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

Part 1: Steel plant with blast furnace

Méthode de calcul de l'intensité de l'émission de dioxyde de carbone de la production de la fonte et de l'acier —
Partie 1: Usine sidérurgique avec fourneau

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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

ISO 14404-1 was prepared by Technical Committee ISO/TC 17, *Steel*.

ISO 14404 consists of the following parts, under the general title of *Calculation method of carbon dioxide emission intensity from iron and steel production:*

Part 1: Steel plant with blast furnace

Part 2: Steel plant with electric arc furnace (EAF)

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.

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 various products including: sheet products, plate products, long products, pipe and tubes and many other types of products. In addition, steel plants produce unique speciality grade steel products with high-performance, which are achieved by various sub-processes including micro-alloying and applying surface treatments like galvanizing and coating that require additional heat treatments. Therefore, none of the steel plants in the world is exactly identical.

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 for steel plants and specific processes. Each method was created to match the objectives of a particular country or region. In some cases, a single country can have several calculation methods in order to fulfill different objectives. Every one of these methods reflects the unique local characteristics of a particular country or region. As a result, these methods cannot be used for comparisons of CO_2 emission intensity of steel plants in different countries and regions.

The World Steel Association (worldsteel), which consists of more than 130 major steel companies in 55 countries and regions of the world, has been working on the development of a calculation method for CO_2 emission intensity of steel plants to facilitate steel plant CO_2 emissions improvement by the objective comparison of the intensity among the member companies' steel plants located in various 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.

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 equipments 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 commonly used data in the management of plants. However, because 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 plant as a whole. As was explained earlier, most steel plants manufacture vast range of products with various shapes and specifications. This calculation method ensures the simplicity and universal applicability by not accommodating 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. Also, and for this reason, this method can be used neither for establishing caps or benchmarks for emissions under emissions trading scheme in any specific local or regional economic system, nor for the generation of CO_2 data that would allow a comparison of 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 1:
Steel plant with blast furnace

1 Scope

This part of ISO 14404 specifies calculation methods for the carbon dioxide (CO_2) intensity of plant where steel is produced through a blast furnace.

NOTE The steel plant is generally called "the integrated steel works".

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 part of ISO 14404 supports the steel producer to establish CO_2 emissions attributable to a site. This part of ISO 14404 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 Terms and definitions

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

2.1 Emissions

2.1.1
emission source
process emitting CO_2 during 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 part of ISO 14404 are given in 2.1.2, 2.1.3 and 2.1.4.

2.1.2
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.

2.1.3
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: Possible outsourced activities are, for example, production of coke, burnt lime, burnt dolomite, pellet, sintered ore, hot metal, cold iron, direct reduced iron, oxygen, nitrogen and argon.

Note 2 to entry: CO_2 emissions from imported material in this term is categorized as "other indirect GHG emissions" in ISO 14064-1.

Note 3 to entry: CO_2 emissions from imported electricity and steam in this term are categorized as "energy indirect GHG emissions" in ISO 14064-1.

2.1.4
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.

2.2 Gas fuel

2.2.1
natural gas
mixture of gaseous hydrocarbons, primarily methane, occurring naturally in the earth and used principally as a fuel

2.2.2
coke oven gas
COG
gas recovered from coke oven

2.2.3
blast furnace gas
BFG
gas recovered from blast furnace

2.2.4
BOF gas
LDG
gas recovered from basic oxygen furnace (Linze Donawitz converter)

Note 1 to entry: BOF: basic oxygen furnace

2.3 Liquid fuel

2.3.1
heavy oil
No. 4- No. 6 fuel oil defined by ASTM

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

2.3.2
light oil
No. 2- No. 3 fuel oil defined by ASTM

2.3.3
kerosene
paraffin (oil)

2.3.4
LPG
liquefied petroleum gas

2.4 Solid fuel

2.4.1
coking coal
coal for making coke, including anthracite

2.4.2
BF injection coal
pulverized coal injection (PCI) coal, including anthracite

Note 1 to entry: BF: blast furnace

2.4.3
sinter coal
BOF coal
coal for sinter/BOF, including anthracite

2.4.4
steam coal
boiler coal for producing electricity and steam, including anthracite

2.4.5
coke
solid carbonaceous material

2.4.6
charcoal
devolatilized or coked carbon neutral materials

EXAMPLE Trees, plants.

2.5 Auxiliary material

2.5.1
limestone
calcium carbonate, $CaCO_3$

2.5.2
burnt lime
CaO

2.5.3
crude dolomite
calcium magnesium carbonate, $CaMg(CO_3)_2$

2.5.4
burnt dolomite
$CaMgO_2$

2.5.5
nitrogen
N_2
inert gas separated from air at oxygen plant, imported from outside the boundary or exported to outside the boundary

2.5.6
argon
Ar
inert gas separated from air at oxygen plant, imported from outside the boundary or exported to outside the boundary

2.5.7
oxygen
O_2
gas separated from air at oxygen plant, imported from outside the boundary or exported to outside the boundary

2.6 Energy carriers

2.6.1
electricity
electricity imported from outside the boundary or exported to outside the boundary

2.6.2
steam
pressurized water vapour imported from/exported to outside the boundary

2.7 Ferrous containing materials

2.7.1
pellets
agglomerated spherical iron ore calcinated by rotary kiln

2.7.2
sinter
bulk iron ore sintered by baking mixture of fine iron ore, coke breeze and pulverized lime

2.7.3
hot metal
intermediate liquid iron products containing 3 % to 5 % by mass carbon produced by smelting iron ore with equipment such as blast furnace

2.7.4
cold iron
solidified hot metal as an intermediate solid iron products

2.7.5
gas-based DRI
direct reduced iron (DRI) reduced by a reducing gas such as reformed natural gas

2.7.6
coal-based DRI
direct reduced iron (DRI) reduced by coal

2.8 Alloys

2.8.1
ferro-nickel
alloy of iron and nickel

2.8.2
ferro-chromium
alloy of iron and chromium

2.8.3
ferro-molybdenum
alloy of iron and molybdenum

2.9 Product and by-product

2.9.1
CO_2 for external use
CO_2 exported to outside the boundary

2.9.2
coal tar
by-products of the carbonization of coal to coke, containing complex and variable mixtures of phenols and polycyclic aromatic hydrocarbons

2.9.3
coal light oil
benzole
light oil recovered by COG gas purification, consisting mainly of benzene, toluene and xylene (BTX)

2.9.4
BF slag to cement
blast furnace slag supplied to cement industry

2.9.5
BOF slag to cement
BOF slag supplied to cement industry

2.10 Others

2.10.1
other emission source
other related emission sources such as plastics, scraps, desulfurization additives, graphite electrodes, alloys, fluxes for secondary metallurgy, dust, sludges, etc.

2.10.2
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.

Note 2 to entry: Major facilities in iron and steel production in boundaries are given in 2.10.2.1 to 2.10.2.13.

2.10.2.1
blast furnace
BF
vertical shaft furnace for producing hot metal from iron ore

2.10.2.2
basic oxygen furnace
BOF
vessel where hot metal from blast furnace and scrap is converted into molten steel using oxygen

2.10.2.3
casting
pouring steel directly from a ladle through a tundish into a mold shaped to form billets, blooms, or slabs, or pouring steel from a ladle into a mold shaped to form ingots

2.10.2.4
sinter plant
plant used to produce a fused clinker-like aggregate or sinter of fine iron-bearing materials suited for use in a blast furnace

2.10.2.5
pellet plant
plant for agglomeration and thermal treatment to convert the raw fine iron ore into spherical pellets with characteristics appropriate for use in a blast furnace

2.10.2.6
lime kiln
kiln used to produce burnt lime by the calcination of limestone (calcium carbonate)

2.10.2.7
coke oven
oven for the conversion of coal into coke by heating the coal in the absence of air to distill the volatile ingredients

2.10.2.8
oxygen plant
cryogenic air separator to produce high-purity oxygen

2.10.2.9
steam boiler
boiler for production of steam

2.10.2.10
power plant
plant that generates electricity

2.10.2.11
hot rolling
rolling at elevated temperature

2.10.2.12
cold rolling
rolling at room temperature

2.10.2.13
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.

3 Symbols

The symbols used in this part of ISO 14404 are given in Table 1.

Table 1 — Symbols

Symbol	Unit	Descriptions
$E_{d,CO2}$	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 (or tonne)	CO_2 intensity factor
$K_{t,d,CO2}$	tons (or tonnes) of CO_2 per unit	Emission factor for calculation of direct CO_2 emissions
$K_{t,u,CO2}$	tons (or tonnes) of CO_2 per unit	Emission factor for calculation of upstream CO_2 emissions
$K_{t,c,CO2}$	tons (or tonnes) of CO_2 per unit	Emission factor for calculation of credit CO_2 emissions
P	tons (or tonnes)	Annual crude steel production
$Q_{t,d,CO2}$	—	Quantities of direct CO_2 emission sources
$Q_{t,u,CO2}$	—	Quantities of upstream CO_2 emission sources
$Q_{t,c,CO2}$	—	Quantities of credit CO_2 emission sources