the management. Even though, the use of measured carbon content and net calorific values are highly recommended to obtain more accurate emissions accounting for each material considered. Any home metrics needs to be referenced with link to a transparent and accessible source, including indirect emission factors. To ensure transparency in communicating results to interested parties, these distinctions should be clearly stated.

With this method, a steel company can calculate a single figure for the CO_2 emissions intensity of a steel plant as a whole. By observing changes in CO_2 emissions intensity over time using this methodology, steel companies can evaluate whether their efforts to reduce CO_2 emissions are being properly implemented. As was explained earlier, most steel plants manufacture 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 production processes of such diverse products, and treats a whole steel plant as one unit with one CO_2 emission intensity. Therefore, this calculation method is not applicable for calculating and determining the carbon footprint of any specific steel product.

When comparing CO_2 emission intensity between different steel plants, it should be kept in mind that each steel plant has a different composition of manufacturing products and that the energy sources and raw materials available varies among countries and regions. In addition, since the ISO 14404 series strictly defines the boundary of the target process route for each part, only steel plants using the same part of the ISO 14404 series (i.e., ISO 14404-1, ISO 14404-2, ISO 14404-3) can be compared with each other. Note that the default emission factors provided in the ISO 14404 series are global averages and is not adjusted to reflect regional differences in energy sources and raw materials. When calculating total CO_2 emissions or CO_2 emission intensity for inventory or benchmarking purposes, the emission factors applicable to the conditions of the target country or region should be selected.

In order to give guidance to users on which areas of interest will be dealt with as future sources for direct and indirect CO_2 emission factors in programmed revisions of this document, tentative list is provided in Annex D.

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 manufacturers using an electric arc furnace (EAF) to produce steel and having direct reduced iron (DRI) facilities within their premises.

This document allows the user to cover those particular cases of agglomeration of iron ore on site. It can be used to evaluate the total annual carbon dioxide (CO_2) emissions and the emission factor of CO_2 intensity 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.

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 terminology databases for use in standardization at the following addresses:

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

— IEC Electropedia: available at https://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 site boundary and from imported electricity and steam into the site 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 on earth, and used in metallurgic plants either as a fuel or as raw material

3.2.2
town gas
fuel gas manufactured for domestic and industrial use

3.3 Liquid fuel

3.3.1
heavy oil
No. 4 and No. 6 fuel oil defined by the American Society for Testing and Materials (ASTM)

Note 1 to entry: For No.4 and No.6 fuel oil, see ASTM Fuel Oils Standard Specification.

3.3.2
light oil
No. 2 to No. 3 fuel oil defined by the American Society for Testing and Materials (ASTM)

Note 1 to entry: For No.2 and No.3 fuel oil, see ASTM Fuel Oils Standard Specification.

3.3.3
kerosene
light petroleum distillate that has maximum distillation temperature of 204 °C and a final boiling point of 300 °C

Note 1 to entry: Also known as paraffin (oil).

Note 2 to entry: U.S. Energy Information Administration, Petroleum and other liquids, units are modified.

3.3.4
liquefied natural gas
LNG
butaneliquids composed predominantly of methane

[SOURCE: ISO 6578:2017, 3.1.4]

3.3.5
liquified petroleum gas
LPG
liquid composed predominantly of any of the following hydrocarbons or mixtures thereof: propane, propene, butanes and butene

[SOURCE: ISO 6578:2017. 3.1.4.]

3.4 Solid fuel

3.4.1
EAF coal
solid fuel used for an electric arc furnace *EAF* (3.10.4), including anthracite

Note 1 to entry: Coal can be either fossil coal derived from geological> deposits or biocoal derived from biomass.

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

Note 1 to entry: Coal can be either fossil coal derived from geological> deposits or biocoal derived from biomass.

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
solid fuel used for smelting reduction (SR)/direct reduction iron (DRI), including anthracite

Note 1 to entry: Coal can be either fossil coal derived from geological> deposits or biocoal derived from biomass.

3.5 Auxiliary material

3.5.1
limestone
calcium carbonate, $CaCO_3$mineral used in metallurgic plants as slag former or as raw material for *burnt lime* (3.5.2)

3.5.2
burnt lime
calcium oxide
CaO
limestone (3.5.1) calcinated in blast furnaces or in lime kiln

Note 1 to entry: Usually used as slag former.

3.5.3
crude dolomite
calcium magnesium carbonate
CaMg(CO3)2
mineral used in metallurgic plants as raw material for *burnt dolomite* (3.5.4)

3.5.4
burnt dolomite
CaMgO2
crude dolomite (3.5.3) calcinated in lime kilns Note 1 to entry: Usually used as slag former.

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
electrical power 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

3.6.3
waste heat
any heat that can be collected economically and re-used for low grade heating or even low pressure steam generation for social heating or process heating or cleaning, within the industry or other industries

3.7 Ferrous containing materials

3.7.1
pellets
agglomerated spherical iron ore calcinated by rotary kiln

3.7.2
pig iron
hot metal, intermediate liquid iron products produced by smelting iron ore with equipment such as blast furnace.

Note 1 to entry: many companies report emissions from purchased pig iron in solid state as metallic charge under this product category, for this specific process route.

Note 2 to entry: according to International Iron Metals Association, (IIMA) on average, pig iron makes up between 5-10 percent of the global EAF metallics charge. In some parts of the world where scrap is scarce, pig iron can be used at up to 60 percent of the charge.

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) using natural gas as fuel and reduction agent.

3.7.6
coal-based DRI
direct reduced iron (DRI) using coal as fuel and reduction agent

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

3.8.4
ferro-manganese
alloy of iron and manganese

3.8.5
ferro-silicon
alloy of iron and silicon

3.8.6
silico-mangenese
alloy of silicon and manganese

3.9 Product and by-product

3.9.1
crude steel
steel in its first solid (or usable) form

Note 1 to entry: crude steel is the normalization unit for this calculation methodology.

Note 2 to entry: crude steel examples are ingots, semi-finished products (billets, blooms, slabs), and liquid steel for castings, defined by Steel Statistical Yearbook

3.9.2
CO_2 for external use
CO_2 exported to outside the boundary