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Title Water Quality Analysis

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Maintainer Tanuj Misra <tanujmisra102@gmail.com>

Description A varied array of mathematical derivations from various titrimetric and colorimetric methods for analyzing water quality parameters were condensed and integrated for the better physicochemical analysis. It is indispensable for managing any aquatic ecosystem, including aquaculture facilities. By substituting titrant and spectrophotometric absorbance readings, accurate determination of the concentrations of critical parameters such as Dissolved Oxygen, Free Carbon Dioxide, Total Alkalinity, Water Hardness, Hydrogen Sulfide, Total Ammonia Nitrogen, Nitrite, Nitrate, Chlorinity, Salinity, Inorganic Phosphate, and Transparency can be facilitated APHA(2017,ISBN:9780875532875).

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Author Ganesh Kumar [aut, ctb, cph], Tanuj Misra [aut, cre, ctb, cph], Sudhanshu Raman [aut, ctb, cph], Girija Saurabh Behere [aut, ctb, cph], Anuj Tyagi [aut, ctb, cph], Abhishek Srivastava [aut, ctb, cph], Priyadharsini [aut, ctb, cph]

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Contents

CL *Chlorinity in Water using Mohr-Knudsen Method*

Description

Chlorinity is a measure of the total concentration of halides (mainly chloride) in seawater.

Principle:

Titration of chloride ions in seawater with silver nitrate, forming a precipitate of silver chloride. Potassium chromate is used as an indicator, which turns red when all chloride has reacted and silver chromate begins to form. The volume of silver nitrate used corresponds to the chlorinity of the sample. Chlorinity is then converted to salinity using a standard formula. APHA(2017,ISBN:9780875532875).

Usage

```
CL(chl_std_seawater, T1, T2)
```

Arguments

`chl_std_seawater`	Chlorinity of standard seawater
`T1`	Volume of silver nitrate required to titrate a sample
`T2`	Volume of silver nitrate required to titrate standard seawater

Value

Chlorinity in Water(gm/L)

References

APHA, 2017. Standard methods for examination of water and wastewater, 23rd edn. APHA, AWWA, WPCF, Washington

Examples

```
CL(19, 25, 30)
```

DO *Dissolved Oxygen using Winkler method*

Description

Dissolved oxygen (DO) refers to the concentration of oxygen gas incorporated in water. Oxygen enters water by direct absorption from the atmosphere (surface diffusion), which is enhanced by turbulence or oxygen released by aquatic plants and algae during photosynthesis.

Principle of analysis:

In this method a divalent manganese solution, followed by strong alkali, is added to the sample. Any dissolved oxygen rapidly oxidizes an equivalent amount of divalent manganese to basic hydroxides of higher valency states. When the solution is acidified in presence of iodide ions, the oxidized manganese ions again reverts to divalent state and iodine, equivalent to the original dissolved oxygen content of the water, is liberated. This iodine is titrated with standardized thiosulphate solution. APHA(2017,ISBN:9780875532875).

Usage

```
DO(Vol1, Vol2, N)
```

Arguments

`Vol1`	Volume of titrant (mL)
`Vol2`	Volume of fraction of sample taken for Analysis (mL)
`N`	Normality of thiosulphate solution

Value

Dissolved Oxygen (in mL/L)

References

APHA, 2017. Standard methods for examination of water and wastewater, 23rd edn. APHA, AWWA, WPCF, Washington

Examples

```
DO(0.5, 25, 0.039)
```

FCO2 *Free Carbon Dioxide using Phenolphthalein Titration Method*

Description

Carbon dioxide is in gaseous form and its solubility in water is relatively high compared to other gases. Carbon dioxide enters aquatic ecosystems through respiration, surface diffusion, and the decomposition of organic matter. CO2 is essential for aquatic plants, helps maintain the water's pH balance, and influences calcium carbonate levels and nutrient availability.

Principle of analysis:

When NaOH is added to a water sample, it reacts with free Co2 to form sodium bicarbonate. This reaction consumes a known amount of NaOH, leaving the remaining NaOH to be measured. Phenolphthalein is used as an indicator to detect the titration endpoint, changing color from pink to colorless as the NaOH is used up. The amount of free Co2 in the water can then be calculated based on the volume of NaOH consumed in the reaction. APHA(2017,ISBN:9780875532875).

Usage

```
FCO2(Vol1, Vol2, N)
```

Arguments

Vol1	Volume of NaOH
Vol2	Volume of the water sample
N	Normality of NaOH

Value

Free Carbon Dioxide (in mg/L)

References

APHA, 2017. Standard methods for examination of water and wastewater, 23rd edn. APHA, AWWA, WPCF, Washington

Examples

```
FCO2 (5, 100, 0.01)
```

H2S *Hydrogen Sulfide in Water using Iodometric Titration Method*

Description

Hydrogen sulfide is a gas naturally found in aquatic environments like oceans, lakes, rivers, and wetlands. It is often produced by bacteria that break down organic matter without oxygen. As dead plants, animals, and algae decompose, they release sulfur, leading to the formation of Hydrogen sulfide. High levels of this gas can be toxic to aquatic life, deplete oxygen, and harm the overall health of ecosystems.

Principle of analysis:

The principle involves first precipitating hydrogen sulfide as manganous sulfide using manganous sulfate and alkaline potassium iodide to form iodine, which is subsequently oxidized by potassium iodate and sulfuric acid. The amount of iodine produced is quantified by titration with sodium thiosulfate, and the result is used to determine the concentration of hydrogen sulfide in the water sample. APHA(2017,ISBN:9780875532875).

Usage

```
H2S(Fact, A, B)
```

Arguments

Fact	Factor of Sodium thiosulphate
A	The amount of sodium thiosulphate used for the blank (mL)
B	Sodium thiosulphate used in the sample (mL)

Value

Hydrogen sulfide in Water (in mg/L)

References

APHA, 2017. Standard methods for examination of water and wastewater, 23rd edn. APHA, AWWA, WPCF, Washington

Examples

```
H2S(1, 10, 9.99)
```

IP *Inorganic Phosphate in Water*

Description

Inorganic phosphate is the bioavailable dissolved form of phosphorus.

Principle:

Filtered water sample is allowed to react with a mixed reagent of molybdate, ascorbic acid, and trivalent antimony. The molybdic acid formed is converted by the reducing agent to a blue-coloured complex which is spectrophotometrically measured at 882nm. APHA(2017,ISBN:9780875532875).

Usage

```
IP(std_cons, A1, A1_s, AB1, Ao)
```

Arguments

std_cons	Standard concentration
A1	Absorbance of standard with reagent
A1_s	Absorbance of samples with reagent
AB1	Absorbance of distilled water and reagent
Ao	Absorbance of sample without NEED reagent

Value

Inorganic Phosphate in Water(micro gm/L)

References

APHA, 2017. Standard methods for examination of water and wastewater, 23rd edn. APHA, AWWA, WPCF, Washington

Examples

```
IP(500, 0.3, 0.2, 0.05, 0.1)
```

Nitrate *Nitrate in Water*

Description

After treating it with cadmium column nitrate in water sample is reduced to nitrite and measured using the sulphanilamide method. Total nitrite and reduced nitrate is detected from the nitrite available.APHA(2017,ISBN:9780875532875).

Usage

```
Nitrate(Conc_std_sol, E1c, E1_sc, E0c, EB1c, E1, E1_s, E0, EB1)
```

Arguments

Conc_std_sol	Concentration of standard solution
E1	Absorbance of standard with reagent
E1_s	Absorbance of sample with reagent
E0	Absorbance of sample without NEED reagent
EB1	Absorbance of distilled water and reagent
E1c	Absorbance of standard with reagent after passing through cadmium column
E1_sc	Absorbance of sample with reagent after passing through cadmium column
E0c	Absorbance of sample without NEED reagent after passing through cadmium column
EB1c	Absorbance of distilled water and reagent after passing through cadmium column

Value

Nitrate (micro gm/L)

References

APHA, 2017. Standard methods for examination of water and wastewater, 23rd edn. APHA, AWWA, WPCF, Washington

Examples

```
Nitrate(1000, 0.30, 0.320, 0.1, 0.05, 0.30, 0.220, 0.1, 0.05)
```

`Nitrite` *Nitrite in Water*

Description

Nitrite is the key part of the nitrogen cycle in water. During denitrification, which occurs in low oxygen conditions, nitrite can build up. High levels of nitrite are harmful to fish, shrimp, and other aquatic organisms, making it important to manage for their health and well-being.

Principle of analysis:

Sulphanilamide is used as the amino compounds which is coupled with n-(1-napthyl)-ethylene diamine dihydrochloride. This reaction leads to the formation of azo dye formed is proportional to the initial concentration of nitrite. Absorbance is measured 543nm in spectrophotometer. APHA(2017,ISBN:9780875532875).

Usage

```
Nitrite (Conc_std_sol, E1, E1_s, E0, EB1)
```

Arguments

`Conc_std_sol`	Concentration of standard solution
`E1`	Absorbance of standard with reagent
`E1_s`	Absorbance of sample with reagent
`E0`	Absorbance of sample without NEED reagent
`EB1`	Absorbance of distilled water and reagent

Value

Nitrite (micro gm/L)

References

APHA, 2017. Standard methods for examination of water and wastewater, 23rd edn. APHA, AWWA, WPCF, Washington

Examples

```
Nitrite (1000, 0.30, 0.20, 0.10, 0.05)
```

Salinity *Salinity in Water using Mohr-Knudsen Method*

Description

Salinity refers to the concentration of dissolved salts in water, typically measured in parts per thousand (ppt). APHA(2017,ISBN:9780875532875).

Usage

```
Salinity (chl_std_seawater, T1, T2)
```

Arguments

chl_std_seawater	Chlorinity of standard seawater
T1	Volume of silver nitrate required to titrate a sample
T2	Volume of silver nitrate required to titrate standard seawater

Value

Salinity in Water(gm/L)

References

APHA, 2017. Standard methods for examination of water and wastewater, 23rd edn. APHA, AWWA, WPCF, Washington

Examples

```
Salinity (19, 25, 30)
```

TA *Total Alkalinity using Double Indicator Titration Method*

Description

Total alkalinity measures the water's capacity to neutralize acids, reflecting the presence of bicarbonates, carbonates, and hydroxides.APHA(2017,ISBN:9780875532875).

Usage

```
TA (P, M, N, Vol)
```

Arguments

P	Volume of sulp. acid used for phenolphthalein end point
M	Volume of sulp. acid used for methyl orange end point
N	Normality of sulp. acid
Vol	Volume of sample (mL)

Value

Total alkalinity (in mg/L)

References

APHA, 2017. Standard methods for examination of water and wastewater, 23rd edn. APHA, AWWA, WPCF, Washington

Examples

```
TA (5, 10, 0.02, 100)
```

TAN *Total Ammonia Nitrogen (TAN) using Indophenol Method*

Description

Total ammonia nitrogen (TAN) is a measure of the total amount of ammonia nitrogen present in a sample, including both ammonium ion and ammonia gas. Ammonia exists in two forms in water: ionized and unionized. The primary difference between ionized and unionized ammonia is their chemical state, which can affect their behavior and toxicity. Only a fraction of the TAN exists as toxic (un-ionized) ammonia, and a balance exists between it and the nontoxic ionized ammonia based on pH and temperature.Unionized ammonia is more toxic to aquatic life than ionized ammonia.

Principle of analysis:

Water sample is treated in an alkaline citrate medium with sodium hypochlorite and phenol in the presence of sodium nitroprusside which acts as a catalyzer and colour intensifier. The blue indophenol colour formed with ammonia is measured spectrophotometrically at 640nm. APHA(2017,ISBN:9780875532875).

Usage

```
TAN(Conc_std_sol, A_s, A_b, A_st)
```

Arguments

Conc_std_sol	Concentration of standard solution
A_s	Mean absorbance of samples
A_b	Mean absorbance of blanks
A_st	Mean absorbance of standards

Value

Total Ammonia Nitrogen (TAN) (in micro gm/L)

References

APHA, 2017. Standard methods for examination of water and wastewater, 23rd edn. APHA, AWWA, WPCF, Washington

Examples

```
TAN(1000, 0.17, 0.1, 0.8)
```

TH *Total Hardness using Complexometric Titration Method*

Description

Water hardness measures the concentration of divalent cations, primarily calcium and magnesium, expressed as mg/L of calcium carbonate. It is categorized into temporary hardness (associated with carbonate and bicarbonate salts) and permanent hardness (due to sulfates and chlorides). High hardness can cause mineral buildup, harming aquatic life by affecting gill function and growth, while low hardness can reduce pH stability and increase metal toxicity. The acceptable hardness range in aquaculture is 50-350 ppm.

Principle of analysis:

In complexometric titration for water hardness, EDTA forms stable complexes with calcium and magnesium ions in the water sample. Eriochrome Black T is used as an indicator; it remains wine red while calcium and magnesium ions are free. As EDTA is added, the indicator changes to blue when it binds with the hardness ions. The volume of EDTA required to cause this color change is measured to determine the concentration of hardness ions in the water. APHA(2017,ISBN:9780875532875).

Usage

```
TH(Tt, M, Vol)
```

Arguments

`Tt`	Volume of Titrant (mL)
`M`	Concentration of EDTA
`Vol`	Volume of sample (mL)

Value

Total hardness (in mg/L)

References

APHA, 2017. Standard methods for examination of water and wastewater, 23rd edn. APHA, AWWA, WPCF, Washington

Examples

```
TH(7.49, 0.02, 50)
```

ToW *Transparency of Water using Secchi Disk*

Description

The transparency of water in aquatic systems refers to the degree to which light can penetrate and travel through the water without being absorbed or scattered. It is also referred to as water clarity. APHA(2017,ISBN:9780875532875).

Usage

```
ToW (A, B)
```

Arguments

A	Depth of disappearance
B	Depth of reappearance

Value

Transparency of Water(cm)

References

APHA, 2017. Standard methods for examination of water and wastewater, 23rd edn. APHA, AWWA, WPCF, Washington

Examples

```
ToW (90, 30)
```

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