TDMA
TITANIUM DIOXIDE MANUFACTURERS ASSOCIATION
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The Carbon Footprint of Titanium Dioxide Pigment

The Titanium Dioxide Manufacturers Association (TDMA) has undertaken a project to determine the cradle-to-gate carbon footprint of the manufacturing processes for titanium dioxide pigments (TiO2). This has been a multiyear undertaking using the most current and up to date accepted methods for this type of calculation.

TDMA members are committed to provide high quality products that enable more sustainable solutions in downstream applications. We believe that product sustainability should be assessed across the whole value chain using a cradle-to-grave life cycle approach, from sourcing raw materials through product manufacture to the use phase in applications and finally end of life.

The TDMA chose carbon footprint as a first environmental indicator to monitor and report progress in cradle-to-gate footprint reductions, and to support downstream value chain partners in their own efforts to calculate meaningful and accurate product life cycle carbon footprints. Recognizing the lack of product specific guidance for TiO_2, the TDMA has developed an accounting and reporting methodology based on commonly accepted generic standards for life cycle assessment and carbon footprints. This methodology facilitates relevant and consistent calculations of the cradle-to-gate carbon footprint of TiO_2 and can be used by any TiO_2 producer globally. Comprehensive documentation on the method can be obtained upon request from the TDMA Secretariat.

TDMA members have committed to calculate carbon footprint for all of their TiO_2 production sites globally, have their results externally reviewed for conformity with the carbon footprinting method, and publish an industry average cradle-to-gate carbon footprint figure on a biennial basis. The most recent TDMA industry average cradle-to-gate carbon footprint figure is available now for the year of 2012.

TDMA members are committed to continuously improve the cradle-to-gate carbon footprint of TiO_2 manufacturing. Going forward, the accounting methodology as well as the monitoring and reporting efforts may be extended to other environmental impacts.

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TDMA Carbon Footprint Methodology

The Titanium Dioxide Manufacturers Association (TDMA) has undertaken a project to determine the cradle-to-gate carbon footprint of the manufacturing processes for titanium dioxide products (TiO_2).

Care has been taken to ensure the footprint uses the most up-to-date accepted methods for this type of calculation. A key output of this work has been the development of the Product Carbon Footprint Accounting and Reporting Methodology for Titanium Dioxide Products, prepared by Environmental Resources Management (ERM) in association with members of TDMA.

Purpose

The Methodology provides guidelines, accounting rules and data requirements for calculating the product carbon footprint and is intended for use by any TiO_2 manufacturer globally, who desires to calculate and have verified their own carbon footprint.

The document is designed to accommodate the need for a prescriptive approach to ensure a level playing field and consistency in the Greenhouse Gas (GHG) assessment.

Scope

The footprint of upstream and core manufacturing processes associated with the production of TiO_2 products, ready for distribution to a customer, are considered in a 'cradle-to-gate' approach.

The document serves as the methodological background to enable TDMA to calculate and publish an industry average carbon footprint value of tonnes of CO_2 equivalents per tonne of TiO_2 produced ($tCO_{2e}/tTiO_2$), where participants consider their own data that captures all their sites around the world.

The scope of impact assessment considers the carbon footprint of TiO_2 products, covering only GHG emissions and their direct contribution to climate change. The opportunity exists for expansion of the methodology to address wider environmental impacts in the future.

Functional Unit

The functional unit is the quantified performance of the product system for which results are reported and in the methodology it is defined as:

1 kg dry weight of product containing > 80% TiO_2 (moisture content can be disregarded for powder products), ready for delivery and produced in the designated calendar year.

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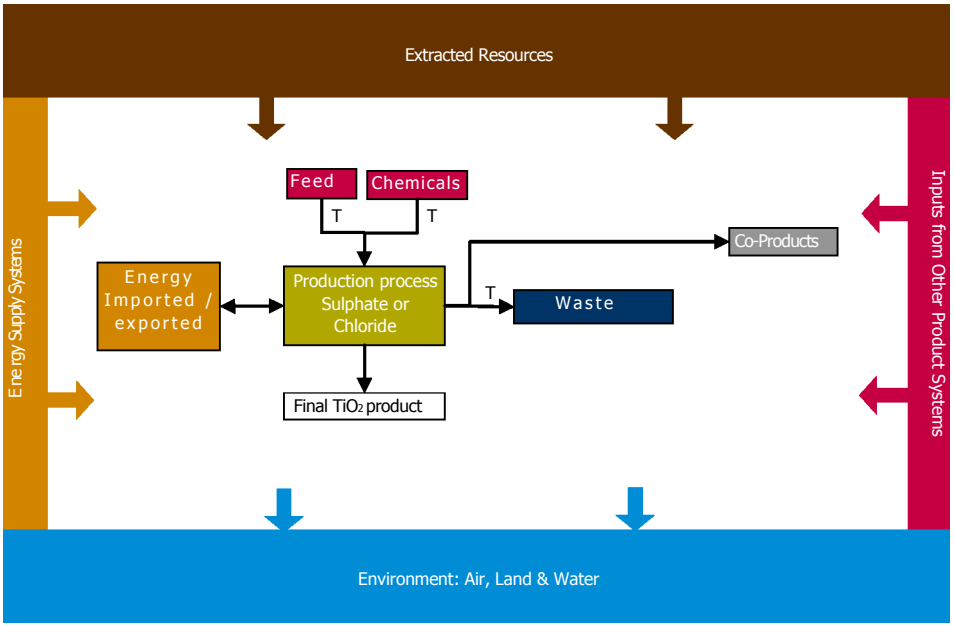
System Boundary

The system boundary captures core processes, upstream processes, wastes, coproducts, energy and transportation and is summarized in the following diagram:



As part of boundary setting, the methodology contains process maps for the sulfate and chloride TiO_2 production processes. For each of the processes the principle sources of GHG emissions in the above criteria for the cradle-to-gate production of TiO_2 has been identified and compiled into an annex.

A 95% minimum mass threshold is applied for all process raw material inputs at each site.

Data and GHG Calculations

The activity data required to conduct the Carbon Footprint is divided into the following activities:

- Quantities of specific inputs (raw materials, electricity, etc.) and outputs (TiO_2, gypsum, wastes etc.) within a 12 month period
- Material transportation details
- GHG emissions from production processes

Emission factors for GHG emissions have been applied based on upstream emissions associated with producing raw materials (in production or as embodied CO_2) and emission from fuels, energy and transportation carriers.

Primary data has been used for all core processes in individual production plants that convert TiO_2 ore to TiO_2 product. A secondary data source (based on publically available information) has been generated for all upstream emission factors for use in calculating the TDMA industry product carbon footprint. The secondary data/emission factors were sought to be regionally representative wherever possible.

Coproducts and Wastes

A consistent and unambiguous approach has been applied for assigning coproduct emissions. Here economic allocation is applied to the site boundary, effectively treating the TiO_2 production operation as a “black box.”

In such a case the outputs are considered either TiO_2 product, coproduct or waste, and the cradle-to-gate emissions are allocated in accordance with relative revenue for each product.

Coproducts have been defined as an output that is sold as a secondary product. A waste is defined as an output that is removed (either at cost or no cost) for waste treatment (including recycling). GHG emissions arising from management of disposed and recycled wastes are accounted for in the footprint, and clear guidance is provided.

Accounting for Energy

The methodology clearly defines guidance on internally and externally sourced energy, including grid and non-grid electricity, fuel inputs, external steam, energy from waste and self generation and CHP (combined heat and power) systems. All emission factors to be used for the various energy sources are compiled in the document.

Direct CO_2 Emissions

Guidance is provided on how to calculate direct CO_2 emissions that evolve from the chemical reactions in the processes. Simple stoichiometric calculations are demonstrated for the oxidation of coke during chlorination, and also for neutralizations with calcium carbonate.

Reporting and Verification Requirements

The methodology describes the reporting and verification requirements. A key feature is that all producers who submit their data for the TDMA carbon footprint assessment must:

- Confirm that their calculation is in conformance with the methodology
- Provide a statement confirming their assessment has been critically reviewed

Critical review must be carried out by an external competent body, with experience in the application of LCA standards ISO 14040 & ISO 14044 and an understanding of chemical processes.

References

The methodology builds on the following existing product carbon footprint and life cycle assessment (LCA) standards:

- BSI PAS 2050: 2011, *Specification for the Assessment of the Life Cycle Greenhouse Emissions of Goods and Services*
- WRI/WBCSD (2011), *Greenhouse Gas Protocol Product Accounting & Reporting Standard*
- ISO 14040 (2006), *Life Cycle Assessment – Principles and procedures*
- ISO 14044 (2006), *Life Cycle Assessment – Requirements and guidelines*
- IPPC 2007, *Reference Document on Best Available Techniques for the Manufacture of Large Volume Inorganic Chemicals – Solids and Others Industry, Chapter 3*

Acknowledgement

The following members of the TDMA have:

- contributed to the development and approved content of the TDMA Carbon Footprint Methodology
- submitted their data for all of their global facilities to calculate the 2012 Industry Average carbon footprint in compliance with the methodology,
- using an externally approved calculation method that was developed by TDMA and reviewed by an external competent body
- committed to continuously improve the cradle-to-gate carbon footprint of TiO_2 manufacturing.

  - ✓ Cinkarna Celje.d.d. (Slovenia)
  - ✓ Cristal (Australia, Brazil, France, Great Britain, Saudi Arabia, USA)
  - ✓ E. I. du Pont de Nemours and Company (Mexico, Taiwan, USA)
  - ✓ Grupa Azoty Zaklady Chemiczne "Police" S.A. (Poland)
  - ✓ Huntsman Pigments (France, Great Britain, Italy, Malaysia, South Africa, Spain, USA)
  - ✓ KRONOS (Belgium, Canada, Germany, Norway, USA)
  - ✓ Precheza AS (Czech Republic)
  - ✓ Sachtleben GmbH (Germany, Finland)
  - ✓ Tronox Pigments (Holland) BV (Australia, The Netherlands, USA)

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Titanium Dioxide Industry Average Carbon Footprint

Producers that represent more than half of the annual global titanium dioxide (TiO_2) manufacturing capacity have calculated the cradle-to-gate carbon footprint of all pigment products from their global production facilities using the Product Carbon Footprint Accounting and Reporting Methodology.

The methodology describes the reporting and verification requirements. A key feature is that all producers who submit their data for the TDMA carbon footprint assessment must:

- Confirm that their calculation is in conformance with the methodology
- Provide a statement confirming their assessment has been critically reviewed

Critical review must be carried out by an external competent body, with experience in the application of LCA standards ISO 14040 & ISO 14044 and an understanding of chemical processes.

All companies who have participated in the Industry Average calculation have gone through the above steps.

The Industry Average calculated based on 2012 data is:

5.3 $tCO_{2e}/tTiO_2$ product

Compared to the results compiled in 2010, the 2012 industry average cradle-to-gate carbon footprint remained essentially flat, despite economic headwinds[1]

TiO_2 is a unique and versatile material which for the vast majority of end-use applications has no viable alternative. The performance benefits obtained in end-use applications are essential to the product or article being produced. Hence the TDMA believe it is critical to assess sustainability through a full life cycle approach, considering the functionality and performance benefits of the end-use. The TDMA members are committed and able to advise on how to optimize the use of TiO_2 pigments in final applications and are actively engaging with industry associations to discuss their sustainability agendas.

1 See Cefic Chemdata International for industry trends, available on-line www.cefic.org/Facts-and-Figures/chemicals-trends-report/

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TDMA members are committed to continuously improve the cradle-to-gate carbon footprint of TiO_2 manufacturing. Periodically the industry average results shall be updated. Companies who have provided input for all of their global facilities to the 2012 Industry average:

- ✓ Cinkarna Celje.d.d. (Slovenia)
- ✓ Cristal (Australia, Brazil, France, Great Britain, Saudi Arabia, USA)
- ✓ E. I. du Pont de Nemours and Company (Mexico, Taiwan, USA)
- ✓ Grupa Azoty Zaklady Chemiczne "Police" S.A. (Poland)
- ✓ Huntsman Pigments (France, Great Britain, Italy, Malaysia, South Africa, Spain, USA)
- ✓ KRONOS (Belgium, Canada, Germany, Norway, USA)
- ✓ Precheza AS (Czech Republic)
- ✓ Sachtleben GmbH (Germany, Finland)
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