Recycled Content of Semi-finished Products

– Guideline to enable transparent calculation –

1 Introduction

Recycled content refers to the portion of recycled material used in a product. Recycled material is material that has been diverted from a solid waste stream, either during the manufacturing process of a product or after consumer use. In the first case, the recycled material is referred to as *pre-consumer recycled material*, in the second case, as *post-consumer recycled material*. The most relevant recycled material used in the manufacturing of semi-finished products made of copper and copper alloys is metallic scrap.

Recycled content was originally introduced to promote the usage of recycled materials, particularly in the production of non-metallic materials, where the quality and properties of the recycled material might be different to those of the primary material. Since copper and copper alloys can be recycled again and again without loss in quality, well-established scrap cycles have existed for decades, and all available scrap is already used today in the production of new products from copper and copper alloys. Nevertheless, there is a high demand in the market for further information on recycled content, including for copper and copper alloy products.

Since the relevant standards for the definition of recycled content leave room for interpretation, further specifications must be made to enable a transparent and comparable product claim regarding the recycled content of semi-finished products made from copper and copper alloys.

This document specifies the method used by the Wieland Group for evaluating the recycled contents in their products. It is also proposed that this methodology be used as a guiding principle across the copper industry to foster comparability. The method follows the approach of EN 45557:2020[1] and applies the provisions of ISO 14021:2016 to the manufacture of semi-finished products.

2 Definitions

2.1 Primary material

Raw material which originates from mining.

2.2 Recycled material

Sometimes also referred to as “secondary material”. Material which is either pre-consumer material or post-consumer material.

2.3 Pre-consumer material (ISO 14021)

Material diverted from the waste stream during a manufacturing process. Excluded is reutilization of materials such as rework, regrind or scrap generated in a process and capable of being reclaimed within the same process that generated it.

The term “*same process*” needs further definition, as described in Chapter 3.

2.4 Post-consumer material (ISO 14021)

Material generated by households or by commercial, industrial, and institutional facilities in their role as end-users of the product which can no longer be used for its intended purpose. This includes returns of material from the distribution chain.

2.5 Recycled content (ISO 14021)

Proportion, by mass, of recycled material in a product. Only pre-consumer and post-consumer materials shall be considered as recycled content.

[1] EN 45557:2020: General method for assessing the proportion of recycled material content in energy-related products

2.6 Run-around scrap

Scrap originating from the own manufacturing process, and which is capable of being reclaimed within the same process that generated it without further material preparation. The amount of run-around scrap is directly linked to the material efficiency (i.e. yield) of the production processes.

The term "*same process*" needs further definition, as described in Chapter 3.

2.7 Shipments

Formats or ingots that meet the respective quality requirements and that are supplied for further internal downstream processing or sold to customers.

2.8 Format / Ingot

A casted product in solid form as output of a continuous or dis-continuous melting and casting process with a defined geometry. Formats in rectangular form are often called slabs, in round form billets. However, other shapes of formats are also possible. In most cases, formats are further mechanically processed into semi-finished products and components. Ingots are used for additional re-melting and casting.

3 System boundaries

According to the definition in ISO 14021, material diverted from a waste stream during a manufacturing process that is capable of being reclaimed within the same process that generated it (run-around scrap) is not eligible for calculation of the recycled content. Accordingly, material that is not reclaimed and reutilized within the same process that generated it, and that needs to undergo material preparation[2] before it can be used again, is considered as pre-consumer material. However, the ISO standard does not provide an example of how "the same process", or of how the system boundaries for the calculation of the recycled content should be defined.

Therefore, different approaches are used in the market to calculate recycled content. In some cases, the term "same process" is interpreted as all process steps in the responsibility of a company, or, in case of more complex operations, all process steps up to a certain intermediate product. The recycled content is then calculated with respect to these boundaries. For fabricators, this would mean that all scrap generated from production processes from the foundry to the point where the product leaves the company, or until it reaches a certain processing stage, would be considered run-around scrap. If this scrap is used in the foundry of the fabricator to produce new materials, it doesn't count in the calculation of the recycled content. The objective for this approach is often to link the material efficiency of the production processes to the recycled content and to prevent that lower material efficiency is rewarded by a higher recycled content.

Recycled content should primarily be an indicator of the amount of material from waste streams that can be used for new products, rather than an indicator used for process efficiency. In addition, system boundaries set in the way described above are technically difficult to justify, particularly given a different vertical integration of production processes within companies. Recycled contents calculated based on such system boundaries are to a certain extent arbitrary and difficult to compare.

Fabricators of semi-finished products typically run three types of processes:

1. melting and casting (which may also include upstream refining),
2. hot and cold mechanical transformation like e.g., rolling, extrusion, or drawing, and
3. surface treatment/finishing.

The recycled content is fixed after melting and casting of primary material and scrap into a solid format, such as slabs, billets, or ingots.

Only the melting and casting process is capable of reclaiming its own scrap within the same process. Any scrap originating from mechanical transformation or surface treatment/finishing processes cannot be recycled within those forming and finishing process steps and needs additional material preparation by being returned to the foundry and remelted.

[2] Simple treatment steps like cutting to size, sorting or degreasing are not considered as an additional material preparation.

According to this, the European standard EN 45557:2020[3] defines the system boundary after the foundry and considers only scrap produced inside the foundry as run-around scrap and scrap from further processing as pre-consumer scrap. This document follows the approach of EN 45557 and with this it ensures good comparability between the recycled contents or different products and organizations, respectively.

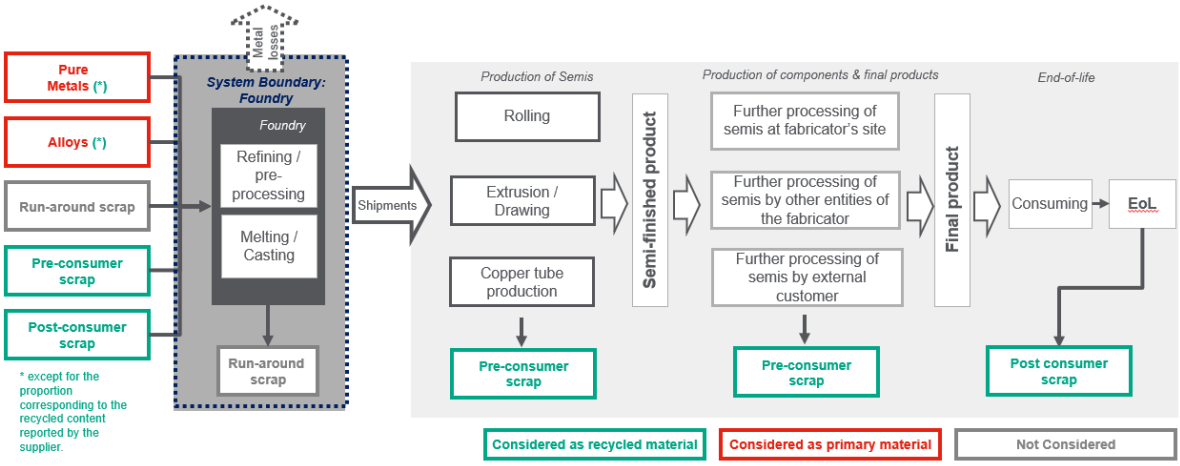
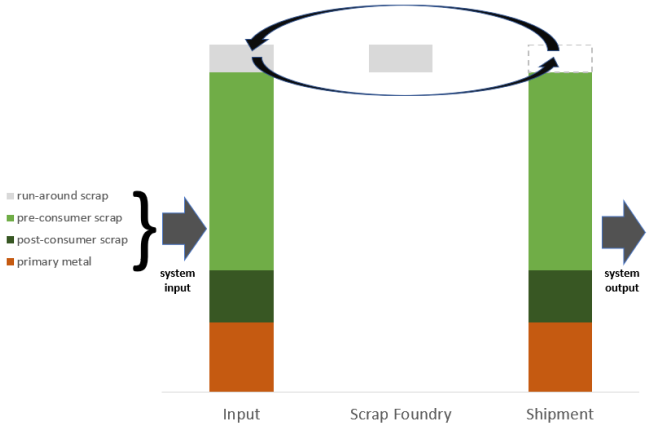


FIGURE 1: DEFINITION OF SYSTEM BOUNDARIES FOR CALCULATING THE RECYCLED CONTENT OF FORMATS

Figure 1 shows the definition of the system boundaries used in this document for calculating the recycled content of formats. In compliance with EN 45557, only the melting and casting process is considered as "the same process". Scrap generated during melting and casting processes, as well as from potential pre-processing processes that can be remelted without an additional material preparation process[2], is considered as run-around scrap. This type of scrap is not considered in the calculation of the recycled content. Examples of typical scrap from melting and casting include: rejected sections from the head and foot of the format, chips from sawing, rejected castings and formats or material from cleaning batches.

FIGURE 2: RUN-AROUND SCRAP



Metals that are obtained from slags or drosses by complex material preparation operations are considered as pre-consumer material, even if this material is re-used in the same melting and casting process. However, simple operations like sorting, sieving, or crushing are not sufficient to be considered as complex material preparation. Therefore, material obtained by these operations is considered as run-around scrap.

[3] EN 45557:2020: General method for assessing the proportion of recycled material content in energy-related products

The melting and casting process typically ends with a casted format (e.g., slab, billet, or casted rod) that is delivered to further hot or cold mechanical processing steps. In case of more complex or integrated production steps, e.g., when a first mechanical processing is already performed in-line with the melting and casting process, the melting and casting process ends when an isolated solid product is available and it is ready for further downstream processing for the first time.

Sawing of formats is in most cases an integral pre-requirement for further downstream processing. For this reason, chips from sawing of formats are considered as run-around scrap, even if the sawing operation is performed in the next production stage.

Metal losses include material that leaves the system boundaries without being incorporated into a format. In most cases, these are slags from the foundry, or rejected castings or ingots which cannot be re-used in the foundry due to their chemical composition and that are delivered further upstream to smelting and refining process steps.

Scrap generated from further processing of casted formats into semi-finished products, components and final products will be sent as raw material to the melting and casting process or even further upstream to smelting and refining process steps, depending upon quality and commercial/technical needs for the processes. Therefore, scrap generated from these processes shall count as pre-consumer material.

Once products have reached the end of their life, metals obtained from collected waste and treated waste is considered post-consumer materials. Products may reach end-of-life shortly after being traded commercially or having left the final manufacturing facility. This might happen when products are damaged or cannot be sold from their distribution chain (e.g., a new version of a product replaces the previous one which cannot be sold anymore). Materials can only be considered post-consumer materials after they have become part of a finished product for the end-user and are subsequently discarded.

According to the system boundaries as shown in Figure 1, the input and output flows for the foundry are:

$$Shipments + metal\ losses^{4} = pre\ consumer\ scrap^{5} + post\ consumer\ scrap + pure\ metals + master\ alloys - changes\ in\ stock^{6}$$

EQUATION 1: SYSTEM INPUT / OUTPUT FLOWS

Scalable system boundaries

The system boundaries are scalable. Depending on which alloy and format are covered by the system boundaries, claims regarding recycled content can be made from an average recycled content for all formats of the foundry down to a group of formats or even a single format.

Recycled content of downstream products and of organizations

To calculate the recycled content of products made from further processing of formats, like e.g. semi-finished products, or to calculate the average recycled content of an organization that consists of more than just the foundry, a new system downstream from the foundry must be defined. The boundaries of the new system must correspond to the intended product statement on the recycled content. All formats or other feedstock that are processed within this system are regarded as input flows, regardless of whether the material comes from the production of the own foundry or from external sources.

In case a semi-finished product or a component is produced using formats from just one input source (foundry), the average recycled content of the semi-finished product corresponds to the

[4] Metal losses include metals in slags as well as scrap from the foundry going outside the system.
[5] From downstream processes run by the company or sourced from the market.
[6] The change in stock needs to be considered for each material flow.

average recycled content of the formats. The same is true for the recycled content of organizations that source from only one foundry.

In case of different input sources, or if the recycled content claim shall be made for a more complex system, e.g., several processing sites and input flows from the company's foundries as well as from external sources, a weighted average recycled content has to be calculated.

As an example, Figure 3 shows the different systems boundaries for use in the calculation of an average recycled content or semi-finished products manufactured by a fabricator.

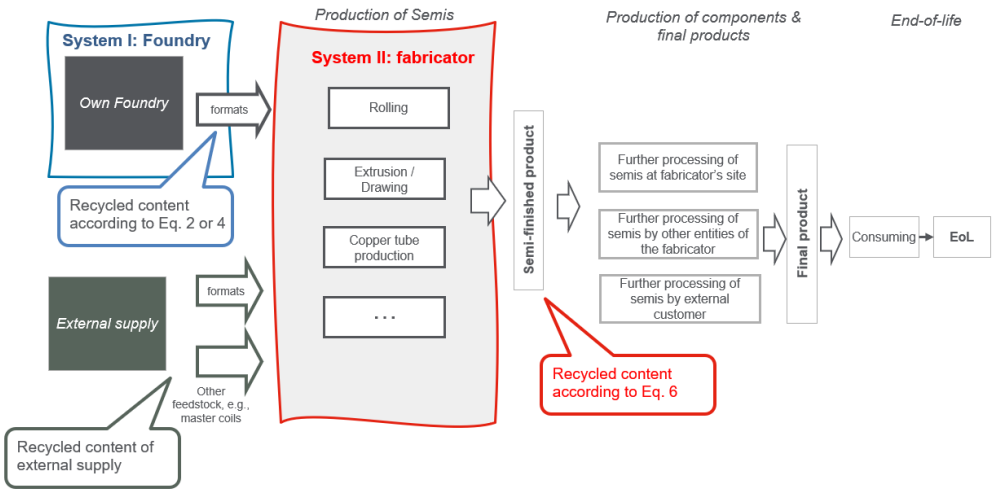


FIGURE 3: SYSTEM BOUNDARIES FOR THE CALCULATION OF AN AVERAGE RECYCLED CONTENT FOR SEMI-FINISHED PRODUCTS

Scalable system boundaries

As for the foundry, the system boundaries of the second system are scalable. Depending on which formats are considered as inputs into the system, claims regarding recycled content can been made from a corporate perspective down to a single product.

4 Calculation of the Recycled Content

4.1 Average Recycled Content of Formats

ISO 14021 defines the recycled content as the proportion of recycled material in a product. The average recycled content is calculated for a defined evaluation period according to:

$$Recycled\ Content = \frac{m_{pre} + m_{post} + m_{R;\,metals} + m_{R;\,alloys}}{m_{shipments} + m_{metal\ losses}} \cdot 100\%$$

EQUATION 2: CALCULATION OF THE RECYCLED CONTENT BASED ON RECYCLED MATERIAL

with:

m_{pre} = *total quantity of pre-consumer scrap*

m_{post} = *total quantity of post-consumer scrap*

$m_{R;\,metals}$ = *total quantity of recycled material in pure metals* $= \sum_{i}^{Input} m_{i;\,metal} \cdot \frac{RC_{i;\,metal}}{100\ \%}$

$m_{R;\,alloys}$ = *total quantity of recycled material in master alloys* $= \sum_{j}^{Input} m_{j;\,alloys} \cdot \frac{RC_{j;\,alloys}}{100\ \%}$

$m_{Shipments}$ = *total volume of formats*

$m_{metal\ losses}$ = *total quantity of metals in slags and other waste leaving the system*

m_i = *mass of material i*

RC_i = *recycled content of material i as reported by supplier in percent*

For cases in which the pre-and post-consumer recycled content should be reported separately, the recycled materials contained in pure metals, alloys and external supply are considered as pre-consumer material, unless evidence is provided by the supplier that the recycled content is post-consumer material. If it's unclear whether a scrap is pre- or post-consumer scrap, this scrap quantity shall be considered as pre-consumer scrap.

$$Pre\ Consumer\ Recycled\ Content = \frac{m_{pre} + m_{R(pre);\,metals} + m_{R(pre);\,alloys}}{m_{shipments} + m_{metal\ losses}} \cdot 100\%$$

$$Post\ Consumer\ Recycled\ Content = \frac{m_{post} + m_{R(post);\,metals} + m_{R(post);\,alloys}}{m_{shipments} + m_{metal\ losses}} \cdot 100\%$$

EQUATION 3: CALCULATION OF PRE- AND POST-CONSUMER RECYCLED CONTENT BASED ON RECYCLED MATERIAL

with

$m_{R(pre);\,metals}$ = *total quantity of pre-consumer recycled material in pure metals*

$m_{R(pre);\,alloys}$ = *total quantity of pre-consumer recycled material in alloys*

$m_{R(post);\,metals}$ = *total quantity of post-consumer recycled material in pure metals*

$m_{R(post);\,alloys}$ = *total quantity of post-consumer recycled material in alloys*

Calculation of the Recycled Content based on the amount of primary material

In case of complex operations at the foundry, e.g., when receiving scrap from many different suppliers or when calculating the recycled content for individual formats, the quantities of primary materials rather than the scrap volumes should be tracked, as it is more efficient, transparent, and less likely to cause errors. With respect to the input/output flows, Equation 2 can be re-written to:

$$Recycled\ Content = 1 - \frac{amount\ of\ primary\ materials}{shipments + metal\ losses}$$

Having in mind that pure metals and master alloys may also contain recycled material, the recycled content can then be calculated according to:

$$Recycled\ Content = 1 - \frac{m_{P;\,metals} + m_{P;\,alloys}}{m_{shipments} + m_{metal\ losses}}$$

EQUATION 4: CALCULATION OF THE RECYCLED CONTENT BASED ON PRIMARY MATERIALS

with:

$m_{P;\,metals}$ = *total quantity of primary material in pure metals*

$m_{P;\,alloys}$ = *total quantity of primary material in alloys*

In cases where the pre-and post-consumer recycled content should be reported separately, the most efficient way is to keep track of the quantities of post-consumer materials in addition to those from primary material, and to calculate the post-consumer material recycled content according to

Equation 5. If it's unclear whether a scrap quantity is pre- or post-consumer scrap, this scrap quantity shall be considered as pre-consumer scrap. The pre-consumer material recycled content can be calculated as:

$$Pre\ Consumer\ Recycled\ Content = Recycled\ Content - Post\ Consumer\ Recycled\ Content$$

EQUATION 5: CALCULATION OF THE PRE-CONSUMER RECYCLED CONTENT BASED ON PRIMARY MATERIALS

4.2 Average Recycled Content of Semi-finished Products and Organizational units

In case semi-finished products are produced using formats or feedstock from just one input source (foundry), the recycled content of the semi-finished products corresponds to the recycled content of the formats.

In case of different input sources, or if the recycled content claim shall be made for a more aggregated downstream system, such as product groups or organizational units consisting e.g., of several processing sites and input flows from own foundries as well as from external sources, a weighted average recycled content has to be calculated according to Equation 6. To calculate the weighted average recycled content, only the relevant input flows of the materials have to be considered.

$$RC_{System} = \frac{\sum_{k}^{Input} m_{tot,k} \cdot RC_k}{\sum_{k}^{Input} m_{tot,k}}$$

EQUATION 6: AVERAGE RECYCLED CONTENT OF A DOWNSTREAM SYSTEM

with

RC_{System}	=	*average recycled content of the output of the system under consideration in percent*
$m_{tot,\ k}$	=	*total quantity of format / feedstock /source k as input into the system*
RC_k	=	*recycled content of format / feedstock / source k in percent*
Input	=	*total number of formats / feedstocks / sources into the system*

5 Documentation

For each supply, the following minimum input and output data need to be collected. The input and output data always refer to the system for which a recycled content claim shall be made.

5.1 Average Recycled Content of Formats

Input data – foundry:

- Date of supply
- Quantity of supply
- Type of material (scrap (pre-consumer / post-consumer scrap, if available), metal, master alloy)
- Changes in stock for each material type
- Recycled content of metals and master alloys (if available)
- Pre-consumer material content of metals and master alloys (if available)
- Post-consumer material content of metals and master alloys (if available)
- Changes in stock

Output data – foundry:

- Shipments of formats
- Metal losses and their metal content
- Changes in stock.

5.2 Average Recycled Content of Downstream Systems

Input data for formats / feedstocks / sources

- Date of supply of formats or other feedstock (internal and external supply)
- Quantity of supply
- Recycled content of supply
- Pre-consumer material content of metals and master alloys (if available)
- Post-consumer material content of metals and master alloys (if available)
- Changes in stock

6 Product Claim

Following this guideline product claims regarding the recycled content and, if required, product claims regarding pre- and post-consumer material recycled content can be made.

The product claims must clearly indicate for which system the claim is made (for example average corporate recycled content, average recycled content of a specific site or average content of a specific product group) and for which evaluation period.

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