Carbon footprints of inorganic coagulants produced by INCOPA member organisations

AN EXECUTIVE SUMMARY

Format of this document

This is a summary of the report Carbon footprints of inorganic coagulants (U6780), authored by IVL Swedish Environmental Research Institute and commissioned by INCOPA, containing carbon footprints and a short description of the methodology. The carbon footprints are based on LCA methodology and cover the production of inorganic coagulants from cradle to gate.

More detailed information and all results can be found in the main report which can be obtained on request at info@incopa.org.

Carbon footprints

Figure 1 below illustrates typical carbon footprint values for inorganic coagulants produced by member companies of INCOPA.

The results indicate that the carbon footprints for aluminium-based coagulants range from approximately 40 to 120 g of carbon dioxide equivalents per mole of aluminium, or 1.5 to 4.5 kg of carbon dioxide equivalents per kg of aluminium. The carbon footprints for iron-based coagulants range from 40 to 70 g of carbon dioxide equivalents per mole of iron, or 0.7 to 1.3 kg of carbon dioxide equivalents per kg of iron.

Production of raw material is vital

As indicated by the results in this study, it is the production of raw materials which contributes the most to the climate change impact during the production of coagulants. It is vital for the overall results and based on this, it is more important to select suppliers based on their environmental performance rather than based on their proximity to the coagulant production site. The impact from raw material transports is relatively small in comparison to raw material production.

Reduced impact from using secondary raw materials

By using secondary raw materials, the carbon footprint can be decreased. In this study, the production of primary materials is fully allocated to the first life cycle, and secondary materials enter the system boundaries without any burden from previous life cycles. In some cases, the secondary raw materials are diluted with water. This can increase the energy consumption and have a negative impact on the carbon footprints if the water needs to be evaporated to achieve a specified product concentration.

However, it is important to consider that the intended application of the coagulant allows for a product with a suitable quality. Also, important to remember is that the use of recycled raw materials is even more central in a resource perspective and may not always be assessed accurately through a carbon footprint.

Changed footprints since 2014

Compared to the previous study from 2014, the carbon footprints of coagulants have changed. Coagulants utilising hydrochloric acid and sodium hydroxide have a considerably lower carbon footprint in this study than previously, and the reason for this is that the water content of chemicals in solutions were not considered in the study from 2014. The result of this is an overestimation of the impact of producing hydrochloric acid and sodium hydroxide in the previous study.

Meanwhile, coagulants utilising copperas as raw material have a higher carbon footprint in this study compared to the previous study. The reason for this increase is an alternative approach of allocating the burdens between copperas and titanium dioxide. The allocation is performed based on economic values, while in the previous study, titanium dioxide carried the full burden and copperas none.

CARBON FOOTPRINTS OF INORGANIC COAGULANTS

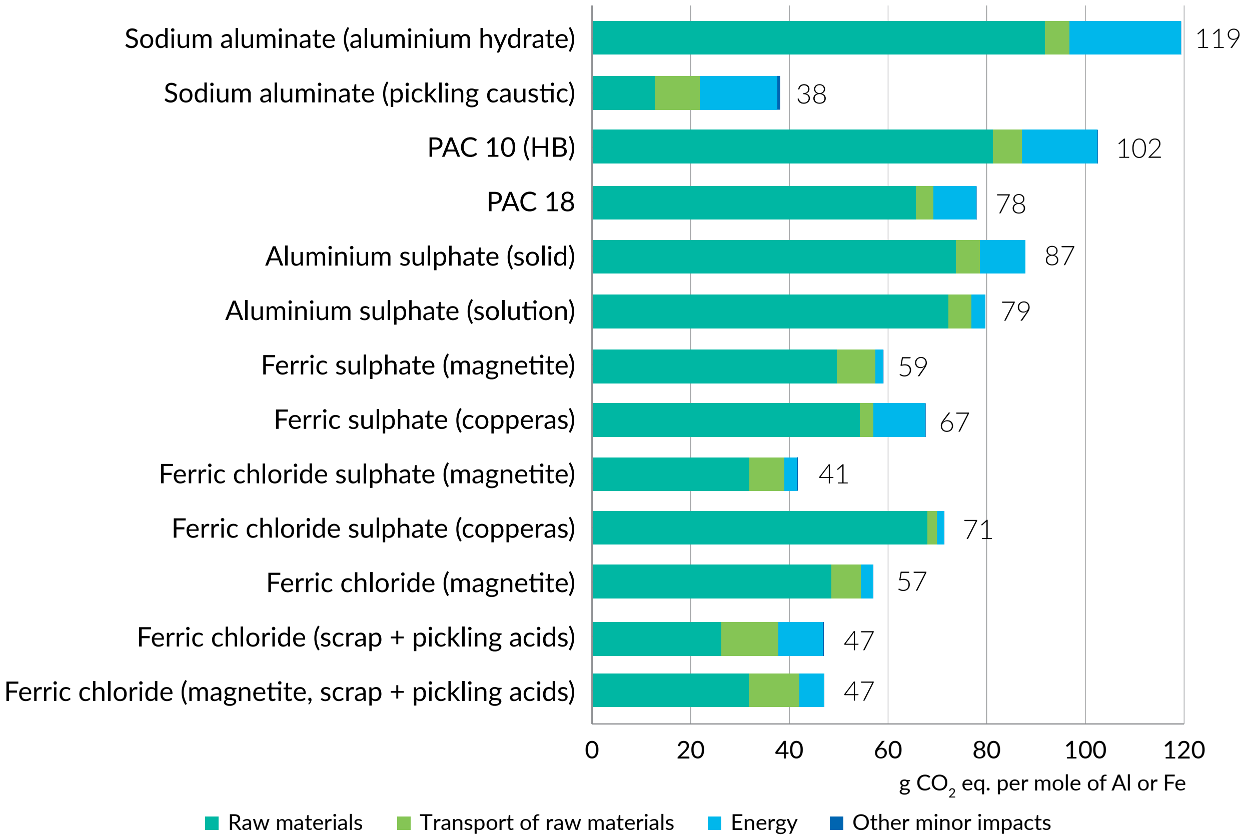

Figure 1. Carbon footprints of inorganic coagulants covering all emissions of greenhouse gases from the "cradle" (i.e., extraction of natural resources) to the factory gate. The category Energy includes the steam and electricity used in the production of the coagulants. The impact on climate change is expressed as grams of carbon dioxide equivalents per mole of aluminium or iron.

LCA methodology

Goal and scope

The goal of the study is to calculate typical carbon footprints of inorganic coagulants produced by member companies of INCOPA. An additional goal of this study is to analyse the results with regards to their hot spots to identify important contributors in the life cycle of the coagulants.

The products and their variations included in the study are listed in the tables below.

To quantify the carbon footprints of coagulants, the functional unit applied is **one mole of aluminium or iron**.

Product	Concentration of Al_2O3	Concentration of aluminium [Al]
Sodium aluminate (aluminium hydrate)	18.9 %	10.0 %
Sodium aluminate (pickling caustic)	13.2 %	7.0 %
PAC 10 (HB)	10.4 %	5.5 %
PAC 18	17 %	9.0 %
Aluminium sulphate (solid)	17 %	9.0 %
Aluminium sulphate (solution)	8.1 %	4.3 %

Table 1. Coagulants based on aluminium included in the study, including the concentration of Al. The concentrations are expressed as weight-% in products as sold.

Product	Product concentration	Concentration of iron [Fe]
Ferric sulphate (magnetite)	40 %	11.4 %
Ferric sulphate (copperas)	41 %	11.6 %
Ferric chloride sulphate (magnetite)	39 %	11.5 %
Ferric chloride sulphate (copperas)	41 %	12.2 %
Ferric chloride (magnetite)	40 %	13.8 %
Ferric chloride (scrap, pickling)	40 %	13.8 %
Ferric chloride (magnetite + scrap, pickling)	40 %	13.8 %

Table 2. Coagulants based on iron included in the study, including the concentration of Fe. The concentrations are expressed as weight-% in products as sold.

The system boundaries of this study cover the environmental impacts from cradle to the factory gate, i.e., raw material extraction, transports, and production of coagulants. Transportation of the products to customers is not included within the system boundaries. Production of process equipment (e.g., vessels, reactors, pumps, pipes) and buildings are not included in the carbon footprints of the coagulants.

The study covers one environmental impact category: climate change. Characterisation factors from IPCC AR6 (Intergovernmental Panel on Climate Change, Assessment Report 6) from 2021 is applied.

By-products and secondary products

No co-products are generated in the manufacturing of the studied coagulants. Some raw materials used in the production of coagulants are generated from multifunctional processes (e.g., sodium hydroxide, chlorine, and hydrochloric acid) and the environmental impact of producing these materials has been allocated between the co-products.

The following raw materials are considered to be secondary materials and carry no upstream burden: steel scrap, pickling liquors, pickling caustic, hydrochloric acid (20%, recycled), sulphuric acid (20%, recycled) and aluminium hydrate sludge. Since the materials are recycled, the upstream burden has been cut off and only transportation of the material to the coagulant production site is included. Production of the primary materials are fully allocated to the first life cycle.

Copperas is a by-product from the production of titanium dioxide, and it therefore carries a share of the environmental burden. The allocation is performed based on economic values in this study to better reflect that the titanium dioxide is the main product driving the production. In the previous study from 2014, copperas carried no upstream burden from titanium dioxide production.

Data collection and modelling

Data is collected from member companies of INCOPA and is based on production during year 2022. The inventory data do not represent an average production based on many sites, but the data should be interpreted as a selection of typical values rather than industry averages.

The production of raw materials and energy is based on European averages: electricity is assumed to be supplied as an average European grid mix and steam is assumed to be produced from natural gas for all coagulant production sites.

Raw materials, such as hydrochloric acid, sulphuric acid, aluminium hydroxide, magnetite, and copperas, are modelled as European averages to be representative for all coagulants. Environmental data is generally based on information from LCA databases or industry associations.

Like all LCAs and environmental footprint studies, the results are connected to some uncertainties. The uncertainties can be as a result of the choice of representative production units providing inventory data for this study, or as a result of modelling and data choices made in the study.

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