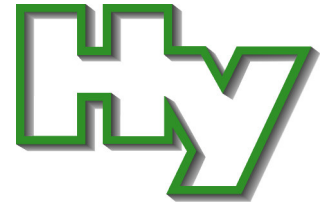


Hygiene-Institut des Ruhrgebiets

Institut für Umwelthygiene und Toxikologie

Direktor: Prof. Dr.rer.nat. Lothar Dunemann

Träger: Verein zur Bekämpfung der Volkskrankheiten im Ruhrkohlengebiet e.V.



HYGIENE-INSTITUT · Postfach 10 12 55 · 45812 Gelsenkirchen

HeidelbergCement
Engineering und Innovation
Zur Anneliese 7
59320 Ennigerloh

Besucher-/Paketanschrift:
Rotthaus Str. 21, 45879 Gelsenkirchen

Zentrale (0209) 9242-0
Durchwahl (0209) 9242-350
Telefax (0209) 9242-333
E-Mail s.bien@hyg.de
Internet www.hyg.de

Unser Zeichen: A-309272-19-Bi_en
Ansprechpartner: Herr Bien

Gelsenkirchen, den 25.02.2019

Page 1 of 3

Building material "ThermoCem® basic"

here: Water hygiene testing and evaluation while taking into account the Technical Rules of LAGA [Working Group of the German Federal States on Waste] No. 20

Your letter dated 26.10.2018; Dr Andreas Märten / Mr Rainer Knaup
and our test report A-234127-13-To dated 06.09.2013

Dear Sir or Madam,

We have tested, as ordered, the sample of a building material called "ThermoCem® basic", sent together with the aforementioned letter, with regard to its composition (substance analysis) in accordance with Table II.1.2-2 of LAGA Notice M20.

Compared with the last testing of this building material in our house (A-234127-13-To), it was to be tested whether the composition was subject to consistent quality and to what extent the results from previous water hygiene tests continued to be transferable.

The results of our tests and assessments apply to the examined test objects and the statutory rules at the time of testing. The accreditation applies to the test procedures listed in the attachment to the accreditation certificate (<http://www.hyg.de>). Examinations which do not fall into the accredited area are marked.



Institute owner: Verein zur Bekämpfung der Volkskrankheiten im Ruhrkohlengebiet e.V., Gelsenkirchen, Association register: VR 519 District court Gelsenkirchen
VAT ID: DE125018356, Board of directors: Prof. Dr. Werner Schlake (chairman), Prof. Dr. Jürgen Kretschmann, Dr. Emanuel Grün, Dr. Dirk Waider, Prof. Dr. Lothar Dunemann

On the basis of the laboratory tests performed, in our view, it can be deduced that the solid characteristics continue to correspond to the product quality of the previous tests. In this sense, we can ascertain transferability also with regard to the resulting water soluble components.

Test results

1. Substance analysis

On the basis of the test results obtained, the nature of building material called "ThermoCem® basic" was largely comparable to that of an anthropogenically unpolluted soil with regard to the ingredients tested by us. The contents of heavy metals and metalloids and the concentrations of the organic ingredients determined, could therefore be classified as unremarkable. By way of derogation from this, the pH value indicated a strong alkaline reaction of the material, as is typical of building materials of similar origin.

2. Eluate analyses

With regard to elutable ingredients and on the basis of the reference values available, it could be expected that these are equally present in largely unremarkable concentrations only.

So far, both briefly after solidification of the test specimen and after a curing period of 28 days (cf. Attachments 4 and 5), no appreciable content of heavy metals including chromium VI and arsenic compounds could be detected in the corresponding aqueous elution solutions. The measured values for electrical conductivity established (EL: 316 μScm^{-1} and 243 μScm^{-1}) were only slightly higher than in case of leaching of anthropogenically unaffected soils.

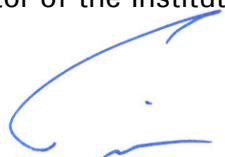
In contrast, the waters are characterized by a significant alkalinity (elution during the curing phase: pH = 10.99, elution after the 28-day curing phase: pH = 10.98), which is mainly due on dissolved alkaline earth metal hydroxides (Calcium hydroxide). This fact is - as already expressed in Section 1 (Substance analysis) - typical for building materials of the origin given here.

Evaluation

By taking into consideration the test results obtained, it was established that building material "ThermoCem® basic" can continue to be considered harmless from a water hygiene point of view. The pH value shift and increase of salinity of any existing ground or surface water expected in the course of construction measures is to be considered temporary only and locally limited only.

With reference to the abovementioned LAGA Guideline No. 20, Tables II 1.2-2 and II 1.2-3, the sample of "ThermoCem® basic" tested by us can be classified under RCL ("recycled building materials") utilisation class Z 0.

Yours faithfully
On behalf of
Director of the Institute



Dipl.-Umweltwiss. Sebastian Bien
Deputy Head of Department of
Waste Water, Soil and Air Hygiene

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Sample from 31.10.2018
 HY-Code A2018-26833

Product "ThermoCem® basic"

here: Examination according Tables II.1.2-2, Techn. Rules LAGA notice „M 20“

Parameter	Sample		Thermo Cem® basic	Allocation values				Examination method
				Z 0	Z 1.1	Z 1.2	Z 2	
Solid analysis								
Water Content	W _c	%	0.70	-	-	-	-	DIN ISO 11465
Dry matter	D _m	%	99.30	-	-	-	-	DIN ISO 11465
pH-value			12.34	5.5 - 8 / -*	5.5 - 8 / -*	5 - 9 / -*	-	DIN ISO 10390
Copper	Cu	mg/kg	20	40	100	200	600	DIN EN ISO 11885
Zinc	Zn	mg/kg	81	120	300	500	1500	DIN EN ISO 11885
Nickel	Ni	mg/kg	11	40	100	200	600	DIN EN ISO 11885
Chromium	Cr	mg/kg	22	50	100	200	600	DIN EN ISO 11885
Cadmium	Cd	mg/kg	0.25	0.6	1	3	10	DIN EN ISO 11885
Mercury	Hg	mg/kg	0.014	0.3	1	3	10	DIN EN 1483
Lead	Pb	mg/kg	9.7	100	200	300	1000	DIN EN ISO 11885
Arsenic	As	mg/kg	2.6	20	30	50	150	DIN EN ISO 11885
Thallium	Tl	mg/kg	< 0.10	0.5 / -*	1 / -*	3 / -*	10 / -*	DIN 38406-E 26
Total cyanide.	CN	mg/kg	0.24	1 / -*	10 / -*	30 / -*	100 / -*	LAGA CN 2/79 / E DIN ISO 17380
Σ Polycycles (US-EPA)**		mg/kg	0.23	1	5 (20)*	15 (50)*	20/75*(100)*	LUA NRW MB 1
thereof: Benzo(a)pyrene		mg/kg	0.02	-	< 0.5	< 1.0	-	
thereof: naphthalene		mg/kg	0.01	-	< 0.5	< 1.0	-	
Hydrocarbons		mg/kg	< 75	100	300	500	1000	E DIN EN 14039
Benzene		mg/kg	< 0.050					
Toluene		mg/kg	< 0.050					
Ethylbenzene		mg/kg	< 0.050					
m + p - Xylone		mg/kg	< 0.050					
o-Xylene		mg/kg	< 0.050					
Σ BTEX		mg/kg	n.d.	< 1 / -*	1 / -*	3 / -*	5 / -*	DIN 38407-F 9.2
Dichloromethane		mg/kg	< 0.050					
trans-1,2-dichloroethene		mg/kg	< 0.050					
1,1-Dichlorethane		mg/kg	< 0.050					
cis-1,2-Dichlorethane		mg/kg	< 0.050					
Trichlormethane		mg/kg	< 0.050					
1,1,1-Trichlorethane		mg/kg	< 0.050					
1,2-Dichlorethane		mg/kg	< 0.050					
Tetrachlormethane		mg/kg	< 0.050					
Trichlorethene		mg/kg	< 0.050					
1,1,2-Trichlorethane		mg/kg	< 0.050					
1,3-Dichloropropane		mg/kg	< 0.050					
Tetrachlorethene		mg/kg	< 0.050					
Σ LHKW		mg/kg	n.d.	< 1 / -*	1 / -*	3 / -*	5 / -*	DIN EN ISO 10301
Extractable organically bound halogens								
EOX		mg/kg	< 1.0	1	3	10 / 5*	15 / 10*	DIN 38414-S 17
Σ Polychlorinated biphenyls***	PCB	mg/kg	n.d.	0.02	0.1	0.5	1	DIN 38414-S 20

Unless otherwise noted, the results of the analysis are related to the undried sample

* Deviating guideline values for recycled building materials/ unprocessed building rubble; in individual cases the mentioned value in the brackets can be deviated

** Limit of determination per substance: ≤ 0.01 mg/kg

*** Sum of PCB 28, 52, 101, 138, 153 180, Limit of determination per substance: ≤ 0.001 mg/kg

n.d. = not detectable

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Sample from 31.10.2018
 HY-Code A2018-26832

Produkt "ThermoCem® basic"

here: Overview analysis according to DIN ISO 22309:2015-11

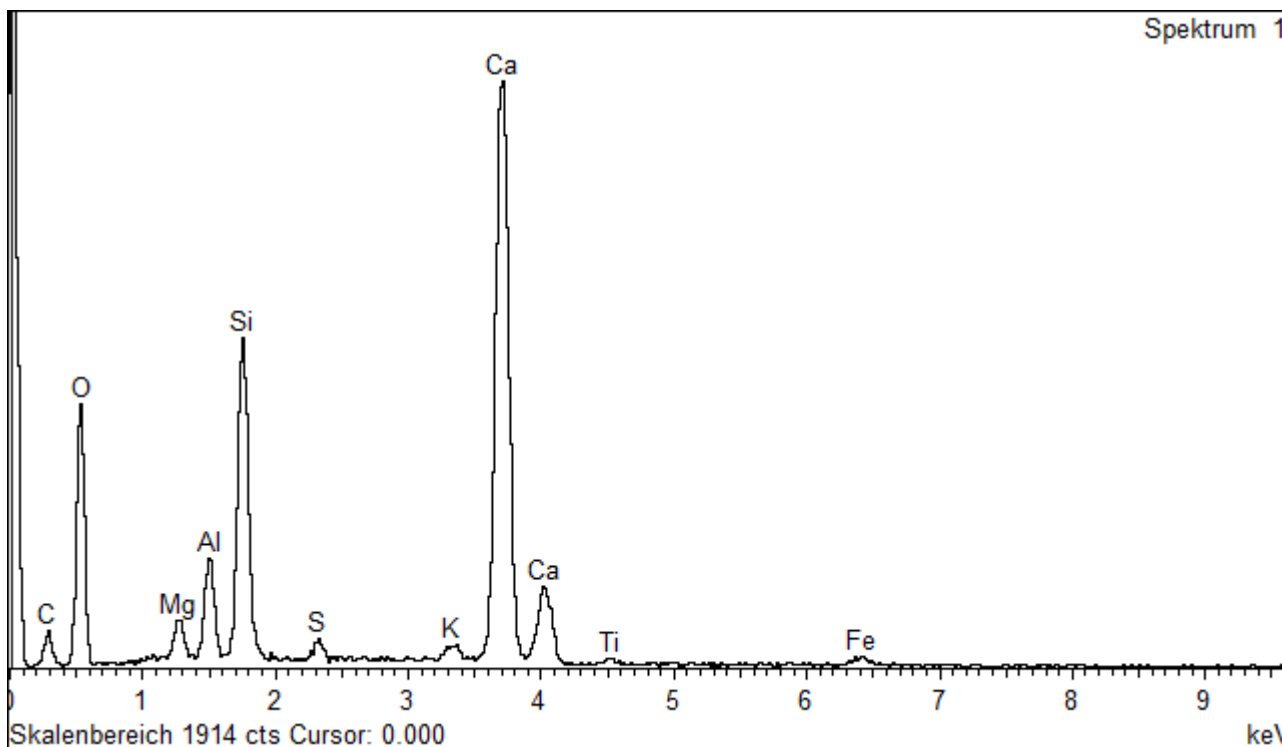
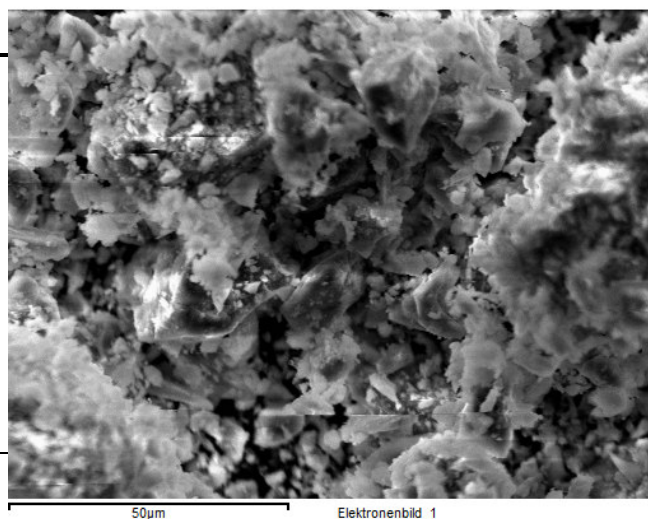
Spectrum processing:

Peaks omitted: 8.015 keV

Processing option: Normalized

Number of Iterations = 5

Element	Mass%	Atom%
C K	3.61	8.60
O K	37.60	67.36
Mg K	0.96	1.13
Al K	1.94	2.06
Si K	6.35	6.48
S K	0.45	0.40
K K	0.38	0.28
Ca K	18.39	13.15
Ti K	0.26	0.16
Fe K	0.74	0.38
Total	70.68	



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Sample from 09.08.2013
 HY-Code A2013-13270

Product "ThermoCem® basic"

here: Examination according Tables II.1.2-2, Techn. Rules LAGA notice „M 20“

Parameter	Sample		Thermo Cem® basic	Allocation values				Examination method
				Z 0	Z 1.1	Z 1.2	Z 2	
Solid analysis								
Water Content	W _c	%	0.45	-	-	-	-	DIN ISO 11465
Dry matter	D _m	%	99.55	-	-	-	-	DIN ISO 11465
pH-value			12.32	5.5 - 8 / -*	5.5 - 8 / -*	5 - 9 / -*	-	DIN ISO 10390
Copper	Cu	mg/kg	22	40	100	200	600	DIN EN ISO 11885
Zinc	Zn	mg/kg	86	120	300	500	1500	DIN EN ISO 11885
Nickel	Ni	mg/kg	11	40	100	200	600	DIN EN ISO 11885
Chromium	Cr	mg/kg	29	50	100	200	600	DIN EN ISO 11885
Cadmium	Cd	mg/kg	0.50	0.6	1	3	10	DIN EN ISO 11885
Mercury	Hg	mg/kg	< 0.1	0.3	1	3	10	DIN EN 1483
Lead	Pb	mg/kg	14	100	200	300	1000	DIN EN ISO 11885
Arsenic	As	mg/kg	< 3.0	20	30	50	150	DIN EN ISO 11885
Thallium	Tl	mg/kg	0.5	0.5 / -*	1 / -*	3 / -*	10 / -*	DIN 38406-E 26
Total cyanide.	CN	mg/kg	< 0.05	1 / -*	10 / -*	30 / -*	100 / -*	LAGA CN 2/79 / E DIN ISO 17380
Σ Polycycles (US-EPA)**		mg/kg	0.03	1	5 (20)*	15 (50)*	20/75*(100)*	LUA NRW MB 1
thereof: Benzo(a)pyrene		mg/kg	< 0.01	-	< 0.5	< 1.0	-	
thereof: naphthalene		mg/kg	< 0.01	-	< 0.5	< 1.0	-	
Hydrocarbons		mg/kg	< 75	100	300	500	1000	E DIN EN 14039
Benzene		mg/kg	< 0.050					
Toluene		mg/kg	< 0.050					
Ethylbenzene		mg/kg	< 0.050					
m + p - Xylone		mg/kg	< 0.050					
o-Xylene		mg/kg	< 0.050					
Σ BTEX		mg/kg	n.d.	< 1 / -*	1 / -*	3 / -*	5 / -*	DIN 38407-F 9.2
Dichloromethane		mg/kg	< 0.250					
trans-1,2-dichloroethene		mg/kg	< 0.250					
1,1-Dichlorethane		mg/kg	< 0.050					
cis-1,2-Dichlorethane		mg/kg	< 0.250					
Trichlormethane		mg/kg	< 0.005					
1,1,1-Trichlorethane		mg/kg	< 0.005					
1,2-Dichlorethane		mg/kg	< 0.050					
Tetrachlormethane		mg/kg	< 0.005					
Trichlorethane		mg/kg	< 0.005					
1,1,2-Trichlorethane		mg/kg	< 0.005					
1,3-Dichloropropane		mg/kg	< 0.050					
Tetrachlorethane		mg/kg	< 0.005					
Σ LHKW		mg/kg	n.d.	< 1 / -*	1 / -*	3 / -*	5 / -*	DIN EN ISO 10301
Extractable organically bound halogens								
EOX		mg/kg	< 1.0	1	3	10 / 5*	15 / 10*	DIN 38414-S 17
Σ Polychlorinated biphenyls***	PCB	mg/kg	n.d.	0.02	0.1	0.5	1	DIN 38414-S 20

Unless otherwise noted, the results of the analysis are related to the undried sample

* Deviating guideline values for recycled building materials/ unprocessed building rubble; in individual cases the mentioned value in the brackets can be deviated

** Limit of determination per substance: ≤ 0.01 mg/kg

*** Sum of PCB 28, 52, 101, 138, 153 180, Limit of determination per substance: ≤ 0.001 mg/kg

n.d. = not detectable

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Sample from 09.08.2013
 HY-Code A2013-13273

Product "ThermoCem® basic"

hier: Examination according to Tables II.1.2-3, Techn. Rules LAGA Notice „M 20“

Parameter	Sample	„Eluate during curing period“	Zuordnungswert				Examination method
			Z 0	Z 1.1	Z 1.2	Z 2	
<i>Elutriate analysis (DIN 38 414 - S 4)</i>							
Colour		colourless					
Odour		free					
pH-Value		10.99	6.5 – 9 7.0 – 12.5*	6.5 – 9 7.0 – 12.5*	6 – 12 7.0 – 12.5*	5.5 – 12 7.0 – 12.5*	DIN 38404-C 5
Electr. conductivity	μScm^{-1}	316	500	500 / 1500*	1000 / 2500*	1500 / 3000*	DIN EN 27888
Chloride	Cl ⁻ mg/l	< 5.0	10	10 / 20*	20 / 40*	30 / 150*	DIN EN ISO 10304-2
Sulphate	SO ₄ ²⁻ mg/l	< 5.0	50	50 / 150*	100 / 300*	150 / 600*	DIN EN ISO 10304-2
Total Cyanide	CN ⁻ mg/l	< 0.01	< 0.01 / -*	0.01 / -*	0.05 / -*	0.10** / -*	DIN EN ISO 14403 / DIN 38405-13
Cyanide, l.fr.	CN ⁻ mg/l	< 0.01	-	-	-	< 0.05** / -*	DIN EN ISO 14403 / DIN 38405-13
Copper	Cu mg/l	< 0.001	0.05	0.05	0.15	0.30 / 0.200*	DIN EN ISO 11885
Zinc	Zn mg/l	< 0.005	0.10	0.10	0.30	0.60 / 0.40*	DIN EN ISO 11885
Nickel	Ni mg/l	< 0.001	0.04	0.05	0.15 / 0.10*	0.20 / 0.10*	DIN EN ISO 11885
Chromium	Cr mg/l	< 0.001	0.015	0.03	0.075	0.15 / 0.10*	DIN EN ISO 11885
Cadmium	Cd mg/l	< 0.0001	0.002	0.002	0.005	0.010/0.005*	DIN EN ISO 11885
Mercury	Hg mg/l	< 0.0002	0.0002	0.0002	0.0010	0.0020	DIN EN 1483
Lead	Pb mg/l	< 0.001	0.02	0.04	0.10	0.20 / 0.10*	DIN EN ISO 11885
Arsenic	As mg/l	< 0.001	0.010	0.010	0.040	0.060/0.050*	DIN EN ISO 11969
Thallium	Tl mg/l	< 0.001	< 0.001	0.001	0.003	0.005	DIN 38406-E 26
Phenol index	mg/l	< 0.010	< 0.010	0.010	0.050	0.100	DIN EN ISO 14402 / DIN 38409-H 16 DIN 38405-D 24
Chrom VI	Cr ⁶⁺ mg/l	< 0.005	--	--	--	--	
Total organic carbon (TOC)	TOC mg/l	2.3	--	--	--	--	DIN EN 13137

* Deviating guideline values for recycled building materials / unprocessed building rubble

** Recovery according to Z 2 permissible, if total CN⁻ concentration > 0.10 mg/l and the CN⁻ l.fr. Concentration < 0.05 mg/l.

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Sample from 21.08.2013
 HY-Code A2013-14127

Product "ThermoCem® basic"

here: Examination according to Tables II.1.2-3, Techn. Rules LAGA Notice „M 20“

Parameter	Probe	„Eluate after 28 days of curing period“	Allocation values				Examination-method
			Z 0	Z 1.1	Z 1.2	Z 2	
Eluatanalyse (DIN 38 414 - S 4)							
Colour		colourless					
Odour		free					
pH-value		10.98	6.5 – 9 7.0 – 12.5*	6.5 – 9 7.0 - 12.5*	6 – 12 7.0 - 12.5*	5.5 – 12 7.0 - 12.5*	DIN 38404-C 5
Electr. conductivity	μScm^{-1}	243	500	500 / 1500*	1000 / 2500*	1500 / 3000*	DIN EN 27888
Chloride	Cl ⁻ mg/l	< 5.0	10	10 / 20*	20 / 40*	30 / 150*	DIN EN ISO 10304-2
Sulphate	SO ₄ ²⁻ mg/l	5.0	50	50 / 150*	100 / 300*	150 / 600*	DIN EN ISO 10304-2
Total Cyanide.	CN ⁻ mg/l	< 0.01	< 0.01 / -*	0.01 / -*	0.05 / -*	0.10** / -*	DIN EN ISO 14403 / DIN 38405-13
Cyanid. l.fr.	CN ⁻ mg/l	< 0.01	-	-	-	< 0.05** / -*	DIN EN ISO 14403 / DIN 38405-13
Copper	Cu mg/l	< 0.001	0.05	0.05	0.15	0.30 / 0.200*	DIN EN ISO 11885
Zinc	Zn mg/l	< 0.005	0.10	0.10	0.30	0.60 / 0.40*	DIN EN ISO 11885
Nickel	Ni mg/l	< 0.001	0.04	0.05	0.15 / 0.10*	0.20 / 0.10*	DIN EN ISO 11885
Chromium	Cr mg/l	< 0.001	0.015	0.03	0.075	0.15 / 0.10*	DIN EN ISO 11885
Cadmium	Cd mg/l	< 0.0001	0.002	0.002	0.005	0.010/0.005*	DIN EN ISO 11885
Mercury	Hg mg/l	< 0.0002	0.0002	0.0002	0.0010	0.0020	DIN EN 1483
Lead	Pb mg/l	< 0.001	0.02	0.04	0.10	0.20 / 0.10*	DIN EN ISO 11885
Arsenic	As mg/l	< 0.001	0.010	0.010	0.040	0.060/0.050*	DIN EN ISO 11969
Thallium	Tl mg/l	< 0.001	< 0.001	0.001	0.003	0.005	DIN 38406-E 26
Phenol index	mg/l	< 0.010	< 0.010	0.010	0.050	0.100	DIN EN ISO 14402 / DIN 38409-H 16
Chrom VI	Cr ⁶⁺ mg/l	< 0.005	--	--	--	--	DIN 38405-D 24
Total organic carbon (TOC)	TOC mg/l	1.5	--	--	--	--	DIN EN 13137

* Deviating guideline values for recycled building materials / unprocessed building rubble

** Recovery according to Z 2 permissible, if total CN⁻ concentration > 0.10 mg/l and the CN⁻ l.fr. Concentration < 0.05 mg/l.

Examination methods "LAGA 2003"

Parameter	Method
Water content	DIN ISO 11465 (12-1996)
Dry residue	DIN ISO 11465 (12-1996)
pH-Value	DIN EN ISO 10523 (C5) (04-2012)
Aqua regia extraction	DIN EN 13346 (S 7a) (04-2001)
Copper	DIN EN ISO 17294-2 (E 29) (01-2017)
Zinc	DIN EN ISO 17294-2 (E 29) (01-2017)
Nickel	DIN EN ISO 17294-2 (E 29) (01-2017)
Chromium	DIN EN ISO 17294-2 (E 29) (01-2017)
Cadmium	DIN EN ISO 17294-2 (E 29) (01-2017)
Mercury	DIN EN ISO 12846 (E 12) (08-2012)
Lead	DIN EN ISO 17294-2 (E 29) (01-2017)
Arsenic	DIN EN ISO 17294-2 (E 29) (01-2017)
Thallium	DIN EN ISO 17294-2 (E 29) (01-2017)
Total Cyanide	DIN EN ISO 14403-2 (D3) (07-2002) / LAGA CN 2/79 (12-1983)
∑ Polycycles (US-EPA) Hydrocarbons	DIN ISO 18287 (05-2006) DIN EN 14039 (01-2005) i.V. mit LAGA – Richtlinie KW/04 (12-2009)
∑ BTEX	DIN EN ISO 22155 (07-2006)/ Handbuch d. Altlasten HLOG 7, Teil 4 (08-2000)
∑ LHKW	Handbuch d. Altlasten HLOG 7, Teil 4 (08-2000)
Extractable organically bound halogens	DIN 38414-S 17 (11-1989)
∑ polychlorinated biphenyls	DIN 38414 - S 20 (01-1996) / DIN EN 15308 (05-2008)
Leachability by water	DIN 38 414 - S4 (10-1984)
Colour	organoleptic
Odour	organoleptic
Electr. conductivity	DIN EN 27888 (11-1993)
Chloride	DIN EN ISO 10304-1 (D 20) (07-2009)
Sulphate	DIN EN ISO 10304-1 (D 20) (07-2009)
Total Cyanide	DIN EN ISO 14403-2 (D3) (07-2002)
Cyanide, l.fr.	DIN EN ISO 14403-2 (D3) (07-2002)
Phenol index	DIN EN ISO 14402 (12-1999) / DIN 38409 H 16 (06-1984)