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MQuant®

Total Hardness Test

1. Definition

The hardness (total hardness) of a given water is due to its content of salts of the alkaline earth metals calcium, magnesium, strontium, and barium ("hardening constituents"). Since strontium and barium are generally present in waters only in traces, the hardness is defined as the content in a water of calcium ions, Ca^{2+} , and magnesium ions, Mg^{2+} ("hardness ions"). The conventional procedure is to relate the statement of the water hardness only to calcium, in other words to express also the content of magnesium ions as calcium content.

The units for the water hardness relate to calcium or its compounds CaO ($1^\circ\text{d} \triangleq 10 \text{ mg/l CaO}$) or CaCO_3 ($1^\circ\text{e} \triangleq 14.25 \text{ mg/l CaCO}_3$; $1^\circ\text{f} \triangleq 10 \text{ mg/l CaCO}_3$), with the magnesium content being expressed as calcium content and included in the calculation accordingly.

2. Method

Titrimetric determination with dropping bottle

Calcium and magnesium ions react with an indicator to form a red complex compound. The indicator is released from this compound by titration with a solution of ethylenedinitrilotetraacetic acid disodium salt dihydrate (Titriplex® III). At the titration end-point the color changes to green. The total hardness is determined from the consumption of titration solution.

3. Measuring range and number of determinations

Graduation ¹⁾	Number of determinations ²⁾
1 drop \triangleq 1.25 °e 17.8 mg/l CaCO_3	100 at 12.5 °e at 180 mg/l CaCO_3

¹⁾ for conversion factors see section 9

²⁾ In the case of total hardness values exceeding 12.5 °e, the maximum number of determinations possible is fewer than 100 (see section 11).

4. Applications

Sample material:

Groundwater, surface water, and seawater
Waters from aquaculture
Drinking water and mineral water
Swimming-pool water
Boiler water

5. Influence of foreign substances

Cadmium, cobalt, copper, iron, mercury, nickel, and zinc interfere with the determination.

6. Reagents and auxiliaries

The test reagents are stable up to the date stated on the pack when stored closed at +15 to +25 °C.

Package contents:

1 bottle of reagent H-1 (indicator solution)
2 bottles of reagent H-2 (titration solution)
1 graduated 5-ml plastic syringe
1 test vessel
1 card with brief instruction

Other reagents:

MQuant® Universal indicator strips pH 0 - 14, Cat. No. 109535
Sodium hydroxide solution 1 mol/l Titripur®, Cat. No. 109137
Hydrochloric acid 1 mol/l Titripur®, Cat. No. 109057
Calcium chloride dihydrate for analysis EMSURE®, Cat. No. 102382

7. Preparation

The pH must be within the range 6 - 8.

Adjust, if necessary, with sodium hydroxide solution or hydrochloric acid.

8. Procedure

Rinse the test vessel several times with the pretreated sample.

Pretreated sample (15 - 30 °C)	5 ml	Inject into the test vessel with the syringe.
Reagent H-1	3 drops ¹⁾	Add and swirl. The sample turns red in color in the presence of hardening constituents.

Holding the reagent bottle **vertically**, **slowly** add reagent H-2 dropwise to the sample **while swirling** until its color changes from **red** via **grey-violet** (shortly before the complete color change) to **green**. Shortly before the color changes, wait a few seconds after adding each drop.

Result in °e = number of drops x 1.25

¹⁾ Hold the bottle vertically while adding the reagent!

Assessment:

Hardness range	mg/l CaCO_3	mmol/l CaCO_3 (Ca)	°e
soft	<150	<1.5	<10.5
moderately hard	150 - 250	1.5 - 2.5	10.5 - 17.5
hard	>250	>2.5	>17.5

9. Conversions

required given	mmol/l CaCO_3 (Ca)	mg/l CaCO_3	mg/l Ca	English degree °e	French degree °f	German degree °d
1 mmol/l CaCO_3 (Ca)	1	100.1	40.08	7.02	10.01	5.61
1 mg/l CaCO_3	0.010	1	0.400	0.070	0.100	0.056
1 mg/l Ca	0.025	2.50	1	0.175	0.250	0.140
1 English degree °e	0.142	14.25	5.71	1	1.43	0.799
1 French degree °f	0.100	10.00	4.00	0.702	1	0.560
1 German degree °d	0.178	17.85	7.15	1.25	1.78	1

10. Method control

To check test reagents and handling:

Dissolve 3.67 g of calcium chloride dihydrate in distilled water, make up to 1000 ml with distilled water, and mix. Ca content: 1000 mg/l (\triangleq 175 °e).

Dilute this standard solution with distilled water to 50 mg/l Ca (\triangleq 8.75 °e) and analyze as described in section 8.

Additional notes see under www.qa-test-kits.com.

11. Notes

- Reclose the reagent bottles immediately after use.
- Rinse the test vessel and the syringe **with distilled water only**.
- In titrimetric determinations the consumption of titration solution is dependent on the concentration of the substance to be determined (here: the hardness ions). The quantities of indicator and titration solution contained in the reagent bottles have been calculated to suffice for 100 determinations each of 12.5 °e. The following applies for softer or harder waters:

Hardness °e	Number of determinations	Indicator solution	Titration solution
1.25 - 12.5	100	is used up completely	A remainder is left over.
>12.5	<100	A remainder is left over.	is not sufficient for 100 determinations

- Information on disposal can be obtained at www.disposal-test-kits.com.

