Coalition Clean Baltic
For protection of the Baltic Sea environment

River monitoring

Manual for public environmental monitoring

APPENDIX 6. Determination of total water hardness

Water hardness is mainly caused by presence of soluble and low soluble mineral salts, mainly of calcium ions (Ca2+) and magnesium ions (Mg2+).

Total hardness can be determined using the TH-1[1] test kit.

Total hardness measurement

Equipment and chemical reagents:

Water bath; scissors, glass stick; 2 ml or 5 ml pipette with rubber bulb (medical syringe) and connecting tube; dropper pipette; flask with 10 ml mark; Distilled water, ammonia buffer; Eriochrome Black T indicator solution; Trilon B solution (0.05 mol/l eqv.).

Procedure:

1. Pour exactly 10 ml of analyte water to the flask.
2. Using the pipette, add 6-7 drops of ammonia buffer and 4-5 drops of Eriochrome Black T indicator solution.
3. Stopper the flask hermetically and shake it up for mixing.
4. Titrate the flask content gradually with Trilon B solution till the color changes from wine red to bright blue at the equivalent point. Shake up the flask from time to time for mixing the sample. Measure the volume of the solution used for titration of total hardness (VTH, ml).
5. Calculate the value of total hardness (STH) in mmol/l eqv. by the formula:

Total hardness (STH) in mmol/l eqv. is calculated by the formula:

$$C_{ож} = \frac{V_{TP} \times H \times 1000}{V_A},$$

where: V_{TR} is the volume of Trilon B used for titration, ml;
H is the concentration of Trilon B titration solution, mol/l eqv.;
VA is the volume of analyte water, ml;
1000 is the ratio for translation of units of measure from mol/l to mmol/l.

For V_A = 10 ml and H = 0.05 mol/l eqv., you can use the formula:

$$C_{TH}=V_{TH}\times 5$$

Note. After the color change, keep the sample for another 0.5 minutes for full completion of the reaction and then make your decision on finishing the titration (the color of the solution may come back partly. In this case, add a few more drops of Trilon B.)

[1] TH-1 test kit is intended for quantitative express- determination of total water hardness (sum of molar concentrations of calcium ions (Ca2+) and magnesium ions (Mg2+) equivalents) in water in field, laboratory, and production industrial conditions (http://www.christmas-plus.ru/portkits/portkitswater/tk02/tkoj1).

Conclusions

The value of water hardness may vary in a broad range depending on the soils and minerals of the water basin, the season, and weather conditions. The hardness goes up because of evaporation and goes down in rainy seasons and snow melting periods. Water from different natural sources has very diverse hardness. River water, with a few exceptions, has relatively low hardness (1-6 mg-eqv/l). At the same time, water of the rivers running through the thickness of lime and gypsum rocks often has very high hardness. High water hardness impairs the organoleptic qualities of water by giving it a bitter flavor.

When analyzing results of water hardness measurement, note that calcium hardness is caused by dilution of limestone and chalk which are present in the watercourse bottom and banks. In areas where dolomite rocks are prevailing, magnesium hardness can be predominant.

A detailed description of the methods of carbonate hardness and alkalinity, calcium and magnesium testing can be found in A.G. Muraviev's Manual for Determination of Water Quality Indexes in Field Conditions.