ENVIRONMENTAL PRODUCT DECLARATION

as per *ISO 14025* and *EN 15804+A2*

Owner of the Declaration	Dyckerhoff GmbH
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-DYK-20210306-IAA1-EN
Issue date	26.01.2022
Valid to	25.01.2027

Dyckerhoff Class C acc. to API Spec 10A

Dyckerhoff GmbH

Werk Lengerich

Institut Bauen und Umwelt e.V.

www.ibu-epd.com | https://epd-online.com

ECO PLATFORM EPD EN 15804 VERIFIED

1. General Information

Dyckerhoff GmbH Werk Lengerich

Programme holder
IBU – Institut Bauen und Umwelt e.V.
Panoramastr. 1
10178 Berlin
Germany

Declaration number
EPD-DYK-20210306-IAA1-EN

This declaration is based on the product category rules:
Cement, 11.2017
(PCR checked and approved by the SVR)

Issue date
26.01.2022

Valid to
25.01.2027

Dipl. Ing. Hans Peters
(chairman of Institut Bauen und Umwelt e.V.)

Dr. Alexander Röder
(Managing Director Institut Bauen und Umwelt e.V.))

Dyckerhoff Class C

Owner of the declaration
Dyckerhoff GmbH
Lienener Str. 89
49525 Lengerich
Germany

Declared product / declared unit
1 metric ton API Well Cement Class C at Grade O

Scope:
This Environmental Product Declaration (EPD) covers the product life cycle stages A1-A3. It is valid for API Well Cement Class C at Grade O, manufactured by Dyckerhoff GmbH at plant Lengerich.

This analysis relies on transparent, plausible and documented basis data. All the model assumptions, which influence the results, are declared. The life cycle assessment is representative for the products introduced in the declaration for the given system boundaries.

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+A2*. 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 14025:2010*
☐ internally ☒ externally

Angela Schindler
(Independent verifier)

2. Product

2.1 Product description/Product definition

Dyckerhoff is an international producer of cement and ready-mixed concrete. We are a Buzzi Unicem company. Buzzi Unicem is a corporation located in Italy, which operates plants in 14 countries, with more than 10,000 employees worldwide. In Germany, we operate seven cement plants and around 110 ready-mixed concrete plants. Our additional production sites are located in Luxembourg, the Netherlands, Poland, the Czech Republic and Slovakia as well as in Russia and Ukraine.
For more than 70 years Dyckerhoff Well Cements have been setting the benchmarks for high and consistent quality and excellent field performance.

Cement is a hydraulic binder. It consists of finely ground, non-metallic inorganic compounds. Cement is produced by grinding cement clinker and other main or minor constituents. When water is added to cement, a cement paste is formed, which sets and hardens through hydration reactions. After hardening, it retains its strength and stability even under water.
According to *API Spec 10A t*he declared cement is intended for use when conditions require high early-strength.
Well cements are used for cementing steel casings in boreholes for producing various subsurface fluids.

For the use and application of the product, the respective national provisions at the place of use apply, in Germany for example the building codes of the federal states and the corresponding national specifications.

2.2 Application

Well cementing are used to fill the space between the well-bore and casing or to the annular space between two continuing casing strings.
Well Cements are typically used for cementing

- exploration and production wells for oil and gas,
- wells for producing groundwater,
- wells for producing geothermal energy,
- wells for underground storages of gas, oil, or even hydrogen,
- wells for capturing CO2 in underground structures.

2.3 Technical Data

Dyckerhoff Well Cement API Class C at Grade O fulfils the requirements of *API Spec 10A*.

Constructional data

API Spec 10A designates several types of oil-well cement. Each class is specified for use in a certain range of well depth, temperature and pressure. *API Spec 10A* also designates three grades of oil-well cement to address sulfate environments.

Name	Value	Unit
Type	Class	C
Sulfate environment class	Grade	O

Performance data of the product with respect to its characteristics in accordance with the relevant technical provision (no CE-marking).

2.4 Delivery status

Cement is a powdery bulk material stored in silos at plant and ready for bulk transport.

2.5 Base materials/Ancillary materials

Clinker: approx. 90 %
Cement clinker is made of a raw material mixture that is added to the cement kiln and sintered at a temperature of 1450 °C. The basic materials for the production of cement clinker consists of calcium oxide (CaO), silicon dioxide (SiO2) and small amounts of aluminum oxide (Al2O3) and iron oxide (Fe2O3). Raw materials that provide these constituents are limestone, chalk and clay or limestone marl as its natural occurring mixture.

Gypsum: approx. 5 %
Gypsum is added as setting regulator.

Limestone/filler: appox. 5 %

This product contains substances listed in *the candidate list* of Substances of Very High Concern for Authorisation (SVHC; date: 25.06.2020) exceeding 0.1 percentage by mass: no
This product contains other carcinogenic, mutagenic, reprotoxic (CMR) substances in categories 1A or 1B which are not on *the candidate list*, exceeding 0.1 percentage by mass: no
Biocide products were added to this construction product or it has been treated with biocide products (this then concerns a treated product as defined by the *Regulation (EU) Ordinance on Biocide Products No. 528/2012*): no

2.6 Manufacture

Clinker is produced from raw materials such as limestone and clay which are crushed, homogenized and fed into a rotary kiln. The raw materials are sintered at a temperature of 1450°C to form new compounds. Clinker consists mainly of calcium, silicon, aluminium- and iron-oxides.

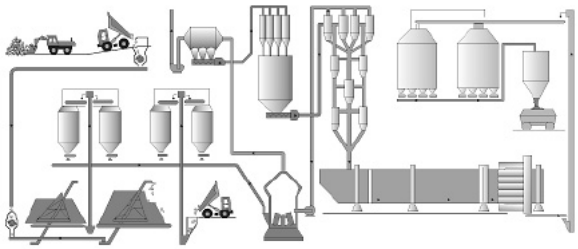

Figure 1: Clinker production

In a second phase, calcium sulphates and possibly additional cementitious or inert materials are added to the clinker. All constituents are ground leading to a fine and homogenous powder. The following figure is a schematic representation of the cement manufacturing process from quarry to dispatch (A1 to A3).

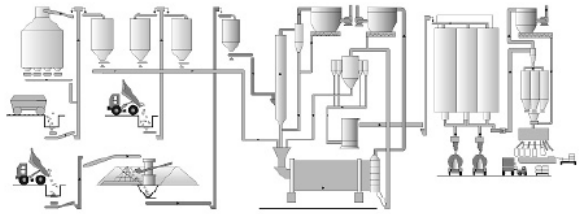

Figure 2: Cement production

2.7 Environment and health during manufacturing

The construction and operation of a cement plant subject to the regulations of the BundesImmissionsschutzgesetzes, *TA Luft*, *17. BImSchV* (combustion of residue) and the *TA Lärm*. In addition, the relevant regulations of the employers' liability insurance association are valid.

With its installed management systems, the site is certified for occupational safety according to *OHSAS 18001*, for energy according to *ISO 50001* and for the environment according to *ISO 14001*.

2.8 Product processing/Installation

Well cements are used directly for their final application and are mixed with water, chemical and mineral additions for forming a pumpable slurry which then is pumped into the borehole for its intended purpose (see 2.2).

2.9 Packaging

Not relevant for this analysis.

2.10 Condition of use

Not relevant for cement.

2.11 Environment and health during use

Important information can be found in the safety data sheet for oil well cement (see 2.16).

2.12 Reference service life

Not relevant for cement.

2.13 Extraordinary effects

Fire
Cement is neither flammable nor explosive.

Fire protection

Name	Value
Building material class	A1

Water
Hardened cement forms a solid mass that does not react with its environment.
Cement must not be released unintentionally in large quantities into the groundwater or sewage system. Exposure possibly may cause an increase of the pH value. At a pH value above 9, ecotoxicological effects may occur. The water discharged into the sewage system or into surface water must therefore not lead to a corresponding pH value. Waste water and Groundwater regulations must be observed.

Mechanical destruction
Not relevant for cement.

2.14 Re-use phase
Not relevant for cement.

2.15 Disposal
If cement must be disposed, it should be cured with water and disposed in accordance with local regulations. The disposal of the hardened product can be carried out depending on the origin according to waste code *AVV* 170101 (concrete) or *AVV* 101314 (concrete waste and concrete cutting slurry). Detailed information can be found in the safety data sheets (see 2.16).

2.16 Further information
https://www.dyckerhoff.com/well-cements/products

3. LCA: Calculation rules

3.1 Declared Unit
The declared unit is 1 metric ton oil well cement.

Declared unit

Name	Value	Unit
Declared unit	1	t
conversion factor [Mass/Declared Unit]	1000	-

3.2 System boundary
Type of EPD: cradle-to-gate

The product stage contains modules A1-A3:
Module A1: Extraction and processing of raw materials.
Module A2: Transport of raw materials to the factory gate and internal transport.
Module A3: Cement production.
The use stage and the disposal stage are not included in the life cycle assessment of cement.

3.3 Estimates and assumptions
No estimates or assumptions were made that would be relevant for the interpretation of the life cycle assessment results.

3.4 Cut-off criteria
When modeling the production of cement, individual material resources were neglected, which make up <0.3% of the total mass. The sum of these neglected resources is less than 0.4% of the total mass of the material resources used for cement production.

3.5 Background data
The total quantities of raw materials and fuels were divided by the annual production quantity in order to calculate the composition of the average Portland cement clinker and cement produced in 2020. This type of averaging ensures that the declared cement is representative.
The GCCA tool for life cycle assessments with the data sets contained therein was used to model cement production. The tool refers to the latest cement and concrete PCRs c-PCR-001 cement and building lime (*EN 16908*) for cement and c-PCR-003 concrete and concrete elements (*EN 16757*) for concrete and prefabricated concrete elements, which are registered in the International EPD System (*Environdec*).Both are registered as additional PCRs to PCR 2019:14 construction products (*EN 15804*).

3.6 Data quality
The life cycle assessment was made using the GCCA Industry EPD Tool for Cement and Concrete Version 3.1 (*GCCA tool*) and is based on data collection of raw materials and fuels for the Lengerich plant that has been checked for plausibility.

3.7 Period under review
Period under review: 01.01.2020 - 31.12.2020

3.8 Allocation
In the process steps considered in the cement clinker production and the production of cement, no by-products are generated.
Allocations within the manufacturing chain of pre-products follow the rules of the *EN 15804* and the PCR documents.
No allocations were made.

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.

The background database *ecoinvent v3.5* was used.

4. LCA: Scenarios and additional technical information

Characteristic product properties
Information on biogenic Carbon
The total amount of materials containing biogenic Carbon is lower tha n 5 % of the total mass.

The development of scenarios must be based on the end product and not on the cement as a pre-product.

5. LCA: Results

Disclaimer:
Eutrophication Potential-freshwater: This indicator has been calculated as “kg P eq” as required in the characterization model (EUTREND model, Struijs et al., 2009b, as implemented in ReCiPe; http://eplca.jrc.ec.europa.eu/LCDN/developerEF.xhtml).

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LCA; ND = MODULE OR INDICATOR NOT DECLARED; MNR = MODULE NOT RELEVANT)

PRODUCT STAGE			CONSTRUCTION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARIES
Raw material supply	Transport	Manufacturing	Transport from the gate to the site	Assembly	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
A1	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
X	X	X	ND	ND	ND	ND	MNR	MNR	MNR	ND	ND	ND	ND	ND	ND	ND

RESULTS OF THE LCA - ENVIRONMENTAL IMPACT according to EN 15804+A2: 1 t API Well Cement Class C

Core Indicator	Unit	A1-A3
Global warming potential - total	[kg CO_2-Eq.]	798.00
Global warming potential - fossil fuels	[kg CO_2-Eq.]	798.00
Global warming potential - biogenic	[kg CO_2-Eq.]	5.07E-2
GWP from land use and land use change	[kg CO_2-Eq.]	4.29E-2
Depletion potential of the stratospheric ozone layer	[kg CFC11-Eq.]	7.77E-6
Acidification potential, accumulated exceedance	[mol H^+-Eq.]	1.08
Eutrophication, fraction of nutrients reaching freshwater end compartment	[kg PO_4-Eq.]	0.13
Eutrophication, fraction of nutrients reaching marine end compartment	[kg N-Eq.]	8.23E-3
Eutrophication, accumulated exceedance	[mol N-Eq.]	3.56
Formation potential of tropospheric ozone photochemical oxidants	[kg NMVOC-Eq.]	0.80
Abiotic depletion potential for non-fossil resources	[kg Sb-Eq.]	2.29E-4
Abiotic depletion potential for fossil resources	[MJ]	1550.00
Water (user) deprivation potential, deprivation-weighted water consumption (WDP)	[m^3 world-Eq deprived]	31.50

RESULTS OF THE LCA - INDICATORS TO DESCRIBE RESOURCE USE according to EN 15804+A2: 1 t API Well Cement Class C

Indicator	Unit	A1-A3
Renewable primary energy as energy carrier	[MJ]	420.00
Renewable primary energy resources as material utilization	[MJ]	0.00
Total use of renewable primary energy resources	[MJ]	420.00
Non-renewable primary energy as energy carrier	[MJ]	1550.00
Non-renewable primary energy as material utilization	[MJ]	0.00
Total use of non-renewable primary energy resources	[MJ]	1550.00
Use of secondary material	[kg]	96.60
Use of renewable secondary fuels	[MJ]	722.00
Use of non-renewable secondary fuels	[MJ]	2310.00
Use of net fresh water	[m^3]	0.79

RESULTS OF THE LCA – WASTE CATEGORIES AND OUTPUT FLOWS according to EN 15804+A2: 1 t API Well Cement Class C

Indicator	Unit	A1-A3
Hazardous waste disposed	[kg]	5.09E-2
Non-hazardous waste disposed	[kg]	3.76E-2
Radioactive waste disposed	[kg]	ND
Components for re-use	[kg]	0.00
Materials for recycling	[kg]	0.00
Materials for energy recovery	[kg]	0.00
Exported electrical energy	[MJ]	0.00
Exported thermal energy	[MJ]	0.00

RESULTS OF THE LCA – additional impact categories according to EN 15804+A2-optional: 1 t API Well Cement Class C

Indicator	Unit	A1-A3
Potential incidence of disease due to PM emissions	[Disease Incidence]	6.49E-6
Potential Human exposure efficiency relative to U235	[kBq U235-Eq.]	1.63E+4
Potential comparative toxic unit for ecosystems	[CTUe]	67.50
Potential comparative toxic unit for humans - cancerogenic	[CTUh]	8.32E-5
Potential comparative toxic unit for humans - not cancerogenic	[CTUh]	3.64E-5
Potential soil quality index	[-]	2620.00

Notes waste categories and output flows: Only waste produced directly in the cement plant during clinker and cement production.

Notes Global warming potential (GWP): 182 kg CO_2eq. from the incineration of waste during clinker production are included. According to the polluter-pays principle under *EN 15804*, these would have to be allocated to the product system that caused the waste. Within this EPD, however, no subtraction of this share is made. This is to ensure the comparability of calculated global warming potentials for cements across national borders, even if the secondary fuels used in clinker production do not have waste status in other countries.

Disclaimer 1 – for the indicator “Potential Human exposure efficiency relative to U235”.This impact category deals mainly with the eventual impact of low dose ionizingradiation on human health of the nuclear fuel cycle. It does not consider effects possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in undergroundfacilities. Potential ionizing radiation from the soil, from radon and some construction materials is also not measured by this indicator.

Disclaimer 2 – for the indicators “abiotic depletion potential for non-fossil resources”, “abiotic depletion potential for fossil resources”, “water (user) deprivation potential, deprivation-weighted water consumption”, “potential comparative toxic unit for ecosystems”, “potential comparative toxic unit for humans – cancerogenic”, “Potential comparative toxic unit for humans - not cancerogenic”, “potential soil quality index”. The results of this environmental impact indicator shall be used with care as theuncertainties on these results are high or as there is limited experience with the indicator.

6. LCA: Interpretation

For the interpretation of the LCA, the manufacturing process is divided into three steps:

- raw material extraction
- clinker production and clinker transport
- cement grinding

These steps are representative of the basic structure of the simulation model and cannot be simply assigned to modules A1 - A3. In the LCA (Section 5), modules A1 - A3, therefore, correspond to the basic structure of the manufacturing process shown above.

The share of non-renewable resources of the fuels used in the production process (**PENRE**) is relatively high. The production of cement is very energy-intensive. Large amounts of thermal and electrical energy are required, which can only be replaced to a very limited extent. Nevertheless, the greatest possible use is made of secondary fuels are used (biomass).

The manufacturing process of the cement production process requires only small amounts of fresh water. Waste materials result from production and maintenance processes as well as administration facilities.

The primary energy consumption (**PE**) and the global warming potential (**GWP**) can be attributed almost exclusively to clinker production. Due to the high clinker content of well cements Class C, the kiln fuels and the deacidification of the limestone have a particular effect. The other indicators are also strongly influenced by the high clinker factor - at least 85 % of the environmental impact results from clinker production.

The indicators formation potential for tropospheric ozone (**POCP**) and potential for the abiotic depletion of non-fossil resources (**ADPE**) are influenced by the cement grinding process.

The extraction of raw materials in the quarry does not have a significant impact on the life cycle assessment. Only small amounts of energy are required for this production step. The extraction of raw materials has a major impact on the indicators land consumption and biodiversity. These indicators were considered only partially in the present LCA study.

7. Requisite evidence

Evidence relating to radioactivity and chromate is described below.

Radioactivity
The radioactivity of cements is currently not routinely measured in Germany. Recent research results from the Bundesamtes für Strahlenschutz (published in the *Strahlenschutzbericht 2012*) show that the activity index for cement, evaluated on the basis of the *96/29/Euratom*, is of the same order of magnitude as the activity index for natural soils and rocks.

Chromate
In accordance with the legal requirements of the Regulation *(EC) 1907/2006 (REACH)* and the *ChemVerbotsV*, cements or cement-containing materials containing more than 2 ppm water-soluble chromate based on the mass of dry cement, may not be placed on the market. This does not apply to cements that are used only in closed and fully automated processes and for which there is no risk of skin contact. The content of water-soluble chromate (VI) is determined according to *EN 196-10* and is below 2 ppm. Verification is provided by the manufacturer as part of the self-monitoring.

8. References

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Cements and Materials for Well Cementing, 25th Edition, 2019.

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Regulation (EU) No 528/2012 of the European parliament and of the council of 22 May 2012, concerning the making available on the market and use of biocidal products (Text with EEA relevance).

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