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Life cycle inventory calculation methodology for steel products

Méthodologie de calcul de l'inventaire du cycle de vie des produits en acier

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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 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 17, *Steel*.

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 life cycle inventory (LCI) of steel products is an important component in the support of life cycle assessments for a wide range of products and applications that contain steel or where steel is used to support the manufacture, production or delivery of products.

This document describes the methodology for the calculation of the steel life cycle inventories that can be applied to a wide range of steel products, and represents the main process routes for global steel production. This includes the extraction of raw materials from the earth through to the production of steel products at the factory gate, as well as provision for scrap recycling of steel products and the treatment of steel scrap. The methodology conforms to the principles and framework set out in ISO 14040:2006 and ISO 14044:2006 and demonstrates how these principles can be applied to steel product manufacture and steel recycling.

As illustrated in Figure 1, the life cycle of steel products consists of the following stages:

— sourcing of natural resources (which includes mining, transportation and intermediate processing of raw materials) and ferrous scrap (recovered from both the manufacturing process and the end of life of final products);

— production of steel products at the steelworks;

— manufacturing of final products by downstream users, for example, by customers of the steel industry, such as automotive, construction and engineering industries;

— use of final products, where the environmental performance of the final product depends on the steel products being used; for example, the fuel (or energy) consumption of an automobile depends partly upon the weight of its steel components;

— recovery of material from the end of life of final products;

— recycling of ferrous scrap from both the manufacturing process and the end of life of final products to substitute the use of raw materials from the earth.

The schematic diagram of the full life cycle of steel is shown in Figure 1. This document covers life cycle stages including sourcing of raw materials from the earth and ferrous scrap, production of steel products at the steelworks, and recycling of ferrous scrap. It does not cover the manufacturing of final products and the use of final products.

All global steel production is sourced from different ratios of ferrous scrap and primary ores. Therefore, an understanding of the value of steel recycling becomes a necessary part of the steel product LCI.

It is generally understood that the recycling of materials makes a positive contribution towards reducing resource consumption and energy requirements, and helps to avoid the potential impacts of raw materials extraction and processing. However, all recycling routes (including the processing and transport of recycled materials) carry environmental burdens and these can be quantified as part of a life cycle assessment.

A critical factor in the understanding of the benefits of materials recycling is the quality of the materials and products that can be produced from the recycled material. Where the recycled products can be made to the same inherent properties as those sourced from primary materials, this is described as closed loop recycling.

With the existing process and scrap quality controls, steel sourced from (scrap based) steel recycling can be made to the same specification as steels sourced from the (iron ore based) primary routes. The properties of the different steel grades are achieved through different alloying concepts as well as process steps, such as heat treatment. Steel metallurgy allows the control of alloying and tramp elements to achieve closed loop recycling.

Life cycle assessment can be used to quantify the potential benefits of recycling to conform to the guidance set out in ISO 14040:2006 and ISO 14044:2006.

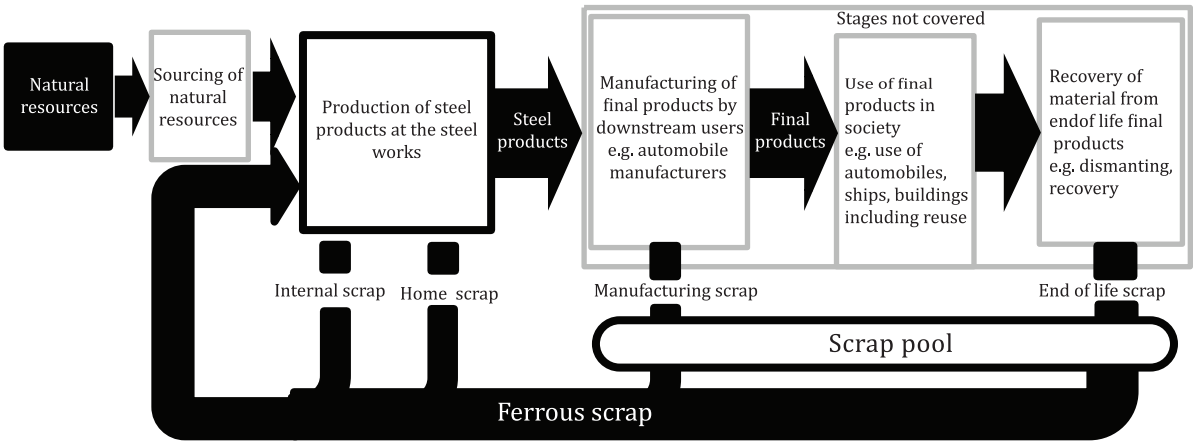

Figure 1 — Schematic diagram of the life cycle of steel

Life cycle inventory calculation methodology for steel products

1 Scope

This document specifies guidelines and requirements for conducting life cycle inventory (LCI) studies of steel products reflecting steel's capacity for closed-loop recycling, including:

a) specification of the functional unit used for LCI calculation of steel products;

b) definition of the system boundaries used for LCI calculation of steel products;

c) evaluation of scrap in LCI calculation of steel products;

d) evaluation of co-products in LCI calculation of steel products;

e) reporting of LCI calculation results of steel products.

The application of LCI results, including life cycle impact assessment (LCIA), is outside the scope of this document.

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 14040:2006, *Environmental management — Life cycle assessment — Principles and framework*

ISO 14044:2006, *Environmental management — Life cycle assessment — Requirements and guidelines*

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 https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
steel product
product produced from steel and shipped out from steelworks

EXAMPLE Hot rolled steel, pickled hot rolled steel, cold rolled steel, finished cold rolled steel, electrogalvanized steel, hot-dip galvanized steel, tin-free steel, tinplated steel, organic coated steel, section, plate, rebar, engineering steel, wire rod, seamless pipe, UO pipe, welded pipe.

3.2
final product
product that requires no additional transformation prior to its use

EXAMPLE Automobiles, building structures, building envelopes, packaging.

[SOURCE: ISO/TS 18110:2015, 2.2, modified — The example has been added.]

3.3
scrap
iron and steel material in metallic form that is recovered in multiple life cycle stages, including steel production processes, the manufacturing processes of *final products* (3.2) and the end of life of final products, and is recycled as a raw material for steel production

3.4
internal scrap
scrap (3.3) from a crude steel making unit process that is then recycled within the same unit process [e.g. basic oxygen furnace (BOF) or electric arc furnace (EAF)]

3.5
home scrap
scrap (3.3) from a downstream steel production process within the steelworks (e.g. rolling, coating) that is returned to steel making processes (e.g. BOF or EAF)

3.6
manufacturing scrap
scrap (3.3) from the manufacturing processes of *final products* (3.2), such as automobiles and buildings

3.7
end of life scrap
scrap (3.3) from after the end of life of *final products* (3.2)

3.8
external scrap
scrap (3.3) provided from outside of the steelworks, including *manufacturing scrap* (3.6) and *end of life scrap* (3.7)

3.9
recycling rate
ratio of the mass of *external scrap* (3.8) recycled to the mass of steel products to be shipped out from the steelworks gate

3.10
end of life recycling rate
ratio of the mass of *end of life scrap* (3.7) recycled to the mass of steel in *final products* (3.2)

3.11
manufacturing yield
ratio of the mass of steel contained in *final products* (3.2) to the total mass of *steel products* (3.1) used for manufacturing the final product

3.12
ferrous raw material
raw material from the earth that becomes one of the main constituents of *steel products* (3.1), and which may have undergone intermediate processing to prepare it for ironmaking

EXAMPLE Lump ore, iron ore fine, sinter, pellet, hot briquetted iron (HBI), direct reduced iron (DRI).

3.13
process coal
coal used in iron and steel making processes

EXAMPLE Coking coal, injection coal, sintering coal, BOF coal, EAF coal, DRI coal.

3.14
non-ferrous raw material
non-ferrous ingredient material for *steel products* (3.1) other than *ferrous raw material* (3.12) or *process coal* (3.13)

EXAMPLE Zinc, tin. aluminium.

3.15
ferro alloy
alloy of iron with non-iron alloy metals, such as manganese, silicon or chromium used in the steelmaking process

3.16
other input material
material input and consumables for steel production other than *ferrous raw material* (3.12), *process coal* (3.13), *non-ferrous raw material* (3.14), *ferro alloy* (3.15) and *scrap* (3.3), which does not ultimately form part of the *steel product* (3.1)

EXAMPLE Refractory, electrode, chemical materials, limestone, dolomite.

3.17
fuel
energy source for generating heat, steam and power other than *process gas* (3.20)

EXAMPLE Boiler coal, fuel oils, natural gas, LPG.

3.18
industrial gas
gas for steel production other than *fuels* (3.17) or reducing agent

EXAMPLE Oxygen, nitrogen, argon, hydrogen, carbon dioxide, compressed air.

Note 1 to entry: Hydrogen can be used as a fuel, or is included here as an industrial gas when used as an uncombusted industrial gas, e.g. for the provision of reducing atmospheres in production processes.

3.19
co-product
any of two or more products coming from the same unit process or product system

[SOURCE: ISO 14044:2006, 3.10]

3.20
process gas
gas that is produced as part of the processes on the steel production site

EXAMPLE Coke oven gas, blast furnace gas, BOF gas.

3.21
waste
materials disposed of in landfills, both internal and external to steel works, or incinerated

4 Basic conditions for LCI of steel products

4.1 General requirements

The requirements and guidelines set in this document shall be followed in addition to those set by ISO 14040:2006 and ISO 14044:2006.

4.2 Function and functional unit

The function of steel products is to form a part of final products, such as automobiles, cans and bridges.

For a LCI of steel products, the functional unit should be set as a mass-based unit of steel products to be shipped out from the steelworks gate. Where applications are based on other functional capacities, suitable explanation and conversion guidance shall be provided.