

1.08047.0001

MColorst<sup>TM</sup>

## 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<sup>2+</sup>, and magnesium ions, Mg<sup>2+</sup> ("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 °d  $\pm$  10 mg/l CaO) or CaCO<sub>3</sub> (1 °e  $\pm$  14.25 mg/l CaCO<sub>3</sub>; 1 °f  $\pm$  10 mg/l CaCO<sub>3</sub>), with the magnesium content being expressed as calcium content and included in the calculation accordingly.

### 2. Method

#### Titrimetric determination with titration pipette

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 (Titrplex<sup>®</sup> 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

Measuring range <sup>1), 2)</sup>	Graduation of the titration pipette	Number of determinations <sup>3)</sup>
0.13 - 7 °e (0.1 - 5.6 °d)	0.13 °e (0.1 °d)	300 at 3.8 °e (3 °d)
1 - 100 mg/l CaCO <sub>3</sub>	1 mg/l CaCO <sub>3</sub>	at 53.5 mg/l CaCO <sub>3</sub>

<sup>1)</sup> with 1 full pipette

<sup>2)</sup> for conversion factors see section 9

<sup>3)</sup> In the case of total hardness values exceeding 3.8 °e, the maximum number of determinations possible is fewer than 300 (see section 11).

### 4. Applications

#### Sample material:

Groundwater and surface water, seawater  
Drinking water and mineral water  
Waters from aquaculture  
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:

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

#### Other reagents:

MColorpHast<sup>TM</sup> Universal indicator strips pH 0 - 14, Cat. No. 109535  
Sodium hydroxide solution 1 mol/l TitrPUR<sup>®</sup>, Cat. No. 109137  
Hydrochloric acid 1 mol/l TitrPUR<sup>®</sup>, Cat. No. 109057  
MQuant<sup>TM</sup> Total Hardness Tests:  
Cat. No. 110025, measuring range <4 - >26 °e or  
Cat. No. 110046, measuring range >6 - >31 °e  
MColorst<sup>TM</sup> Total Hardness Test, Cat. No. 108039,  
measuring range 0.25 - 25 °e (with 1 full pipette)  
Calcium chloride dihydrate for analysis EMSURE<sup>®</sup>, Cat. No. 102382

#### Refill pack:

##### Cat. No. 108040

MColorst<sup>TM</sup> Total Hardness Test,  
Refill pack for 108047

(Reagents **without technical accessories** for 300 determinations at 3.8 °e)

### 7. Preparation

- The pH must be within the range 6 - 8.  
Adjust, if necessary, with sodium hydroxide solution or hydrochloric acid.
- Check the total hardness with the MQuant<sup>TM</sup> Total Hardness Test.  
Samples with a high water hardness should be determined using the MColorst<sup>TM</sup> Total Hardness Test Cat. No. 108039.

### 8. Procedure

#### Determination of total hardness:

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 <sup>1)</sup>	Add and swirl. The sample turns <b>red</b> in color in the presence of hardening constituents.
Place the titration pipette <b>loosely</b> on the open reagent bottle H-2. <b>Slowly</b> withdraw the piston of the titration pipette from the lowest position until the <b>lower</b> edge of the black piston seal is level with the zero mark of the scale. (This fills <b>only the dropping tube</b> with titration solution.)		
Remove the titration pipette and briefly wipe the tip of the dropping tube. Then <b>slowly</b> add the titration solution dropwise to the sample <b>while swirling</b> until its color changes from <b>red</b> via <b>grey-violet</b> (shortly before the complete color change) to <b>green</b> . Shortly before the color changes, wait a few seconds after adding each drop.		
Read off the result in °d or mg/l CaCO <sub>3</sub> from the corresponding scale of the titration pipette at the <b>lower</b> edge of the black piston seal.		

<sup>1)</sup> Hold the bottle vertically while adding the reagent!

#### Notes on the measurement:

- While filling the titration pipette, it must **not** be screwed tightly on the reagent bottle!
- After the analysis inject any titration solution still remaining in the pipette back into reagent bottle H-2 and **close the reagent bottle tightly using the pipette instead of the screw cap**.

#### Determination of residual hardness:

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 <sup>1)</sup>	Add and swirl.
Depending on the residual hardness the measurement solution turns		
	green:	0 °e
	grey-violet:	0,1 °e
	red-violet:	0,6 °e
	red:	>0,6 °e

<sup>1)</sup> Hold the bottle vertically while adding the reagent!

### 9. Conversions

required given	mmol/l CaCO <sub>3</sub> (Ca)	mg/l CaCO <sub>3</sub>	mg/l Ca	English degree °e	French degree °f	German degree °d
1 mmol/l CaCO <sub>3</sub> (Ca)	1	100.1	40.08	7.02	10.01	5.61
1 mg/l CaCO <sub>3</sub>	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, measurement device, 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 ( $\pm$  175 °e). Dilute this standard solution with distilled water to 20 mg/l Ca ( $\pm$  3.5 °e  $\pm$  50 mg/l CaCO<sub>3</sub>) and analyze as described in section 8.  
Additional notes see under [www.qa-test-kits.com](http://www.qa-test-kits.com).

### 11. Notes

- Reclose the reagent bottles immediately after use.
- Store the reagent bottle H-2 (titration solution) **with the titration pipette firmly attached** lying flat in the corresponding depression in the pack.
- 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 300 determinations each of 3.8 °e. The following applies for softer or harder waters:

Hardness °e	Number of determinations	Indicator solution	Titration solution
0.13 - 3.8	300	is used up completely	A remainder is left over.
>3.8	<300	A remainder is left over.	is not sufficient for 300 determinations

- Information on disposal can be obtained at [www.disposal-test-kits.com](http://www.disposal-test-kits.com).

