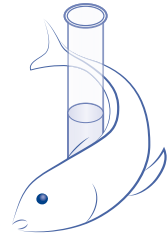


MACHEREY-NAGEL

VISOCOLOR® Fish



- Handbuch
- Manual

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1. Introduction

Through water analysis, keepers of the river as well as laymen can quickly investigate, which chemical parameters (each parameter is important for the overall assessment of a system) deviate strongly from the norm consequently influencing water quality.

After having gained these insights, one can determine the earning capacity of the water as well as its suitability for specific types of fish. Afterwards one can plan stocking, fertilization or quick remediation measures. Also inexperienced users are able to perform the analysis with the help of the *VISOCOLOR® Fish* kits, as each step of the process is accurately described. In the following, easy explanations of the individual analysis values and of the resulting conclusions will assist the user with the analysis and evaluation of fishing water under investigation.

A water sample is perishable, if kept for a longer period of time. Especially under the condition of higher temperatures, biological and chemical processes inside the sample continue to react thereby causing a change of the sample's composition. As a result, it is favorable to perform the analysis at the sampling point. The *VISOCOLOR® Fish* reagent case was especially developed for these requirements. It can be used for the determination of the optimal point in time for stocking new fish tanks.

Furthermore, the reagent case enables the quick analysis of waters e.g. in case of suddenly appearing fish kill, thereby allowing a fast interference. The determinations of the six most important chemical water parameters, which complement the package, make the reagent case an ideal first-aid kit for fishing waters.

Evaluations of the analysis results can be conducted with the help of tables and limits included in this brochure. Beyond that, the measurements enable experienced keepers of the river to initiate the addition of water-improving substances like phosphate fertilizer or calcium carbonate. It is of utmost importance to consider all measurement values in context to each other and in connection with the water's biological circumstances.

Despite the progresses in the field of instrumental analysis, titrimetric and colorimetric analysis techniques continue to be of great, historically based, importance both in the laboratory as well as, and especially, for the mobile on-site analysis. The by now normed and thereby officially acknowledged techniques (according to EN and ISO norms) are adopted for test stripes as well as for colorimetric and photometric analysis. The necessary instruments for these endeavors are assorted in portable cases. Special reagents enable the specific determination of substances in form of colored compounds, whose color intensity increases with concentration.

Kits for water analytic purposes are based on titrimetric as well as colorimetric techniques. Titrimetric determination enables to investigate concentrations by measuring volumes with the help of plastic pipettes or through counting the drops of a dropping bottle. Colorimetric determination is based on the comparison of colors, which develop after having added a reagent into a test vessel, with a collection of standardized colors in order to allocate a concentration and accordingly a concentration range to the substance under investigation. This comparison is carried out with the help of color cards or color pads.

According to the principle of color comparison (in so-called comparators), colored water samples can be analyzed. Inside color comparators there are water samples without a reagent on the colored circle for different concentrations; the others are on circles with the original color of the reagent (the reagent binding solution). The

concentration value is determined if the color impressions in both measuring vessels match.

The length of the measurement glass (which is the layer thickness of the test tube in photometry) determines the sensibility of the procedure. As a result, even compounds at low concentrations can be sufficiently accurately determined.

2. General information

2.1. Refill pack and accessories

Description	REF
Refill pack for <i>VISOCOLOR</i> [®] <i>Fish</i> reagent case including all necessary reagents for ammonium, total hardness, nitrate, nitrite, phosphate and pH	933201
Color chart for <i>VISOCOLOR</i> [®] <i>Fish</i> reagent case	933301
Measuring glasses with screw caps, 10 pcs	931151
Sliding comparator, 2 pcs	931152
Titration test tube with 5 mL marking	915499
Sample beaker 25 mL	914498
Plastic measuring spoon, 10 pcs, 70 mm	914492
Syringe 5 mL	914661
Manual (german / english) for <i>VISOCOLOR</i> [®] <i>Fish</i> reagent case	933151

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2.2. Additional test papers







The case also has room for one pack of pH-Fix and one pack of QUANTOFIX[®] test strips.

pH-Fix test strips are high quality pH test strips. They are non-bleeding and thus prevent sample contamination. The strips are available in many different gradations.

QUANTOFIX[®] test strips are semi-quantitative and can be evaluated using a color scale. There are test strips for a wide variety of parameters available, e.g. ascorbic acid and iron, etc.

For additional information and how to order, please contact your local distributor, check our website (www.mn-net.com) or contact MACHEREY-NAGEL directly.

2.3. Explanation of symbols

 Use by	 Lot number
 Catalog number	 Storage temperature
 Please read instructions	 Observe the safety precautions in instructions

3. Testing procedure

Determinations with *VISOCOLOR® Fish* test kits don't require any previous knowledge and are therefore not only suited for professional use only but also for private persons. Both colorimetric and titrimetric methods are used. Results can be read directly in mg/L or ppm (parts per million, mg/L $\text{\textcircled{4}}$ ppm). Generally accepted exemptions are various degrees of hardness (e.g. °e for english hardness or mmol/L).

3.1. Collection of water samples

To get representative analysis results, the water samples should always be collected directly at the location of interest, e.g. at the inflow, in the middle of the water body to investigate pond or aquarium water or at the outflow.

In every case the sample beakers and measurement glasses should be rinsed thoroughly several times with the water to be investigated prior to the analysis.

Due to ongoing processes converting specific parameters, it is recommended to perform the analysis directly after having collected the sample.

The investigator should firstly note down the removal location, the dates and time of day. From an analytical point of view, the following parameters are of interest for such waters: pH value, total hardness, phosphate, ammonium, nitrate and nitrite. The last two additionally allow for drawing a conclusion about the productivity of the investigated waters. Through monitoring phosphate contents, one is able to detect increased concentrations and therefore treat unwanted algae growth pre-maturely. The concentration of ammonium, nitrite and nitrate and their ratio to each other provide information about the nitrification* in the investigated waters.

3.2. Colorimetric methods

Colorimetric analysis takes advantage of the properties of special reagents, which form colored compounds with the substance in question. The color intensity rises proportionally to the concentration of the sought-for substance.

All colors are then compared to a set of standard colors. Once colors have been assigned or matched, the result can be read directly.

Colorimetric *VISOCOLOR® Fish* test kits use two tubes, which are both filled with the sample. Reagents are only added to one of the tubes (tube B). Once all reagents have been added and the respective reaction time has elapsed, the comparator is moved along the color chart until the colors of tube A and B match (when looking from above through the samples). The result can be read in the gap on the upper side of the comparator.

3.3. Titrimetric methods

There are some substances which are difficult or even impossible to convert into colored, analyzable compounds. In such cases, often titrimetric methods are employed. During such a volumetric analysis, a reagent, which reacts with the sought-for substance, is added dropwise to a define sample volume. As soon as the substance in the sample is entirely converted, adding more drops of titration solution would result in an excess of reagent. This point of completed reaction (equivalent point) is shown by a previously added indicator via a color change.

To use the titrimetric *VISOCOLOR® Fish* test kit, first an indicator is added to 5 mL of the sample. Then the titration reagent is added drop by drop until the sample changes

*Nitrification: definition see Nitrite, page 39

color. The amount of drops necessary to achieve the color change of the indicator represents the amount of the sought-for substance in the water sample.

3.4. Handling of very high concentrations

In certain, but rare, cases, very large amounts of the substance to be determined are dissolved in water. This situation can occur especially during investigations of inflows (waste water). In case the reaction color is darker than the highest color standard, the water sample should be diluted with distilled water until the concentration lies inside the test's measuring range. The dilution must be taken into consideration when interpreting the result.

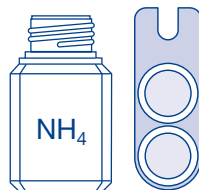
3.5. Disposal

Information regarding disposal can be found in the safety data sheet. You can download the SDS from www.mn-net.com/SDS.

3.6. Safety guidelines

Information regarding safety can be found on the box' label and in the safety data sheet. You can download the SDS from www.mn-net.com/SDS.

4. Ammonium

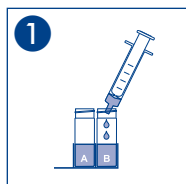


Measuring range

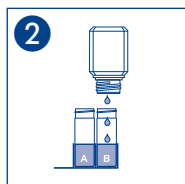
0.2–3 mg/L NH_4^+

Test instructions

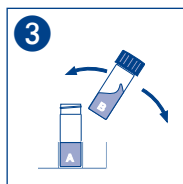
- 1 Fill a **5 mL water sample** into each of the measuring glasses using the plastic syringe. Place a measuring glass on position A in the comparator. Only add the **reagents to measuring glass B**.
- 2 Add **10 drops of NH_4 -1**.
- 3 Seal the glass and mix.
- 4 Add **1 level measuring spoonful of NH_4 -2**.
- 5 Seal the glass and shake the mixture until the powder has dissolved.
- 6 Wait for **5 min**.
- 7 Open the glass, add **4 drops of NH_4 -3**.
- 8 Seal the glass and mix.
- 9 Wait for **7 min**.
- 10 Open the glass, place it in position B of the comparator and slide the comparator along the color scale until the colors match. Check the result in the gap on the upper side of the comparator. Mid-values can be estimated.



2 x 5 mL sample



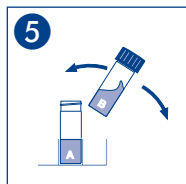
10 NH_4 -1



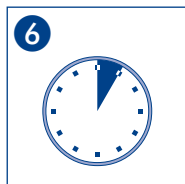
Mix



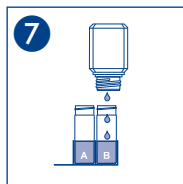
1 NH_4 -2



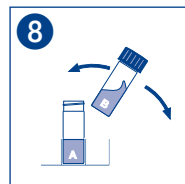
Mix



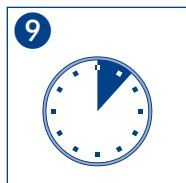
5'00 min



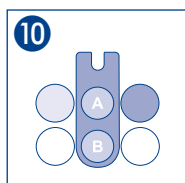
4 NH_4 -3



Mix



7'00 min



Measurement

After use, rinse both measuring glasses thoroughly and seal them.

This method can also be used for analyzing sea water after dilution (1+9).

Background information

In nature, ammonia is formed due to volcanic activity and electrostatic discharge in the upper ranges of the atmosphere from nitrogen and water vapor. Additionally, ammonia is formed during decomposition processes, which means during the mineralization of nitrogen containing plant and animal proteins. Within the mineral kingdom, almost all magmatic rocks contain small amounts of ammonium salts. Large sources of ammonium chloride have been discovered more than 1000 years ago close to smoldering coal deposits. Close to the volcanoes Vesuvius and Mount Etna, ammonium salts can be detected as well. From these different sources, as well as from automobile and industry exhaust fumes, significant amounts of ammonium salts are fed into the soil as nitrogen fertilizer in the form of rainfall.

Both humans and animals excrete ammonia next to urea as nitrogen compounds in their feces. Ammonia is a cytotoxin for higher organisms, which has to be removed as quickly as possible. As metabolic intermediate, it is formed in brain, muscles, liver and kidneys. In the liver, it immediately reacts with carbon dioxide to urea, in the brain it is rendered harmless by conversion to glutamine. In contrast to ammonia, ammonium salts are not toxic.

Ammonium ions can also form as a result of microbial nitrate reduction. As fertilizer run-off or primary decomposition products of organic compounds within municipal waste water, these ions may end up in natural water bodies. Pure water bodies contain less than 0.1 mg/L ammonium ions, in polluted water however, more than 10 mg/L may be detected. Especially in light of hygienic aspects, the ammonium compound content needs to be evaluated critically, as ammonia may form in the decomposition of human or animal feces.

Ammonia is especially toxic to fish (from 0.5 mg/L)* and is present at pH values above 7 due to the pH dependant equilibrium between ammonium ions and ammonia.



During the analysis, one measures the sum of ammonium and ammonia. That is why the pH value has to be determined at the same time in order to be able to evaluate the situation correctly.

At pH 6, the equilibrium almost completely lies on the side of ammonium, at pH 8, already 4 %, at pH 9 25% and at pH 10 even 78 % ammonia are present (at a water temperature of 17 °C, see table).

pH	% Ammonium (NH ₄ ⁺)	% Ammonia (NH ₃)
6	100	0
7	99	1
8	96	4
9	75	25
10	22	78

High ammonium contents also substantially strain the oxygen balance of water bodies. During the bacterial oxidation of ammonium to nitrate, oxygen is consumed.



* 1 mg/L is deadly for most types of fish, but only marks a mean value. It is valid for longer development times at 15 °C. At higher temperatures fish can only tolerate low concentrations, at lower temperatures it can handle higher concentrations. Size and type of fish also have an influence. For fry, already 0.2 mg/L ammonia can be deadly. An ammonia concentration above 0.1 mg/L can harm fish growth.

This process is on the one hand an important step in the self-purification, however, on the other hand it may lead to fish-kill due to the oxygen consumption. The so-called nitrification process transforms ammonium salts via nitrite to nitrate. Nitrate again is used by higher plants in complex biosynthesis steps within their roots and leaves to create essential proteins.

Reaction basis

Monochloramine is derived from ammonium ions as a result of the effect of chlorine in the alkaline range. Combined with thymol, this forms a blue indophenol dye.

Interferences

Primary amines react in the same way as ammonium ions and produce higher results.

Depending on their concentration, substances which consume chlorine may reduce the measurement reading or suppress the reaction totally.

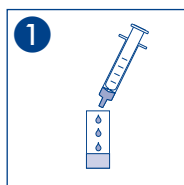
5. Total hardness

Measuring range

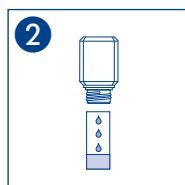
1 drop \triangleq 1.3 °e \triangleq 17.8 mg/L CaCO₃

Test instructions

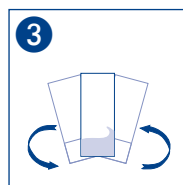
- 1 Fill a **5 mL water sample** into the plastic tube using the plastic syringe.
- 2 Add **2 drops** of **GH-1**.
- 3 Shake gently to mix the contents. The water sample turns **red**. If the water sample turns green, this means that there are no hardness-producing substances.
- 4 Hold the dropping bottle **GH-2** absolutely vertical and add the reagent drop by drop, shaking the specimen at the same time to mix until it turns **green**.
- 5 Count the number of drops. One drop corresponds to 1.3 degree of total water hardness (°e).



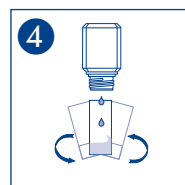
5 mL sample



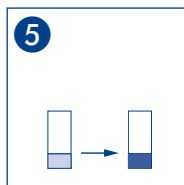
2 GH-1



Shake gently



1 GH-2 until coloration



1 GH-2 \triangleq 1.3 °e
red \rightarrow green

After use, rinse out the plastic tube thoroughly.

Seal the dropping bottles immediately after use. Do not touch the dropping pipettes.

This method can be used also for the analysis of sea water after dilution (1+29).

Background information

The name „hardness“ primarily leads back to the effect of calcium ions to lower the cleaning properties of soap by forming difficult or unsolvable lime soap (calcium salts of higher fatty acids such as palmitic acid). As such hardness components, calcium and magnesium are taken into account together. In natural water bodies, strontium and barium salts can be disregarded due to their very low concentrations (their carbonates and sulfates are hardly soluble).

The sum of calcium and magnesium salts is called *total hardness*. If these alkali earth ions are present as hydrogen carbonates the carbonates precipitate when the water is heated in the form of *limescale*:



Therefore, the water hardness caused by hydrogen carbonates is often referred to as temporary hardness. The salts of other acids (such as hydrochloric or sulfuric acid) remain in solution even when the water is heated. Such hardness is called *permanent hardness* or *sulfate-hardness*.

For fresh-water fish, total hardness should lie between 3.8–25 °e.

Depending on the amount of calcium and magnesium salts, water is classified as hard or soft in different gradations:

Very soft:	0–3.8 °e
Soft:	5–8.8 °e
Medium hard	10–13.8 °e
Fairly hard:	15°e–21.3 °e
Hard:	22.5 – 37.5 °e
Very hard:	more than 37.5 °e

Taken extreme geological conditions into account, generally, water with hardness levels of more than 445 mg/L CaCO₃ (ca. 31.5 °e) are considered to be polluted. Such pollution may for example result due to run-off from landfill sites. Decomposition of plant matter forms carbon dioxide, which seeps away into the ground with rain water. Lime containing soil can thus elute calcium carbonate and calcium hydrogen carbonate (reversal of the limescale equation). Fertilizers may add calcium salts to ground water as well.

Carbonate hardness (see pH value, page 44; interchangeably used with alkalinity) refers to the part of alkaline earth ions present in form of hydrogen carbonate or carbonates. Normally, a proportion of the calcium and magnesium salts are dissolved as sulfates, so that carbonate hardness is always smaller than total hardness. Water bodies are regarded as less fertile, if they contain carbonate hardness with an alkalinity value below 0.5 and as highly fertile with values above 1.5. Water bodies with low acid binding capacity are deficient in lime (acid binding capacity determinable with VISOCOLOR® HE Alkalinity). Very high total hardness together with high alkalinity-values are found in the famous chalk streams in the UK, which are among the best salmonid fishing grounds in the world. In rather acidic water with little calcium carbonate, the fish stock is generally low.

Reaction basis

Complexometric titration

Magnesium and calcium ions, which cause hardness, are combined by the complexing agent EDTA to form chelates. The test is carried out by titration using a metal indicator which changes color when all of the hardness-producing substances have combined (reaction base analog to DIN 38406-3 E3).

Interferences

Copper(II) ions may delay the indicator change or even block this change if higher levels are present. Therefore, in the case of copper pipes, let the water run for a sufficient amount of time before taking the sample.

Conversion table

°d	°e	°f	mg/L CaO	mg/L CaCO ₃	mmol/L CaCO ₃
1	1.3	1.8	10	18	0.18
2	2.5	3.6	20	36	0.36
3	3.8	5.4	30	54	0.54
4	5.0	7.1	40	71	0.71
5	6.3	8.9	50	89	0.89
6	7.5	10.7	60	107	1.07
7	8.8	12.5	70	125	1.25
8	10.0	14.3	80	143	1.43
9	11.3	16.1	90	161	1.61
10	12.5	17.8	100	178	1.78

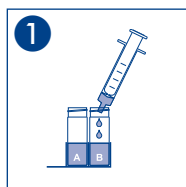
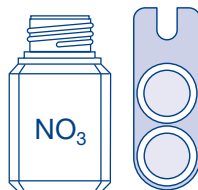
6. Nitrate

Measuring range

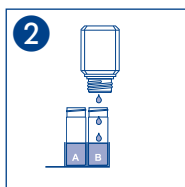
1–90 mg/L NO_3^-

Test instructions

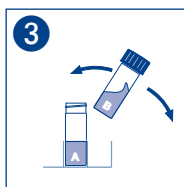
- 1 Fill a **5 mL water sample** into each of the measuring glasses using the plastic syringe. Place a measuring glass on position A in the comparator. Only add the **reagents to measuring glass B**.
- 2 Add **5 drops** of NO_3-1 .
- 3 Seal the glass and mix.
- 4 Add **1 level measuring spoonful** of NO_3-2 .
- 5 Seal the glass and **immediately shake** the mixture **well for 1 min**.
- 6 Wait for **5 min**.
- 7 Open the glass, place it in position B of the comparator and slide the comparator along the color scale until the colors match. Check the result in the gap on the upper side of the comparator. Mid-values can be estimated.



2 x 5 mL sample



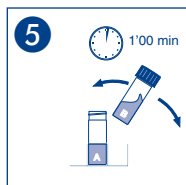
5 NO_3-1



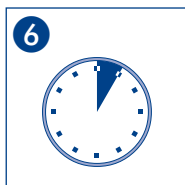
Mix



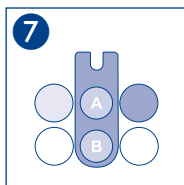
1 NO_3-2



Shake well



5'00 min



Measurement

After use, rinse both measuring glasses thoroughly and seal them.

This method can be used also for analyzing sea water (see conversion table).

Background information

In natural and uncontaminated water, the nitrate ion content is between 0.4 to 8 mg/L, the nitrite ion content at most 0.01 mg/L. From fertilizers (saltpeter) as well as from the aerobic decomposition of nitrogen compounds (e.g. proteins), large amounts of nitrate can get into the water.

In polluted water bodies, nitrate contents can range from 50 to 150 mg/L, even higher values are possible. If such high nitrate contents cannot be traced back to geological saltpeter deposits (especially when concentrations in ground water are high), a contamination is always at hand.

To evaluate the self-purification capacity of a water body, it is important to test if there are high amounts of ammonium and nitrite present as well. If these other parameters are not high, the self-purification capacity to mineralize organic compounds is sufficient. This relation also holds true for the outflow of biological waste water treatment facilities.

Water bodies with low acid binding capacity are deficient in lime (acid binding capacity determinable with *VISOCOLOR® HE* Alkalinity).

Reaction basis

Nitrate ions are reduced to nitrite ions in an acidic medium. Combined with a suitable aromatic amine, an orange-yellow azo dye is formed.

Interferences

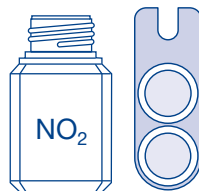
Depending on their concentration, oxidizing substances may reduce the measurement reading or suppress the reaction completely. Chlorine ≤ 10 mg/L does not interfere. Nitrite interferes (same reaction). This can be circumvented by addition of amido sulphonic acid (REF 918973) prior to analysis.

The water sample should be between 18 and 30 °C. At lower temperatures the reaction takes place at a significantly slower rate, and the results are limited.

Conversion table

mg/L NO_3^-	mg/L $\text{NO}_3\text{-N}$ (Nitrate-nitrogen)	mmol/m ³ NO_3^-	mg/L NO_3^- in sea water
1	0.2	16	1
5	1.1	81	5
10	2.3	160	12
20	4.5	320	25
50	11	810	65
90	20	1450	120

7. Nitrite

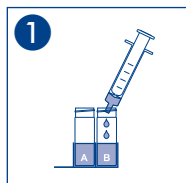


Measuring range

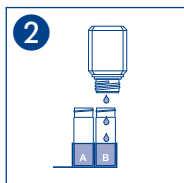
0.02–0.5 mg/L NO_2^-

Test instructions

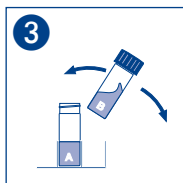
- 1 Fill a **5 mL water sample** into each of the measuring glasses using the plastic syringe. Place a measuring glass on position A in the comparator. Only add the **reagents to measuring glass B**.
- 2 Add **4 drops** of NO_2-1 .
- 3 Seal the glass and mix.
- 4 Add **1 level measuring spoonful** of NO_2-2 .
- 5 Seal the glass and shake the mixture until the powder has dissolved.
- 6 Wait for **10 min**.
- 7 Open the glass, place it in position B of the comparator and slide the comparator along the color scale until the colors match. Check the result in the gap on the upper side of the comparator. Mid-values can be estimated.



2 x 5 mL sample



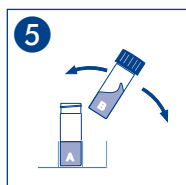
4 NO_2-1



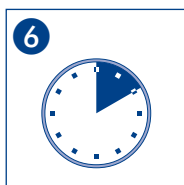
Mix



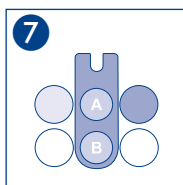
1 NO_2-2



Mix



10'00 min



Measurement

After use, rinse both measuring glasses thoroughly and seal them.
This method can be used also for analyzing sea water.

Backgroundinformation

Nitrite forms as an intermediate during ammonium oxidation (see Ammonium, page 31) or nitrate reduction. It is highly toxic to fish and presents a pre-stage of carcinogenic *N*-nitroso compounds (e.g. reaction with amines to nitrosamines). Usually nitrite contents should not exceed 0.5 mg/L. Higher contents reduce feed intake of fish, which can be a sign of dumped sewage water.

The nitrite ion concentration in ground and surface water is low. Waste water can contain higher amounts of nitrite, which may be caused either by industrial waste water from the metal or chemical industry, or due to the contamination with feces. Another source of nitrite from nitrate may be zinc-plated iron plumbing from domestic pipe systems. Concentrations of up to 1 mg/L are classified as hazard-free, while 2 mg/L

are regarded as deadly for fish. During the decomposition of proteins, higher nitrite contents can appear. The water's salt content and the nitrite's dwell time codetermine the degree of toxicity.

The German drinking water regulations demand a limit of 0.1 mg/L at the water works outflow and 0.5 mg/L at the tap.

Reaction basis

Sulphanilamide is diazotized by nitrite in acidic solution. The diazonium salt is coupled with a naphthylamine to form a reddish-violet azo dye.

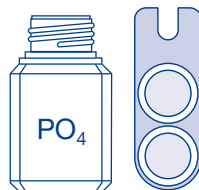
Interferences

Chromium(VI) and iron(III) ions present in concentrations of > 3 mg/L simulate nitrite values which are too high. Chlorine interferes even in minor concentrations.

Conversion table

mg/L NO ₂ ⁻	mg/L NO ₂ -N (Nitrite-nitrogen)
0.02	0.006
0.05	0.015
0.1	0.03
0.2	0.06
0.5	0.15

8. Phosphate

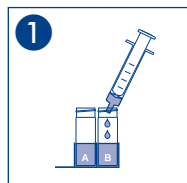


Measuring range

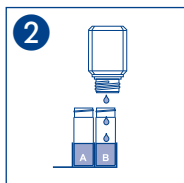
0.6–15 mg/L PO_4^{3-}

Test instructions

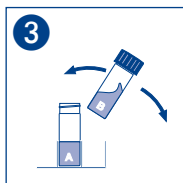
- 1 Fill a **5 mL water sample** into each of the measuring glasses using the plastic syringe. Place a measuring glass on position A in the comparator. Only add the **reagents to measuring glass B**.
- 2 Add **6 drops of PO_4 -1**.
- 3 Seal the glass and mix.
- 4 Add **6 drops of PO_4 -2**.
- 5 Seal the glass and mix.
- 6 Wait for **10 min**.
- 7 Open the glass, place it in position B of the comparator and slide the comparator along the color scale until the colors match. Check the result in the gap on the upper side of the comparator. Mid-values can be estimated.



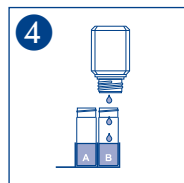
2 x 5 mL sample



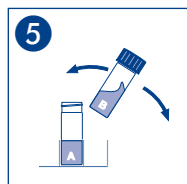
6 PO_4 -1



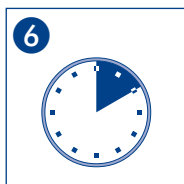
Mix



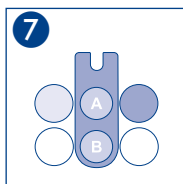
6 PO_4 -2



Mix



10'00 min



Measurement

After use, rinse both measuring glasses thoroughly and seal them.
This technique can also be used for analyzing sea water.

Background information

Clean water bodies, especially in mountains, have phosphate contents of less than 0.1 mg/L, often even below 0.03 mg/L. If concentrations are higher than 0.1 mg/L PO_4^{3-} , contamination is only present if other contamination indicators are positive. Phosphate concentrations exceeding 0.3 mg/L provide strong suspicion for contamination. An exception is marsh water, which may contain up to 1 mg/L.

Because of contamination from domestic waste water (kitchen waste or especially from feces), large amounts of phosphate get into the water. In the case of fecal contamination, high phosphate contents are a reliable chemical indicator.

Chemical fertilizers raise the phosphate content in ground water.

In pond waters, phosphate is barely traceable, as plant's, plankton and the pond's soil quickly absorb small amounts. A good pond soil absorbs and holds several hundred times more phosphate than the above pond water contains.

Phosphate behaves similarly on water soil as on agricultural land. Under aerobic conditions, it is adsorbed on sedimentary particles or it precipitates as iron phosphate. The water's sediment can serve as a "phosphate trap". However, if oxygen saturation levels drop below 10 %, a mobilization of phosphate starts, eventually resulting in a re-integration of phosphate into the production cycle. Elevated phosphate contents in waters lead to an eutrophication (over-fertilization), which causes an increasing growth of water plants, especially of planktonic algae, resulting from the larger nutrition supply. This procedure – also called algal bloom – leads to an increasing consumption of oxygen resulting from an excessive bacterial decomposition of dead algae. If anaerobic conditions occur afterwards, hydrogen sulfide can – amongst others – be released. This condition is extremely harmful for waters populated with fish. Regarding the element phosphorous, one distinguishes between inorganic phosphorous (phosphate or hydrogen phosphate ions and polyphosphate) and organic phosphorous compounds, from which phosphorous is only released after the digestion (destruction) of the organic materials. In the Drinking Water Ordinance of 2001, there is no limit indicated for phosphate. However, there should almost be no phosphate present in drinking water, as higher concentrations can lead to indigestion.

Reaction basis

Ammonium molybdate and phosphate ions form phosphomolybdic acid, which is reduced to phosphomolybdenum blue.

(Reaction basis analog to DIN EN ISO 6878-D11).

Interferences

Larger amounts of oxidizing reagents inhibit formation of the blue color complex and have to be destroyed. H_2S interferes in concentrations above 2 mg/L, but can be expelled after acidification of the water sample. Heavy metals in excess of 10 mg/L can slightly decrease the intensity of the color (vanadium causes an increase in color). Silica interferes in excess of 10 mg/L Si.

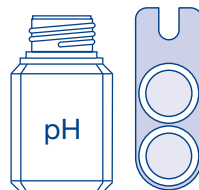
Conversion table

mg/L PO ₄ ³⁻	mg/L PO ₄ -P (Phosphate-phosphorous)	mg/L P ₂ O ₅
0.6	0.2	0.5
0.9	0.3	0.7
1.5	0.5	1.1
2.1	0.7	1.6
3	1	2
6	2	5
9	3	7
15	5	12

9. pH value

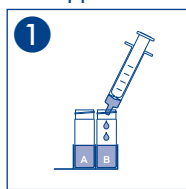
Measuring range

pH 4.0–9.0

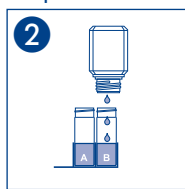


Test instructions

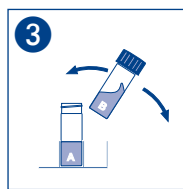
- 1 Fill a **5 mL water sample** into each of the measuring glasses using the plastic syringe. Place a measuring glass on position A in the comparator. Only add the **reagent to measuring glass B**.
- 2 Add **4 drops** of pH-1.
- 3 Seal the glass and mix.
- 4 Open the glass, place it in position B of the comparator and slide the comparator along the color scale until the colors match. Check the result in the gap on the upper side of the comparator. Mid-values can be estimated.



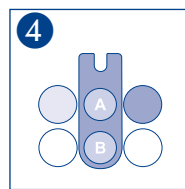
2 x 5 mL sample



4 drops pH-1



Mix



Measurement

After use, rinse both measuring glasses thoroughly and seal them.

This method can be used also for analyzing sea water.

Background information

At room temperature, pure water with the formula H_2O , which contains solved traces of other substances, is to a small degree divided (dissociate) into hydrated hydrogen ions – known as hydronium ions – H_3O^+ and the counter ion OH^- – the hydroxide ion:



1 liter of water contains 0.000001 mole (10^{-7} mole; given the hydrogen atom weight of 1 g/mol also the same amount in gram) hydrogen ions H^+ and at the same time 0.0000001 mole (multiplied by 17 g/mol as mole weight for OH^- in gram) of the hydroxide ion. To simplify notation of these low concentrations, the pH value only indicates the exponent, in this case the number 7 (with positive algebraic sign). Mathematically, the pH value is defined as the negative common logarithm: $\text{pH} = -\lg [\text{H}_3\text{O}^+]$. Thus, a pH value of 7 at room temperature means that the concentration of hydrogen ions corresponds to the concentration from the dissociation of pure water (in equilibrium with hydroxide ions). If a strong acid, such as hydrochloric acid (HCl), is dissolved in distilled water in very low quantities, the amount of hydrogen ions increases (coming from the hydrochloric acid). As a strong acid, hydrochloric acid is almost completely broken down into hydrogen and chloride ions. The resulting increase in hydrogen or hydronium ions respectively is shown in the decreasing pH value. To keep the above mentioned water equation in equilibrium, the concentration of hydroxide ions has to decrease. Therefore, the sum of the exponent of hydrogen and hydroxide ion concentration is always 14.

A one unit decrease in pH value signifies an increase in the hydrogen ion concentration by the power of ten in comparison to the concentration before. Simultaneously, the hydroxide ion concentration decreases by the power of ten.

Compounds reacting with water may cause a change in pH value as well, even if they cannot provide hydrogen or hydroxide ions in the water themselves. If carbon dioxide is dissolved in water, small, but measurable amounts of hydrogen carbonate and hydrogen ions form according to the following equation:



Water and carbon dioxide create one hydronium and one hydrogen carbonate ion each. The pH value of water, which always contains some dissolved carbon dioxide due to contact with air, is therefore always below 7. The solution becomes acidic.

Salts dissolved in water can also cause a change in pH value. If sodium carbonate (soda) is dissolved in water, the following reaction occurs between water and carbonate ions:



As hydroxide ions are formed, the pH value rises above 7. The solution becomes alkaline.

In this context, the concept of acid binding capacity or alkalinity plays an important role in hydro chemistry. Carbonate alkalinity is based on the fact that carbonate ions can bind hydronium ions, thus having a buffering effect. The so called buffer capacity of natural water is therefore mainly determined by the amount of dissolved carbon dioxide, hydrogen carbonate and carbonates (see Total hardness, page 34).

The pH scale ranges from 0 to 14. At the lower end are the strong mineral acids, such as hydrochloric, sulfuric and nitric acid. On the upper end of the scale are caustic soda and caustic potash.

pH 0: hydrochloric acid – 3.65 %

pH 0.9–1.5: stomach acid (also diluted hydrochloric acid)

pH 2.3: lemon juice

pH 3.1: vinegar

pH 3.2–4.6: acidic vegetables

pH 4.5: beer

pH 7: pure water

pH 8.3: sea water

pH 8–10: soap water

pH 12.3: saturated lime water

pH 14: caustic soda – 4.0 %

Determining the pH value of a water body gives initial and basic indications as to water quality in general. The pH value allows evaluation of the degree of aggressiveness on construction material. Moreover and especially, the pH value gives an indication of the water's effect on plant and animal life in water bodies or even in waste water treatment plants.

Fish can only tolerate a certain pH range. At the limits, both at the low and high end, skin and gills are negatively affected. The limits for carp for example are at pH 4.5 in the acidic and 10.8 in the alkaline range. Living for a prolonged time at these limits will

lead to the fishes' death. The brown trout for example can only accept a more narrow range between pH 5.5 and 9.4. Ideal fish water has a pH value between 6.5 and 8.

Reaction basis

A special mixture of indicator dyes produces a specific and characteristic color for every pH value covered.

Interferences

The favorable ratio between indicator and sample minimizes the indicator error. This means that perfect measuring results are ensured even for weakly buffered samples. High concentrations of neutral salts and colloids as well as organic solvent contents above 10 % can cause wrong results.

Notice: If a wider measuring range, or tighter gradations are necessary, pH-Fix test strips are the ideal solution. The strips come in a wide variety of ranges and gradations and the case has room for one package. For a detailed list of options check our catalog or go online to www.mn-net.com.

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