

1.11112.0001

Kompaktlabor für die Bauindustrie

zur Untersuchung von betonangreifendem Wasser

Compact Laboratory for the construction industry

for the investigation of concrete-aggressive water



MERCK

1.11112.0001 Aquamerck® Compact Laboratory for the construction industry

for the investigation of concrete-aggressive water

Reagent kit with waterproof colour cards, reagents, test strips and complete set of accessories for the determination of:

Odour (H₂S): 100 tests

Lime-dissolving carbonic acid (lime-dissolving capacity): 50 tests

pH: 200 tests

Total hardness: 50 tests at 12.5 °e

Carbonate hardness: 50 tests at 12.5 °e

Chloride: 70 tests at 200 mg/l Cl⁻

Magnesium: 50 tests

Ammonium: 100 tests

Sulfate: 100 tests

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1. General

Concrete, while being a reliable and generally durable building material, is susceptible to attack by certain types of water, which impair its otherwise excellent properties.

Such water is said to be aggressive and may be found as ground, bog, spring, river or waste water. Aggressive water can generally be recognized by its dark coloration, by a putrid odour, by precipitation of salts, or by the presence of rising gas bubbles. It is important to realize, however, that concrete is also attacked by water which at first sight may appear to be pure.

DIN 4030 “Beurteilung betonangreifender Wässer, Böden und Gase” (= “Evaluation of water, soils and gases aggressive to concrete”) quotes lime-dissolving capacity (lime-dissolving carbonic acid), pH, chloride, magnesium, ammonium, and sulfate as factors which influence the severity of attack. All of these parameters can be measured using this Compact Laboratory for the construction industry.

The values set by DIN 4030 for the various degrees of attack are listed below:

Aggressive components	Degree of attack	Degree of attack		
		slight	severe	very severe
Lime-dissolving carbonic acid (CO ₂) (marble test acc. to Heyer)	in mg/l	15 – 40	40 – 100	above 100
Acids	pH	6.5 – 5.5	5.5 – 4.5	below 4,5
Magnesium (Mg ²⁺)	in mg/l	300 – 1000	1000 – 3000	above 3000
Ammonium (NH ₄ ⁺)	in mg/l	15 – 30	30 – 60	above 60
Sulfate (SO ₄ ²⁻)	in mg/l	200 – 600	600 – 3000	above 3000

Chloride (Cl⁻) does not attack concrete at concentrations under 500 mg/l.

Assign the results obtained to the various columns in the table above. The initial assessment of severity is governed by the highest column under which any single value falls. However, if two or more results are close to the upper borderline between one column and the next highest (or the lower borderline in the case of pH), the degree of attack is taken as being one step more severe. The figures listed in the table are for “normal conditions”. Aggressivity may be more severe, for instance, at higher water temperatures, or less severe, as when only small quantities of substance are encountered.

Natural waters of very low total hardness (less than 3°d or 0.5 mmol/l) and waters containing hydrogen sulfide, sulfite or organic constituents may have a slight corrosive capacity.

Sulfate resistant cement is required in cases where the sulfate content is greater than 400 mg/l (use HS cement as defined in DIN 1164). DIN 1045 lists further

measures to be considered when mixing concrete which is expected to withstand a high degree of chemical attack.

The Aquamerck® Compact Laboratory for the construction industry for the investigation of concrete-aggressive water is intended to facilitate rapid, semi-quantitative, on-site testing in accordance with DIN 4030. If all values measured are well below the minimum level for slight attack (or above it in the case of pH and total hardness), the water may be considered safe. If, however, the results obtained give reason to fear corrosion, final judgment should be reserved until formal quantitative analysis has been conducted in a chemical laboratory. Also, it is important to consult a specialist if hydrogen sulfide is present (smell of bad eggs, sometimes not noted until the water is acidified with phosphoric acid), or if there is reason to suspect the presence of appreciable amounts of organic constituents.

The Compact Laboratory contains all the reagents and accessories needed to perform the tests, together with printed instructions, in a sturdy plastic case. The tests are simple to perform.

2. Odour

Method of determination:

Hydrogen sulfide may be given off when a water sample is acidified with phosphoric acid. It has a characteristic odour of bad eggs.

Instructions for use:

For this test, please use the following reagent:
Phosphoric acid: "1.11112., Phosphorsäure"

1. Rinse the test vessel with the water to be tested and fill to the 5-ml mark.
2. Add **5 drops of phosphoric acid** and swirl cautiously.
3. Check the odour of the sample before and after adding acid.

Note:

A qualitative test can be performed using lead(II) acetate paper, Cat. No. 1.09511.0001, or a semi-quantitative test using the Microquant® Sulfide Test (former designation: Microquant® Hydrogen Sulfide Test), Cat. No. 1.14777.0001.

3. Lime-dissolving carbonic acid (lime-dissolving capacity)

Method of determination:

Calcium carbonate added to the water dissolves to form hydrogen carbonate at a rate proportional to the amount of lime-dissolving carbonic acid (aggressive

carbon dioxide) present in the water. This causes the carbonate hardness to rise. Undissolved calcium carbonate is then removed, after which the lime-dissolving capacity and, respectively, the content of lime-dissolving carbonic acid can be calculated from the rise in carbonate hardness.

Instructions for use:

For this test, please use the following reagents:

„1.11130., Kohlensäure (kalklösend)-Test“:

Calcium carbonate: „Reagenz 1, Calciumcarbonat“

Indicator solution: „Reagenz 2, Indikatorlösung“

Titration solution: „Reagenz 3, Titrierlösung“

1. Rinse the glass bottle with the water to be tested and fill to the brim.
2. Add **1 level spoonful of calcium carbonate** and close the bottle with the tapered glass stopper, ensuring that no air bubbles are entrained.
3. Shake the glass bottle until the calcium carbonate is evenly distributed and set aside for **5 min.** (Keep the temperature constant by suspending or standing the bottle in the water to be tested and occasionally shake the bottle.)
4. Filter off any undissolved calcium carbonate and discard the first few millilitres of filtrate.
5. Rinse the test vessel with a few millilitres of the filtrate, then fill to the 5-ml mark.



6. Add **3 drops of indicator solution** and shake thoroughly.
7. With shaking add **titration solution** dropwise (hold the dropping bottle **vertically**). **Count the number of drops needed (A)** to turn the solution from **blue** to **red**.
8. Multiply the original carbonate hardness (B) by 1.8 and subtract the result from the number of drops counted (A). Multiply this difference by 5.6 to give the lime-dissolving capacity (C) in mg/l CaO:

$$C = 5.6 (A - 1.8 B)$$

Regard any **negative value** obtained as **zero**.

For the description of the long-term behaviour of concrete in aggressive waters, the concentration of lime-dissolving carbonic acid in mg/l CO₂ is often cited instead of the lime-dissolving capacity (C) in mg/l CaO. For this purpose, the value obtained for C must be multiplied by the factor 1.5696:

$$\text{Concentration of lime-dissolving carbonic acid in mg/l CO}_2 = C \times 1.5696$$

Notes:

If the sample has already been stabilized with calcium carbonate, start the determination at point 4 above.

Determination of carbonate hardness (B) see Chapter 6.

4. pH

Method of determination:

An indicator added to the water sample changes colour according to the pH of the sample. By matching the colour against a scale the pH can be rapidly and accurately measured.

Instructions for use:

For the pH Test, please use the following reagent as indicator solution:
 “1.08038. · 1.08043. · 1.11137., Reagenz, Indikatorlösung”

1. Rinse the test vessel with the water to be tested and fill to the 5-ml mark.
2. Add **3 drops of indicator solution** and shake thoroughly.
3. Place the test vessel on the white strip of the pH colour scale and slide along until the colour of the solution matches a colour on the colour scale or is intermediate between two colours. In doing so, view the solution from above.
4. Record the pH.

5. Total hardness (sum of alkaline earth ions)

Method of determination:

An indicator is added to the water sample and Titrplex® III (EDTA) solution is added dropwise to produce a colour change. The Titrplex® III solution has been adjusted so that 1 drop corresponds to exactly 1 °d or, in other words, the number of drops used is directly equivalent to the total hardness in German degrees of hardness.

Instructions for use:

For the Total Hardness Test (“Gesamthärte-Test”), please use the following reagents:

Indicator solution: “1.11104., Reagenz 1, Indikatorlösung”

Titration solution: “1.11104., Reagenz 2, Titrierlösung”

1. Rinse the test vessel with the water to be tested and fill to the 5-ml mark.
2. Add **3 drops of indicator solution** and swirl cautiously. The sample turns **red** in the presence of hardening constituents.
3. While swirling, add 1 drop of titration solution every 5 sec (hold the dropping bottle **vertically**) until the colour of the water sample changes to **green**. **Count the number of drops.**

1 drop $\hat{=}$ 1 °d = 1.25 °e = 10 mg/l CaO = 17.8 mg/l CaCO₃
= 0.18 mmol/l alkaline earth ions

6. Carbonate hardness

Method of determination:

An indicator is added to the water sample and a hydrochloric acid solution is added dropwise to produce a colour change. The hydrochloric acid solution has been adjusted so that 1 drop corresponds to exactly 1 °d or, in other words, the number of drops used is directly equivalent to the carbonate hardness in German degrees of hardness.

Instructions for use:

For the Carbonate Hardness Test (“Carbonathärte-Test”), please use the following reagents:

Indicator solution: “1.11103., Reagenz 1, Indikatorlösung”

Titration solution: “1.11103., Reagenz 2, Titrierlösung”

1. Rinse the test vessel with the water to be tested and fill to the 5-ml mark.

2. Add **3 drops of indicator solution** and swirl cautiously. The sample turns **blue** in the presence of hardening constituents.
3. Add **titration solution** dropwise from the dropping bottle to turn the sample from blue to **red**. Hold the dropping bottle **vertically** and swirl the test vessel cautiously after each drop added. **Count the number of drops.**

$$1 \text{ drop} \hat{=} 1 \text{ }^\circ\text{d} = 1.25 \text{ }^\circ\text{e}$$

7. Chloride

Method of determination:

The chloride ion concentration is determined by mercurimetric titration with mercury(II) nitrate.

Mercury(II) ions react with chloride ions to form practically undissociated mercury(II) chloride. Excess mercury(II) ions form a blue-violet complex with diphenylcarbazone indicator in a solution acidified with nitric acid.

Instructions for use:

For the Chloride Test (“Chlorid-Test”), please use the following reagents:

Indicator solution: “1.11132., Reagenz 1, Indikatorlösung”

Reagent 2: “1.11106. · 1.11132., Reagenz 2”

Titration solution: “1.11132., Reagenz 3, Titrierlösung”

1. Rinse the test vessel with the water to be tested and fill to the 5-ml mark.
2. Add **2 drops of indicator solution** and shake thoroughly. This generally causes the solution to turn **blue**.
3. With further shaking add **reagent 2** dropwise to turn the solution **yellow**.
4. Add **titration solution** dropwise from the dropping bottle to turn the sample from yellow to **violet**. Hold the dropping bottle **vertically** and swirl the test vessel cautiously after each drop added. **Count the number of drops.**

$$1 \text{ drop} \hat{=} 25 \text{ mg/l Cl}^-$$

8. Magnesium

Method of determination:

Magnesium ions form a red dye with the Mann and Yoe reagent. Since the reagent is very sensitive, the sample must be diluted twice with buffer solution.

Instructions for use:

For the Magnesium Test, please use the following reagents:

Buffer solution: "1.11131., Mg-1, Pufferlösung"

Reagent solution: "1.11131., Mg-2, Reagenzlösung"

1. Use the dropping pipette to transfer **1 drop of water sample** to the test vessel.
2. Add **9 drops of buffer solution** and mix thoroughly.
3. Use the second dropping pipette to transfer **2 drops** of this solution to a second test vessel.
4. Fill the latter vessel to the 5-ml mark with **buffer solution**.
5. Add **10 drops of reagent solution** and shake.
6. Place the test vessel on the white strip of the magnesium colour scale and slide along until the colour of the measurement solution matches a colour on the colour scale or is intermediate between two colours. (In doing so, view the solution from above.)
7. Record the magnesium content in mg/l.

9. Ammonium

Method of determination:

Nessler's reagent contained in the reaction zone of the test strip turns yellow or brown when immersed in a solution containing ammonia or ammonium ions.

Instructions for use:

For the Ammonium Test, please use the following reagent in addition to the test strips:

"1.10024., Reagenz"

1. Rinse the test vessel with the water to be tested and fill to the 5-ml mark.
2. Add **10 drops of reagent** and shake thoroughly.
3. Immerse the reaction zone of a test strip in the solution for 1 sec.
4. Remove the test strip and shake off excess liquid.
5. After 10 sec compare the reaction zone with the colour scale.

10. Sulfate

Method of determination:

The four reaction zones on the strip contain different amounts of the red thorin-barium complex. Depending on the amount of sulfate ions present, the colour changes to that of the yellow thorin.

Instructions for use:

1. Immerse a test strip in the sample solution (not running water) for 1 sec, so that all reaction zones are completely wetted.
2. Withdraw the test strip, shake off excess liquid, wait 2 min, and then compare the reaction zones with the colour scale.

Notes:

The pH of the sample solution should be between 4 and 8. Acidic solutions (pH below 4) must be buffered with sodium acetate (Cat. No. 1.06268.), and alkaline solutions (pH greater than 8) with ascorbic acid (Cat. No. 1.00127.).

If the solution under test has a sulfate content just at the upper borderline of a colour-change range, the reaction zone in question remains slightly red at the edges. At higher sulfate concentrations the edges turn yellow, too.

11. Safety precautions

Keep the test kit under lock and key and out of reach of children. Keep the test kit away from food. Do not eat or smoke when performing the tests. Avoid contact with skin and eyes.

12. Refill packs

- 1.11130.0001 **Aquamerck® Carbonic Acid (lime-dissolving) Test**
Reagent kit with dropping bottles and complete accessories
for 50 tests
- 1.11137.0001 **Aquamerck® pH Test**
Reagent kit with colour card
for 200 tests
- 1.11104.0001 **Aquamerck® Total Hardness Test (sum of alkaline earth ions)**
Reagent kit with dropping bottle
for 50 tests at 12.5 °e
- 1.11103.0001 **Aquamerck® Carbonate Hardness Test**
Reagent kit with dropping bottle
for 50 tests at 12.5 °e
- 1.11132.0001 **Aquamerck® Chloride Test**
Reagent kit with dropping bottle
for 70 tests at 200 mg/l Cl⁻
- 1.11131.0001 **Aquamerck® Magnesium Test**
Reagent kit with colour card
for 50 tests
- 1.10024.0001 **Merckoquant® Ammonium Test**
for 100 tests
- 1.10019.0001 **Merckoquant® Sulfate Test**
Pack containing 100 strips

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