



ERBAqua®

Reagents for Volumetric and Coulometric Titration to determine the water content according to the **Karl Fischer** method

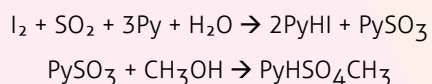


The method

The chemical literature presents many techniques and methods for determining the water content.

Of all the methods available, the Karl Fischer method is the most effective and versatile thanks to its selectivity, practicality and its wide scope.

The Karl Fischer method for the determination of water was developed in 1935 by Karl Fischer¹ by adapting the reaction of Bunsen discovered in 1853.² This method offers greater flexibility and a wider range of possibilities to detect the very low content of water in samples. Later research showed that the reaction of Karl Fischer takes place in 2 steps:



In this reaction, the oxidation of the alkylsulphite in alkylsulfate consumes the water from the sample. Kinetic studies have shown that the reaction is dependent on the concentrations of water, iodine and sulfur dioxide in a stoichiometric ratio of 1: 1: 1. This characteristic allows the determination of the amount of water present in the sample analyzed by calculating the quantity of iodine necessary for the reaction.

There are two ways to determine the quantity of iodine that reacted with water: volumetric or coulometric titration. The coulometric method allows a precise measurement of a very low amount of water, while the volumetric method allows a water measurement of 1-2%.³

CARLO ERBA Reagents proposes a new range of ERBAqua® brand reagents for volumetric and coulometric titration according to the Karl Fischer method, characterized by:

- **Reliable reactivity**
- **Fast reaction**
- **Accurate and reproducible results**
- **Stable reagent**
- **Wide range of solvents for the solubilization of the sample**
- **Pyridine free**

References

1. Fischer, K. *Angew. Chem.* **1935**, 48, 394.
2. Bunsen, R. *Justus Liebigs Ann. Chem.* **1853**, 86, 265.
3. Meyer, A. S.; Boyd, C. M. *Anal. Chem.* **1959**, 31, 215.



One-component VOLUMETRIC TITRATION

For one component Karl Fischer volumetric titration, a known concentration of a titrant rich in iodine is added to a solution to be titrated to consume the water contained in the sample.

By measuring the volume of the added titrant, one can calculate the amount of water contained in the sample. With this method, the titrant contains all the ingredients needed for the Karl Fischer reaction: iodine, base, sulfur dioxide and alcohol.

The ERBAqua® range contains different titrants with concentrations of 2 to 5 mg/ml to cover a wide range of applications.

Advantages of One-Component ERBAqua reagents®

- Extremely high water capacity
- Fast and stable endpoints
- Long shelf life
- Convenient and simple to use
- All KF components in one bottle



ONE-COMPONENT TITRANT

The ERBAqua® product range offers a wide choice of titrants.

These reagents contain all the substances necessary for the titration of the water in the sample. With their formulations without methanol, the majority of the the ERBAqua® products can be used for the determination of the water content in aldehydes and ketones.

Product	Description	Features	SKU
570021	Karl Fischer reagents 2 mg H ₂ O/mL-One component-RS-ERBAqua®	Without methanol, for general use	1L
570251	Karl Fischer reagents 2 mg H ₂ O/mL-One component-RS-ERBAqua®	Alternative formulation, not DOT regulated	1L
570011	Karl Fischer reagents 2 mg H ₂ O/mL-One component-RS-ERBAqua®	Without methanol, for general use	1L
570241	Karl Fischer reagents 2 mg H ₂ O/mL-One component-RS-ERBAqua®	Alternative formulation, not DOT regulated	1L
570081	Karl Fischer reagents 5 mg H ₂ O/mL-One component for aldehydes and ketones-RS-ERBAqua®	Methanol free, methoxyethanol solvent	1L

ONE COMPONENTS SOLVENTS

Used to dissolve the sample, when a one component reagent is used for titration. In addition to methanol and anhydrous chloroform, other solvents are available.

They can be used when the sample contains aldehydes or ketones or for samples containing oils or non-polar substances.

Product	Description	Features	SKU
414981	Methanol-RS-Anhydrous- For analysis	Minimum purity 99.9% water <0.005%	1 L
P02410E16	Chloroform-RS-Anhydrous- For analysis	Stabilized with ethanol water <0.005%	1 L
570091	Karl Fischer solvent for aldehydes and ketones RS-ERBAqua®	Methanol and halogenated solvent free-Solvent for one and two component titrations	1 L
570041	Karl Fischer solvent for aldehydes and ketones and high molecular weight substances and non polar-ERBAqua®	Methanol free, contain chloroform-Solvent for one and two component titrations	1 L
570031	Karl Fischer solvent for the titration of oils and non polar samples-RS-ERBAqua®	Based on methanol and chloroform	1 L

Two components VOLUMETRIC TITRATION

For users who need a higher degree of accuracy than the one component titration provides, the two-component titration offers an alternative.

The major difference between the 2 methods is that the components for the titration are separated in two component volumetric titration.

Advantages of two components ERBAqua® reagents

- Eliminates frequent standardizations
- Exact and stable titer strength
- Faster titrations
- Longer shelf life
- Greater accuracy for low water content
- Higher buffer capacity

TWO COMPONENT TITRANTS

To improve the stability of the reagents, it is possible to separate the substances for the titration, the solvent and the reagent.

The use of a two-component titrant, which contains iodine, necessarily involves the use of a solvent in which one can dissolve the sample containing the base and the sulfur dioxide.

Product	Description	Features	SKU
570061	Two component Karl Fischer reagents 2 mg H ₂ O/mL-RS-ERBAqua®	To combined with a two component solvent	1L
570051	Two component Karl Fischer reagents 2 mg H ₂ O/mL-RS-ERBAqua®	To combined with a two component solvent	1L

TWO COMPONENT SOLVENTS

Together with the two-component titrants, there are different types of solvents.

Some two-component ERBAqua® solvents, as indicated, contain sulfur dioxide and bases and can also be used as two-component reagents.

Product	Description	Features	SKU
570071	Two components Karl Fischer solvent RS-ERBAqua®	Methanol based	1L
570111	Two components Karl Fischer solvent for samples with high acidity RS-ERBAqua®	Methanol based. With a buffer ability of 5 mmol of acid/ml	1L
570101	Two components Karl Fischer solvent for the titration of oil and other non polar samples - RS-ERBAqua®	Methanol and chloroform based	1L
570091	Karl Fischer solvent for aldehyde and ketones RS-ERBAqua®	To be used with 570051 and 570061	1L



COULOMETRIC TITRATION

For the majority of coulometric titrations two solutions are needed, an anolyte and a catholyte. This is the best method when the amount of water contained in the sample is between 10 ppm and 1%.

Iodine is generated electrochemically in the cell by the passage of constant current. The titration of the water takes place in the anode compartment where iodine is formed by the oxidation of the iodides present. In the cathode compartment takes place the opposite reaction with the formation of hydrogen.

For this type of titration, there are two different types of coulometric cells, with diaphragm and without diaphragm.

However, the use of a cell with a diaphragm gives the highest accuracy.

Advantages of ERBAqua® Coulometric

- High accuracy with a detection 50x more accurate than volumetric
- Ideal for small samples (<10 mg of H₂O)
- Auto-adjusts (as the sample reacts with water vapor in the air)



Selection guide for Coulometric titrations

Sample	Reagent	Suggestion
General use, alcohol	570121	570181/570191
Ketones/Aldehydes	570161	570191
Biodiesel/Non-polar/oils	570141	570191
Crude analysis	570171	570191/570181
Solid sample	570151	570191
Without a diaphragm	570131	570191

ANOLYTE SOLUTION FOR CELLS WITH A DIAPHRAGM

When coulometric titration is performed with a cell with a diaphragm there is a need for anolyte or catholyte solutions. In some cases, these solutions can be used for cells without a diaphragm.

Product	Description	Features	SKU
570121	Karl Fischer anolyte solution - pyridine free, RS - ERBAqua®	For a cell with a diaphragm for general use	500 mL
570161	Karl Fischer anolyte solution for ketones and aldehydes - RS-ERBAqua®	Methanol free, for a cell with a diaphragm	500 mL
570141	Karl Fischer anolyte solution - CFC free, RS - ERBAqua®	Halogenated solvent free, for a cell with a diaphragm	500 mL
570151	Karl Fischer anolyte solution, oven, RS-ERBAqua®	Halogenated solvent free to be used with a cell with and without a diaphragm in combination with an oven	500 mL
570171	Karl Fischer anolyte solution for oils, RS-ERBAqua®	With methanol and chloroform for a cell with a diaphragm	500 mL
570131	Karl Fischer anolyte solution - Chloroform free, RS-ERBAqua®	Chloroform free, for a cell with and without a diaphragm	500 mL

CATHOLYTE SOLUTION FOR CELLS WITH A DIAPHRAGM

Product	Description	Features	SKU
570181	Catholyte solution for cells with a diaphragm®	For a cell with a diaphragm for general use	125 mL
570191	Karl Fischer catholyte solution for aldehydes and ketones, RS - ERBAqua®	Methanol free, for a cell with a diaphragm	125 mL

ANOLYTE SOLUTION FOR CELLS WITHOUT DIAPHRAGM

When the coulometric titration is done with a cell without a diaphragm, an anolyte solution is sufficient.

Product	Description	Features	SKU
570131	Karl Fischer anolyte solution - Chloroform free, RS-ERBAqua®	Chloroform free, for cell without a diaphragm	500 mL

ANALYTICAL STANDARDS

Karl Fischer reagents are hygroscopic over time and their reliability inevitably decreases.

It is therefore necessary to check them regularly. This is done with reference standards with a known amount of water.

GRAVIMETRIC STANDARDS

Gravimetric standards with certified value on the content in water in mg/g and its uncertainty.

Product	Description	Features	SKU
483561	Sodium tartrate -RS-ACS - For the control of Karl Fischer reagents	Loss on drying at 150°C between 15.61 and 15.71%	100 g
570201	Karl Fischer standard 0.10 mg/g - RS-ERBAqua®	Gravimetric validation	10x5 mL
570211	Karl Fischer standard 1.0 mg/g - RS-ERBAqua®	Gravimetric validation	10x5 mL
570221	Karl Fischer standard 10.0 mg/g - RS-ERBAqua®	Gravimetric validation	10x5 mL

VOLUMETRIC STANDARDS

Volumetric standards with certified value on water content in mg/g.

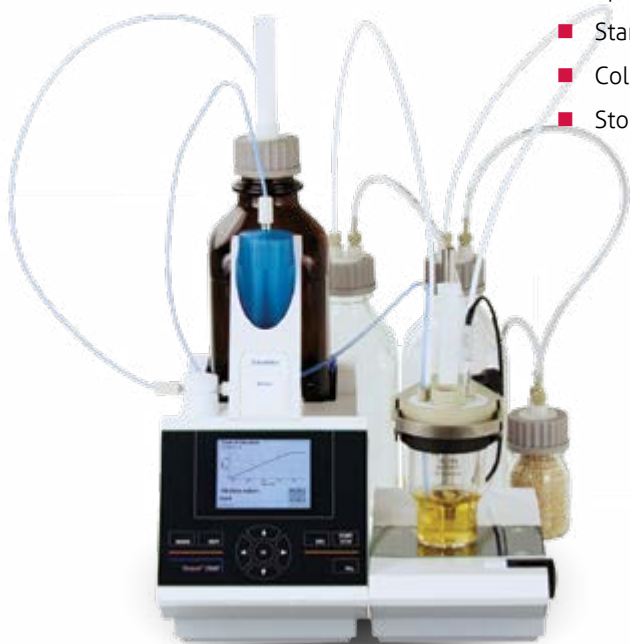
Product	Description	Features	SKU
570231	Karl Fischer standard 5.0 mg/ml -RS-ERBAqua®	Volumetric validation	10x5 mL



KARL FISCHER TITRATORS

CARLO ERBA Reagents offers several Karl Fischer TitroLine® 7500 KF titrators for volumetric and coulometric titrations. These titrators can be adapted to a wide range of water content determination of your sample. This range of devices offers:

- Speed
- Standard methods loaded for different applications
- Color display
- Storage of results via USB drive



LLG Code	SI Analytics Code	Designation	Content of the delivery
LLG09863170	285220810	TitroLine® 7500 KF 05 volumetric KF-Titrator 100-240 V	Titrator unit, interchangeable module WA 05, TM 235 KF titration stand with integrated stirrer and pump, titration vessel TZ 1770, micro-dual platinum electrode KF 1100 and starter kit, power supply 100-240 V
LLG06255582	285220820	TitroLine® 7500 KF 10 volumetric KF-Titrator 100-240 V	Titrator unit, interchangeable module WA 10, TM 235 KF titration stand with integrated stirrer and pump, titration vessel TZ 1770, micro-dual platinum electrode KF 1100 and starter kit, power supply 100-240 V
LLG09863171	285220830	TitroLine® 7500 KF 20 volumetric KF-Titrator 100-240 V	Titrator unit, interchangeable module WA 20, TM 235 KF titration stand with integrated stirrer and pump, titration vessel TZ 1770, micro-dual platinum electrode KF 1100 and starter kit, power supply 100-240 V
LLG09863172	285220860	TitroLine® 7500 KF trace M1 Coulometric KF-Titrator Module 1	Titrator unit, generator electrode TZ 1752 without diaphragm, magnetic stirrer TM 235, titration vessel TZ 1751, micro-dual platinum electrode KF 1150
LLG09863173	285220870	TitroLine® 7500 KF trace M2 Coulometric Titrator Module 2	Titrator unit, generator electrode TZ 1752 without diaphragm, TM 235 KF titration stand with integrated stirrer and pump, titration vessel TZ 1754, micro-dual platinum electrode KF 1150
LLG09863174	285220880	TitroLine® 7500 KF trace M3 Coulometric Titrator Module 3	Titrator unit, generator electrode TZ 1753 with diaphragm, magnetic stirrer TM 235, titration vessel TZ 1751, microdual platinum electrode KF 1150
LLG09863175	285220890	TitroLine® 7500 KF trace M4 Coulometric KF-Titrator Module 4	Titrator unit, generator electrode TZ 1753 with diaphragm, TM 235 KF titration stand with integrated stirrer and pump, titration vessel TZ 1754, micro-dual platinum electrode KF 1150



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