ENVIRONMENTAL PRODUCT DECLARATION
as per ISO 14025 and EN 15804+A1

<table>
<thead>
<tr>
<th>Owner of the Declaration</th>
<th>Lanxess Deutschland GmbH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Programme holder</td>
<td>Institut Bauen und Umwelt e.V. (IBU)</td>
</tr>
<tr>
<td>Publisher</td>
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<tr>
<td>Declaration number</td>
<td>EPD-LAN-20210302-IBG1-EN</td>
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<tr>
<td>Issue date</td>
<td>07.01.2022</td>
</tr>
<tr>
<td>Valid to</td>
<td>06.01.2027</td>
</tr>
</tbody>
</table>

BAYFERROX® 920 - Iron Hydroxide - Yellow Pigment (FeOOH)
Lanxess Deutschland GmbH

www.ibu-epd.com | https://epd-online.com
1. General Information

LANXESS Deutschland GmbH

Programme holder
IBU – Institut Bauen und Umwelt e.V.
Hegelplatz 1
10117 Berlin
Germany

BAYFERROX® 920

Owner of the declaration
Lanxess Deutschland GmbH
BU Inorganic Pigments
Chempark Krefeld-Uerdingen, Gebäude R54
Rheinuferstr. 7-9
47829 Krefeld

Declaration number
EPD-LAN-20210302-IBG1-EN

Declared product / declared unit
1,000 kg BAYFERROX® 920 iron hydroxide yellow pigment (weighted average)

This declaration is based on the product category rules:
Inorganic Pigments in Various Forms of Delivery, 03.2021
(PCR checked and approved by the SVR)

Issue date
07.01.2022

Valid to
06.01.2027

Scope:
This EPD applies to the iron hydroxide yellow pigments BAYFERROX® 920 in the versions compacted (920 C), powder (920), and granulate (920 G). It is an average EPD for which the weighted average of the three versions was calculated on the basis of the mass-specific production rate of the last five years (2016–2020). Production of the pigments in Germany was assessed.

The owner of the declaration shall be liable for the underlying information and evidence; the IBU shall not be liable with respect to manufacturer information, life cycle assessment data and evidences.

The EPD was created according to the specifications of EN 15804+A1. In the following, the standard will be simplified as EN 15804.

Verification
The standard EN 15804 serves as the core PCR
Independent verification of the declaration and data according to ISO 14025.2011

2. Product

2.1 Product description/Product definition
Inorganic pigments are defined as substances that are insoluble in the application medium (ISO 18451-1) and manufactured by means of chemical synthesis. This EPD covers the product BAYFERROX® 920 in its typical versions, namely powder, granulate, and compacted. The average values of the inorganic pigments declared here are based on the product volume in the indicated versions. Regulation (EU) no. 305/2011 (CPR) applies to the placing of the product on the market in the EU/EFTA (except Switzerland). The product requires a declaration of performance with due consideration of DIN EN 12878:2014 Pigments for the coloring of building materials based on cement and/or lime - Specifications and methods of test, and CE marking. The respective national provisions apply to use.

2.2 Application
Inorganic iron oxide pigments are used for coloring building materials made from cement, cement/lime mixtures, lime mortar, and bituminous applications.

2.3 Technical Data
The product technical data that comes within the scope of the EPD is set out in the table below, with reference to the check rules based on EN 12878.

Structural data – influence on concrete properties

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Setting time Setting time (start of setting at least 1 h)</td>
<td>160</td>
<td>min</td>
</tr>
<tr>
<td>Setting time Setting time (end of setting max. 12 h)</td>
<td>160</td>
<td>min</td>
</tr>
<tr>
<td>Influence on cement setting Influence on cement setting Delta</td>
<td>-47</td>
<td>min</td>
</tr>
</tbody>
</table>
2.5 Base materials/Ancillary materials

On average, the pigment BAYFERROX® 920 is made up of the following raw and auxiliary materials:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron sulfate</td>
<td>49.2</td>
<td>% by mass</td>
</tr>
<tr>
<td>Sodium hydroxide</td>
<td>50.0</td>
<td>% by mass</td>
</tr>
<tr>
<td>Cooling water</td>
<td>0.8</td>
<td>Masse-%</td>
</tr>
</tbody>
</table>

1) The product/at least one partial product contains substances on the ECHA list of substances of very high concern (SVHC) (date July 8, 2021) above 0.1% by mass: No.

2) The product/at least one partial product contains further CMR substances in category 1A or 1B that are not on the candidate list, above 0.1% by mass in at least one partial product: No.

3) This construction product has had biocidal products added to it, or it has been treated with biocidal products (it is therefore a treated article as per the Biocidal Products Regulation (EU) no. 528/2012): No.

2.6 Manufacture

A solution of iron sulfate that is designated as waste product from the steel industry is mixed with sodium hydroxide in a controlled manner with the addition of air or oxygen.

\[ 2 \text{FeSO}_4 + 4 \text{NaOH} + \frac{1}{2} \text{O}_2 \rightarrow 2 \text{FeOOH} + 2 \text{Na}_2\text{SO}_4 + \text{H}_2\text{O} \]

After subsequent drying, washing is carried out, followed by grinding.

2.7 Environment and health during manufacturing

LANXESS is continuously investing in modern manufacturing processes at all locations. The Inorganic Pigments business unit and its equipment are certified according to ISO 9001, 14001, and 50001. BAYFERROX® iron oxide pigments are certified by SCS Global Services for their high content of recycled raw materials.

2.8 Product processing/Installation

As this EPD assesses modules A1–A3 and D (cradle to gate), a rough description of the application processes is attached.

Customers typically use dosing units to dose BAYFERROX® 920 into specific color mixtures and to process them into cement-bound, lime-bound, or bituminous products.

2.9 Packaging

All versions of the pigment BAYFERROX® 920 are packaged identically. The finished product is usually packaged in PE/paper sacks with a net weight of 25 kg through to big bags made of PP and LDPE with a net weight of one metric ton.

According to the German Association for Plastics Packaging and Films (IK), the big bags made of PP and LDPE on which the calculations of the EPD are based can be reused in a closed-loop system under
specific conditions for the same product (max. 2 years). The big bags can be recycled at the end of their life. For mechanical recycling, the used synthetic fabrics are treated mechanically with no change to the chemical structure. The recycled materials can be used in various applications and replace new granulate.

2.10 Condition of use
This EPD assesses modules A1–A3 and D (cradle to gate). No material changes are expected within the recommended usage limits.

2.11 Environment and health during use
The product is not a hazardous substance (as per the CLP Regulation). There is no risk if the product is handled and processed in compliance with the applicable regulations in the workplace.

2.12 Reference service life
This EPD assesses modules A1–A3 and D (cradle to gate). The service life corresponds to typical use in the respective application.

2.13 Extraordinary effects
Fire
FeOOH is non-flammable.

Water
No hazardous substances are released as a result of contact with water.

Mechanical destruction
Not applicable.

2.14 Re-use phase
This EPD assesses modules A1–A3 and D (cradle to gate). As BAYFERROX® 920 is bound in the application medium, reuse is not pursued on account of the substantial amount of thermal energy required and the technical options currently available. Recycling management provides individual opportunities for use of the bound pigment.

2.15 Disposal
Disposal is carried out in conjunction with and in accordance with the respective application medium. The waste code for iron oxide is 060316 (as per the German Waste Catalog Ordinance).

2.16 Further information
Further information on BAYFERROX® 920 and further Lanxess IPG products and services is available at www.bayferrox.com.

3. LCA: Calculation rules

3.1 Declared Unit
The selected declared unit relates to an average product. The average was formed as a weighted mean from the annual production quantities of the compacted, powder, and granulate versions over the last five years (2016–2020) (reference to mass).

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Declared unit</td>
<td>1000</td>
<td>kg</td>
</tr>
<tr>
<td>Gross density</td>
<td></td>
<td>kg/m³</td>
</tr>
<tr>
<td>Conversion factor</td>
<td>1000</td>
<td></td>
</tr>
</tbody>
</table>

3.2 System boundary
Type of EPD: Cradle to gate with options. The following modules were taken into account in the LCA calculation.

A1: Supply of raw materials
A2: Transportation of raw materials to the manufacturer
A3: Manufacture of the product (including required energy and water) and manufacture of the product packaging
D: Reuse, recovery, and/or recycling potential

The use and disposal phase is not taken into account in the LCA calculations.

3.3 Estimates and assumptions
Primary data across all versions was used for transportation of the iron sulfate and sodium hydroxide (module A2) and for on-site production processes at Lanxess Deutschland GmbH (module A3). Electricity consumption of 0.072 MJ per tkm was assumed for transportation via pipeline.

Generic data was used for production of feedstocks (module A1) as these are not produced by Lanxess Deutschland GmbH itself and no detailed information was available.

Credits for the avoidance of generation of electricity and steam in another product system through the incineration processes for production waste were also taken into account (module D). 100% incineration including energy recovery (electricity and steam) was assumed here.

3.4 Cut-off criteria
All primary data of the production processes was taken into account. No cut-off rules were applied.

3.5 Background data
The software system GaBi 9 developed by Sphera was used for modeling of the product’s LCA. The data sets contained therein are either from the GaBi Professional database or from the Ecoinvent database (v 3.5).

3.6 Data quality
The GaBi software system for life-cycle analyses and the GaBi Professional database as well as the Ecoinvent database (v 3.5) were used for life-cycle
modeling of the assessed products. The produced quantities for 2020 were gathered by Lanxess.

Corresponding data sets were available for the precursors used, and some of them have been adapted with regard to concentration. The age of the background data used (2016–2020) is less than 15 years and can be regarded as representative for the assessment period. The LCA figures for the average EPD (weighted mean over the last 5 years (2016–2020)) can be regarded as robust as they are a weighted average of high-quality, measured activity data. All data used can be regarded as representative.

3.7 Period under review
The assessment period is 2020. All in-house data was gathered in this period and then correspondingly subjected to average weighting for the average

3.8 Allocation
Module A1 does not take account of any debits for the iron sulfate used as this is pre-consumer material as per ISO 14021. Some of the material used stems from ilmenite treatment at a titanium dioxide factory, and some of it stems from pig-iron pickling plants in the steel industry.

All credits from recovered energy from processes relating to the incineration of production waste were allocated to module D.

3.9 Comparability
Basically, a comparison or an evaluation of EPD data is only possible if all the data sets to be compared were created according to EN 15804 and the building context, respectively the product-specific characteristics of performance, are taken into account.

Background data was taken from the GaBi Professional database. To fill occasional gaps, data sets from Ecoinvent (v 3.5) were used.

4. LCA: Scenarios and additional technical information

The following technical information forms the basis for the declared modules or can be used to develop specific scenarios in the context of a building assessment if modules are not declared (MND).

As disposal of the packaging material on the building site (module A5) is not declared, the assessed quantities of packaging materials are stated below:

- Big bag (PP): 1.94 kg/1,000 kg product
- Big bag (LDPE): 0.88 kg/1,000 kg product

Module D comprises the credits for the incineration processes (i.e. credits for electricity and steam as a result of incineration of production waste). The credits are based on German average data for electrical and thermal energy.
5. LCA: Results

The following tables show the environment-relevant results as per EN 15804 for 1,000 kg BAYFERROX® 920 iron hydroxide yellow pigment (weighted average for the compacted, powder, and granulate versions). Module D sets out the incineration of production waste and reflects thermal treatment with energy recovery.

### DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LCA; MND = MODULE NOT DECLARED; MNR = MODULE NOT RELEVANT)

<table>
<thead>
<tr>
<th>PRODUCT STAGE</th>
<th>CONSTRUCTION PROCESS STAGE</th>
<th>USE STAGE</th>
<th>END OF LIFE STAGE</th>
<th>BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw material supply</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transport</td>
<td>Manufacturing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assembly</td>
<td>Use</td>
<td>Maintenance</td>
<td>Repair</td>
<td>Replacement</td>
</tr>
<tr>
<td>Raw material supply</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transport</td>
<td>Manufacturing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assembly</td>
<td>Use</td>
<td>Maintenance</td>
<td>Repair</td>
<td>Replacement</td>
</tr>
</tbody>
</table>

### RESULTS OF THE LCA - ENVIRONMENTAL IMPACT according to EN 15804+A1: 1,000 kg BAYFERROX® 920 (Durchschnittsprodukt)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>A1</th>
<th>A2</th>
<th>A3</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global warming potential</td>
<td>[kg CO₂-Eq.]</td>
<td>1.12E+3</td>
<td>1.17E+1</td>
<td>1.03E+3</td>
<td>-1.71E+1</td>
</tr>
<tr>
<td>Depletion potential of the stratospheric ozone layer</td>
<td>[kg CFC11-Eq.]</td>
<td>3.33E-11</td>
<td>1.16E-13</td>
<td>1.59E-11</td>
<td>-4.60E-13</td>
</tr>
<tr>
<td>Acidification potential of land and water</td>
<td>[kg SO₄²⁻-Eq.]</td>
<td>1.65E+1</td>
<td>2.06E-2</td>
<td>7.41E-1</td>
<td>-1.43E-2</td>
</tr>
<tr>
<td>Eutrophication potential</td>
<td>[kg PO₄³⁻-Eq.]</td>
<td>3.84E-1</td>
<td>4.75E-3</td>
<td>1.34E-1</td>
<td>-2.72E-3</td>
</tr>
<tr>
<td>Formation potential of tropospheric ozone photochemical oxidants</td>
<td>[kg ethene-Eq.]</td>
<td>1.64E-1</td>
<td>-5.55E-3</td>
<td>8.22E-2</td>
<td>-1.47E-3</td>
</tr>
<tr>
<td>Abiotic depletion potential for non-fossil resources</td>
<td>[kg Sb-Eq.]</td>
<td>3.29E-4</td>
<td>1.87E-6</td>
<td>1.86E-4</td>
<td>-4.71E-6</td>
</tr>
<tr>
<td>Abiotic depletion potential for fossil resources</td>
<td>[MJ]</td>
<td>1.26E+4</td>
<td>1.50E+2</td>
<td>1.42E+4</td>
<td>-2.28E+2</td>
</tr>
</tbody>
</table>

### RESULTS OF THE LCA - INDICATORS TO DESCRIBE RESOURCE USE according to EN 15804+A1: 1,000 kg BAYFERROX® 920 (Durchschnittsprodukt)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>A1</th>
<th>A2</th>
<th>A3</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renewable primary energy as energy carrier</td>
<td>[MJ]</td>
<td>5.91E+3</td>
<td>2.65E+1</td>
<td>2.76E+3</td>
<td>-7.72E+1</td>
</tr>
<tr>
<td>Renewable primary energy resources as material utilization</td>
<td>[MJ]</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
</tr>
<tr>
<td>Total use of renewable primary energy resources</td>
<td>[MJ]</td>
<td>5.91E+3</td>
<td>2.65E+1</td>
<td>2.76E+3</td>
<td>-7.72E+1</td>
</tr>
<tr>
<td>Non-renewable primary energy as energy carrier</td>
<td>[MJ]</td>
<td>1.50E+4</td>
<td>1.56E+2</td>
<td>1.55E+4</td>
<td>-2.50E+2</td>
</tr>
<tr>
<td>Non-renewable primary energy as material utilization</td>
<td>[MJ]</td>
<td>3.93E+2</td>
<td>2.37E+0</td>
<td>1.25E+2</td>
<td>-2.82E+10</td>
</tr>
<tr>
<td>Total use of non-renewable primary energy resources</td>
<td>[MJ]</td>
<td>1.54E+4</td>
<td>1.56E+2</td>
<td>1.56E+4</td>
<td>-2.50E+2</td>
</tr>
<tr>
<td>Use of secondary material</td>
<td>[kg]</td>
<td>2.94E+3</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
</tr>
<tr>
<td>Use of renewable secondary fuels</td>
<td>[MJ]</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
</tr>
<tr>
<td>Use of non-renewable secondary fuels</td>
<td>[MJ]</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
</tr>
<tr>
<td>Use of net fresh water</td>
<td>[m³]</td>
<td>4.98E+0</td>
<td>1.48E+2</td>
<td>1.55E+0</td>
<td>-3.31E-2</td>
</tr>
</tbody>
</table>

### RESULTS OF THE LCA – WASTE CATEGORIES AND OUTPUT FLOWS according to EN 15804+A1: 1,000 kg BAYFERROX® 920 (Durchschnittsprodukt)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>A1</th>
<th>A2</th>
<th>A3</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hazardous waste disposed</td>
<td>[kg]</td>
<td>4.52E-5</td>
<td>4.87E-6</td>
<td>7.27E-6</td>
<td>-1.33E-7</td>
</tr>
<tr>
<td>Non-hazardous waste disposed</td>
<td>[kg]</td>
<td>1.54E+1</td>
<td>4.42E-2</td>
<td>9.61E+0</td>
<td>-1.21E+1</td>
</tr>
<tr>
<td>Radioactive waste disposed</td>
<td>[kg]</td>
<td>8.65E-1</td>
<td>2.29E-3</td>
<td>3.61E-1</td>
<td>-8.34E-3</td>
</tr>
<tr>
<td>Components for re-use</td>
<td>[kg]</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
</tr>
<tr>
<td>Materials for recycling</td>
<td>[kg]</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
</tr>
<tr>
<td>Materials for energy recovery</td>
<td>[kg]</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
</tr>
<tr>
<td>Exported electrical energy</td>
<td>[MJ]</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>7.59E+1</td>
<td>0.00E+0</td>
</tr>
<tr>
<td>Exported thermal energy</td>
<td>[MJ]</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>1.76E+2</td>
<td>0.00E+0</td>
</tr>
</tbody>
</table>

The environment-relevant results (use of resources, output flows, and waste categories) as per EN 15804 for 1,000 kg BAYFERROX® 920 iron hydroxide yellow pigment in the individual versions (compacted, powder, granulate) are set out in the annex.

6. LCA: Interpretation

The product is evaluated below for the weighted average of the three versions, namely compacted, powder, and granulate.

All impact categories are substantially characterized by the provision of raw materials (module A1) and production (module A3), with a relevance of 99%.
The main driver in all impact categories in the raw materials (module A1) is the sodium hydroxide used (100% in module A1) as the yellow pigment is manufactured from two raw materials, and iron sulfate is included in the LCA with no debits. In module A3, the main drivers are the energy sources used, chiefly electricity and natural gas.

Compared with the other modules, transportation processes (module A2) have very little influence on the impact categories (approx. 1%). Furthermore, the separate evaluation of energy recovery (module D) results in credits in all impact categories.

Provision of raw materials accounts for the biggest proportion of the gross energy requirement (PENRT + PERT) of approx. 21,300 MJ (module A1). Approx. 330 MJ is credited for energy recovery (module D) in the production-waste incineration process.

The global warming potential (GWP) for the average product and for the three versions is shown in the chart below. While the GWP figures for compacted pigment and powder are almost identical, the figure for granulate is approx. 457 kg CO2e higher. This is because of the more energy-intensive manufacturing process (module A3).

7. Requisite evidence

No proof has to be provided for this EPD as no hazardous substances as per the CLP Regulation are used.

8. References

Standards

EN 934-1

EN 12878
DIN EN 12878:2014, Pigments for the coloring of building materials based on cement and/or lime - Specifications and methods of test.

EN 15804

ISO 9001

ISO 14001
DIN EN ISO 14001:2015, Environmental management systems - Requirements with guidance for use.

ISO 14025

ISO 18451-1

ISO 50001

Further literature

German Waste Catalog Ordinance (AVV)

CLP Regulation
Regulation (EG) no. 1272/2008 of the European

Ecoinvent database
Ecoinvent database version 3.5, 2020

GaBi Professional database
GaBi Professional database version 9.2.1, 2020

IBU 2021

PCR part A

PCR: Inorganic pigments in different versions
Product category rules for building-related products and services. Part B: Requirements for the EPD for inorganic pigments in different versions, v.1.0. Berlin: Institut Bauen und Umwelt e.V. (publisher), 2021.