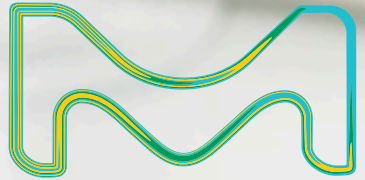


Accurate water determination

Aquastar® reagents for precise Karl Fischer titration results.



Aquastar® Karl Fischer Reagents

Karl Fischer titration using our Aquastar® reagents from Merck allows for easy and highly accurate water content determination in gases, liquids and solids. It is not without reason that no other method is as widespread as this one: determination of water content according to Karl Fischer is rapid, accurate and reliable; it is therefore the method of choice for quality and in-process control, production, and research and development.

Advantages

- High accuracy and excellent precision
- Rapid and reproducible titration results
- Large water capacity
- No crystallization
- Innovative formulations for special applications
- Reagents for all types of applications
- Wide range of water standards

For more information on our products:
[SigmaAldrich.com/Aquastar](https://sigmaaldrich.com/Aquastar)

Accurate results
with Aquastar® Reagents

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Precise water determination every time with 40 years of experience

A proven method, modified according to the latest research

We apply the highest standards to our production processes along with stringent testing requirements, so that our Aquastar® reagents and standards are distinguished by their excellent quality. The measuring results are therefore always reliable and accurate. From the selection of materials, to packaging and quality control of the finished reagents

in our DIN EN ISO /IEC 17025 accredited laboratory, we apply the strictest standards. This ensures consistency, quality and thus comparable and transparent results. The certificates of analysis for our reagents and standards contain all the information important for quality management documentation.

Aquastar® products, the standard for reproducible results



Brand quality

We use only high-quality and approved raw materials. This ensures batch-to-batch consistency and comparable analytical results.

Competence

You benefit from our high scientific standards and our long international experience.

Safety

Merck places great importance on safety. For this reason, the Aquastar® Karl Fischer reagents contain no toxic components or, if this is not possible, they are limited to a minimum.

Service

Our international sales network and local offices ensure safe delivery and service — worldwide.

Support

Whenever you need help, we can supply it via our application and development laboratories. Here we can advise you on applications, offer technical support, and assist you in validation projects. Contact us at Aquastar@Merck.com or visit our application finder: SigmaAldrich.com/application-note

Transparency

Our quality control is carried out in our DIN EN ISO/IEC 17025 accredited calibration and testing laboratory for Karl Fischer titration, according to the most stringent standards. This renders the results achieved completely transparent.



The quality standard for water determination

The significance of water determination with Karl Fischer titration is emphasized by the fact that it has been included in the most important Pharmacopoeias, American Standard Methods (ASTM), industrial norms and other guidelines. Together with our Aquastar® standards our Karl Fischer product line is always reliable, rapid, accurate and globally available to facilitate international product transfer.

Specification / Traceability

- American Standard Methods (ASTM)
- International Organization for Standardization (ISO)
- National Institute of Standards and Technology, USA (NIST)
- EP European Pharmacopeia
- USP United States Pharmacopeia



Aquastar® Reagents

Karl Fischer reagents and standards for sophisticated, precise and consistent water determination. Excellent quality distinguishes our Aquastar® range.

Karl Fischer titration

Since its development in the 1930s, the Karl Fischer titration method has found use worldwide. With this method the water content of a large variety of materials can be determined over a wide concentration range from 1 ppm up to 100%. In contrast to other methods, the Karl Fischer titration is based on a chemical reaction with water, so that water is exclusively determined. Karl Fischer titration has a wide spectrum of applications and is used in a broad range of fields, for example water determination in foodstuffs, chemicals, pharmaceuticals, cosmetics and mineral oils.

Two methods for water determination

Two methods are available for the determination of water using the Karl Fischer method: a volumetric and a coulometric method. The method selected depends primarily on the amount of water to be determined.

- **Volumetry:** In the case of higher levels of water (0.1 – 100%), the volumetric method should be used. For volumetric titration, we supply both one component and two component reagents.
- **Coulometry:** For very low levels of water (<1%) or for water determination of very expensive substances with small sample amount, the coulometric method should be used. In this case, Aquastar® reagents are available for cells both with and without a diaphragm.

Aquastar® Standards

The Aquastar® range is rounded off with water standards for monitoring and qualification of Karl Fischer instruments, for checking measuring results and titer determination.

Aquastar® Reagents and Standards for your individual needs

The right method for any application

To meet the requirements of modern laboratories Merck supplies a broad range of different Karl Fischer reagents in its Aquastar® product line. It covers the whole range of volumetric and coulometric Karl Fischer reagents together with water standards.

Choose the best Karl Fischer reagents to fit your needs and instrument. The choice of the »right« reagent is a decisive factor in

obtaining correct and reproducible results. It depends on the type of sample and the matrix in which the water is encapsulated. To ensure accurate results, it is important that the sample is completely dissolved or dispersed in the Karl Fischer solvent, and that all the water is extracted. Consult the table below for advice on how to choose the most suitable reagents for your sample.

Titrants	Solvents						
	Samples dissolving in Ethanol	Samples dissolving in Methanol	Samples dissolving in Methanol	Samples containing aldehydes + ketones	Mineral oils	Oils + fats in food	Samples of long-chain hydrocarbons
CombiTitrant 5 [188005]	•	•	•		•	•	•
Titrant 5 [188010]			•				•
CombiTitrant 5 Keto [188006]				•			
CombiTitrant 2 [188002]	•	•	•		•	•	•
Titrant 2 [188011]			•				•
CombiTitrant 1 [188001]	•	•	•		•	•	•
CombiCoulomat frit [109255]	Can be used for anode and cathode compartment in cells with diaphragm						
CombiCoulomat fritless [109257]	Can be used for cells with and without diaphragm						
Standards	Water standard: 0.01% / 0.1% / 1% / oven 1% / oil 15 – 30 ppm / 5 mg/mL, Lactose standard 5% Sodium tartrate dihydrate 15.66%						

Get your application note:

[SigmaAldrich.com/application-note](https://sigmaaldrich.com/application-note)

For individual support please contact us under:

Aquastar@merckgroup.com

Benefit from our experience



Volumetric titration

This method is preferably used when the water content of your sample is between 0.1 and 100%. The unknown water content of the sample is determined by measuring the required volume of Karl Fischer titrant to reach the titration endpoint. The sample is completely dissolved or dispersed in a suitable solvent with strict exclusion of atmospheric moisture and titrated with the Karl Fischer titrant. The titration end point is indicated by an excess of iodine and is determined potentiometrically.

Advantages

- High titration rate
- For water content from 0.1% – 100%
- Accurate and reliable results

**water
determination**
according to Karl Fischer





Volumetric titration

1. One component reagents
2. Two component reagents
3. Solvents for oils and fats
4. Reagents for aldehydes and ketones

1. One component reagents

CombiTitrant | CombiSolvent | CombiMethanol

Advantages of one component reagents

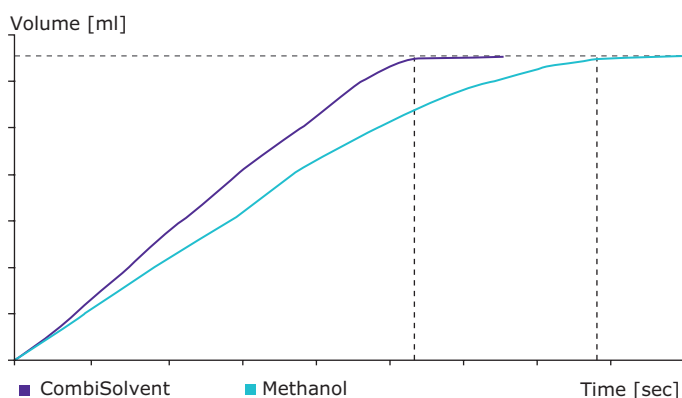
- High titration rate for fast analyses
- Distinct endpoint to ensure confidence in results
- Ensured constant and consistent high quality for comparable results
- No toxic alcohols in CombiTitrant and CombiSolvent for better safety for lab personnel
- More flexibility – the solvent can be suited to the sample matrix
- Unlimited water capacity – more titrations are possible than with two component reagents

CombiTitrant

In one component volumetric Karl Fischer analysis, the titrant contains all ingredients required by the Karl Fischer reaction: iodine, base, sulfur dioxide, and an alcohol. Aquastar® CombiTitrants and CombiSolvent are free from toxic alcohols and available in packaging compatible with all major brands of titrators. The range includes titrants with nominal titer values of 1, 2, or 5 mg H₂O/mL to cover a wide range of practical applications.

CombiSolvent

The Aquastar® CombiSolvent is an innovative methanol-free solvent for one component volumetric titration. This ethanol-based solvent is also without toxic alcohols and, when used in conjunction with the Aquastar® CombiTitrants, allows for non toxic titration. This means more safety for the laboratory staff as well as easy storage of the reagents.



Titration curve: The Aquastar® CombiSolvent is a methanol-free solvent for the one component system. This solvent brings about a higher titration rate and a more distinct endpoint.



CombiMethanol

Methanol – with a low water content – is the solvent typically used in one component titration for standard applications. The quality of methanol used for the Karl Fischer titration is critical to minimize both pretitration and interfering side reactions. Our Aquastar® CombiMethanol is optimized specifically for use in Karl Fischer titrations thanks to strictly limited key impurities and water content.

Ordering information

Product	Content	Packaging	Ord. No.
CombiTitrant 5, approx. 5 mg H ₂ O/mL	500 mL	Glass bottle	1.88005.0500
	1 L	Glass bottle	1.88005.1000
	2.5 L	Glass bottle	1.88005.2500
CombiTitrant 2, approx. 2 mg H ₂ O/mL	1 L	Glass bottle	1.88002.1000
CombiTitrant 1, approx. 1 mg H ₂ O/mL	1 L	Glass bottle	1.88001.1000
CombiSolvent, methanol-free solvent	1 L	Glass bottle	1.88008.1000
	2.5 L	Glass bottle	1.88008.2500
CombiMethanol, dried methanol for Karl Fischer titration max. 0.01% water	1 L	Glass bottle	1.88009.1000
	2.5 L	Glass bottle	1.88009.2500

For water determinations in oils and fats we recommend CombiSolvent oils, (188020) and CombiSolvent fats (188021).

2. Two component reagents

Titrant | Solvent

Unlike one component Karl Fischer reagents, in two component reagent systems the titrant contains only iodine and methanol, while the solvent contains the other Karl Fischer reaction components — sulfur dioxide and a suitable base dissolved in methanol. It is used as the working medium in the Karl Fischer cell. Aquastar® titrants are available with concentrations of 2 and 5 mg H₂O/mL together with Aquastar® solvent.



Advantages of two component reagents

- Slightly faster titration in comparison to one component titration
- High accuracy for reliable results
- Better buffer capacity
- Higher titer stability than one component reagents
- Ensured consistent high quality for comparable results

Two component reagents are distinguished by greater long term stability and a slightly faster titration time in comparison to one component reagents. This is due to the fact that the Karl Fischer reaction components are divided in between the two reagents making each reagent less susceptible to slow side reactions over time.

Faster titration rates result from the initial availability of sulfur dioxide and base in the solvent to which the sample to be analyzed is added.

Ordering information

Product	Content	Packaging	Ord. No.
Titrant 5, approx. 5 mg H ₂ O/mL	500 mL	Glass bottle	1.88010.0500
	1 L	Glass bottle	1.88010.1000
	2.5 L	Glass bottle	1.88010.2500
Titrant 2, approx. 2 mg H ₂ O/mL	1 L	Glass bottle	1.88011.1000
Solvent, solvent for the two component titration	1 L	Glass bottle	1.88015.1000
	2.5 L	Glass bottle	1.88015.2500

3. Solvents for oils and fats

CombiSolvent oils | CombiSolvent fats | Solvent oils & fats

When determining the exact water content in oils and fats it is important that the samples are completely dissolved or dispersed. If the sample is not dissolved or dispersed completely, the water is not completely extracted during determination. Depending on the type of oil or fat to be determined, different solvents are suited for this purpose.



CombiSolvent oils | CombiSolvent fats

Mineral oils are primarily a mixture of long-chain hydrocarbons with aromatic compounds. Fats consist primarily of glycerol esters of higher fatty acids. The two classes of substance have different dissolution properties requiring different dissolution aids. We have therefore developed appropriate solvents for one component titration in both applications: CombiSolvent oils for mineral oils and CombiSolvent fats for fats in foodstuffs. Both are used in combination with CombiTitrants.

CombiSolvent fats is based on decanol, butyl acetate, and methanol, and is recommended for volumetric Karl Fischer analysis of water in fatty food, such as butter, margarine, vegetable fats, chocolate, mayonnaise, etc.

Solvent oils & fats

Solvent oils & fats is a universal solvent for long-chain, nonpolar substances as well as light fats and oils. It can be used with two component titrants, as well as with CombiTitrants.

Advantages

- Good solubility of oils and fats in the corresponding solvent
- No addition of dissolution aids necessary – immediately ready for use
- Constant and consistently high quality
- Without chloroform

Ordering information

Product	Content	Packaging	Ord. No.
Solvent oils & fats, for long-chain substances	1 L	Glass bottle	1.88016.1000
CombiSolvent oils, for mineral oils	1 L	Glass bottle	1.88020.1000
CombiSolvent fats, for fats in foodstuffs	1 L	Glass bottle	1.88021.1000

Solvent oils & fats can be used in combination with two component Titrant (188010), but also in combination with CombiTitrant (188005). For titration of oils and fats with a very low water content we recommend our titrants with the factor 2 and 1, respectively: CombiTitrant 1 (188001), CombiTitrant 2 (188002) and Titrant 2 (188011).

4. Reagents for aldehydes and ketones

CombiTitrant 5 Keto | CombiSolvent Keto

CombiTitrant 5 Keto and CombiSolvent Keto are two products of the Aquastar® product line. When performing water determinations with the Karl Fischer method in samples containing aldehydes and ketones it must be taken into account that these determinations are influenced by side reactions if methanol is used as a solvent.

CombiTitrant 5 Keto

CombiTitrant 5 Keto is a one component titrant — all reactive components required for the Karl Fischer reaction: SO_2 , I_2 and the base dissolved in a long-chain alcohol, are contained in a single reagent system.

CombiSolvent Keto

CombiSolvent Keto is a solvent based upon a mixture of alcohol designed to suppress the impact of side reactions with aldehydes and ketones. At the same time, its composition ensures optimum conditions for titration according to the Karl Fischer method with respect to stoichiometry, reaction rate and indication of the endpoint.

Ordering information

Product	Content	Packaging	Ord. No.
CombiTitrant 5 Keto, approx. 5 mg $\text{H}_2\text{O}/\text{mL}$ for aldehydes and ketones	1 L	Glass bottle	1.88006.1000
CombiSolvent Keto, methanol-free solvent for aldehydes and ketones	1 L	Glass bottle	1.88007.1000



CombiTitrant 5 Keto together with CombiSolvent Keto are designed for samples containing aldehydes and ketones.

Advantages

- Fast titration rate
- Toxic alcohol free
- Improved accuracy and reproducibility of the results
- Suppression of side reactions
- Consistently high quality

Coulometric titration

With diaphragm | Without diaphragm

The coulometric Karl Fischer titration method is preferred for water contents below 1%. In coulometric Karl Fischer titration, the iodine required for reaction is produced in the titration vessel itself by anodic oxidation at the generator electrode. The water

content is accurately determined by calculation from the amount of current used over a specific time period. The measuring cell for coulometric determination consists of anode and cathode compartments which can be separated by a diaphragm.

Advantages

- For low water contents below 1%
- Highly accurate and reliable reproducible results
- Same reagents for anode and cathode cell usable

water determination according to Karl Fischer





Coulometric reagents

CombiCoulomat frit | CombiCoulomat fritless | Coulomat Reagents

Our combined coulometric reagents have long since proved to be excellently suited for water determinations according to the coulometric Karl Fischer method.

CombiCoulomat frit | CombiCoulomat fritless

The CombiCoulomat fritless can be used universally for cells with or without diaphragm. Both reagents, CombiCoulomat frit and CombiCoulomat fritless, are free from chlorinated hydrocarbons. Our Aquastar® coulometric reagents CombiCoulomat frit and CombiCoulomat fritless are comparable to the volumetric one component reagents. All reaction components are contained in one solution, making handling easy.

Compared with volumetric reagents, coulometric reagents do not contain iodine, but iodide and the iodine required for the Karl Fischer reaction to take place develops through electrochemical oxidation. The coulometric method is primarily used for the determination of low water contents (<1%).

Coulomat Reagents

We have expanded our Karl Fischer reagent line with products for your convenience. These new products will bring you more convenience for even the most special applications.

Ordering information

Product	Content	Packaging	Ord. No.
CombiCoulomat frit, for cells with diaphragm	500 mL	Glass bottle	1.09255.0500
CombiCoulomat fritless, for cells with and without diaphragm	500 mL	Glass bottle	1.09257.0500
CombiCoulomat fritless, for cells with and without diaphragm	2.5 L	Glass bottle	1.09257.2500
Coulomat A, anode solution for cells with diaphragm	500 mL	Glass bottle polycoated	AX1697A-1
Coulomat C, cathode solution for cells with diaphragm	25 mL	Glass bottle polycoated	AX1697C-1
Coulomat AK, anode solution for aldehydes & ketones for cells with diaphragm	1 L	Glass bottle polycoated	AX1697E-1
Coulomat CK, cathode solution for aldehydes & ketones for cells with diaphragm	25 mL	Glass bottle	AX1697F-1

We recommend CombiCoulomat frit for coulometric devices with a diaphragm cell. For users working without a diaphragm or who frequently switch from cells with diaphragm to cells without diaphragm we recommend CombiCoulomat fritless. It can be used for both cell types.

Coulometric reagents advantages

- No confusion between anode and cathode cell solutions, since only one solution is required
- Very accurate and reproducible results
- Cell very rapidly ready for use after the first filling
- For samples with low water contents – below 1%
- Consistent quality for comparable results



Auxiliaries for Karl Fischer Titration

Buffer solutions

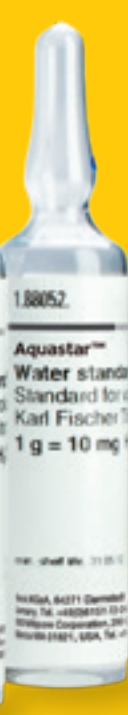
Both the complete dissolution of the sample plus the maintenance of a pH between 5 and 7 are extremely important in order to achieve accurate water determination results. When strong acids or alkalis are used as samples, the pH value can be pushed out of equilibrium. The addition of special buffer solutions ensures that the Karl Fischer

reaction can proceed in the correct pH range. When working with samples that may disturb the pH of the Karl Fischer reaction such as strong bases or strong acids, we offer two ready-to-use buffer solutions. These can be added to maintain the optimum pH range for accurate Karl Fischer results.

Ordering information

Product	Content	Packaging	Ord. No.
Buffer solution for strong acids, additive to the Karl Fischer solvent for titration of strong acids	500 mL	Glass bottle	1.88035.0500
Buffer solution for strong bases, additive to the Karl Fischer solvent for titration of strong bases	500 mL	Glass bottle	1.88036.0500
Karl Fischer Test Kit for Karl Fischer Titration without instruments			
Test Kit for water determination, according to Karl Fischer, Set*	1 set*	Fibre carton	1.88025.0001
Test Kit Titrant for water determination, according to Karl Fischer, Refill pack	100 mL	Glass bottle	1.88027.0001
Test Kit Solvent for water determination, according to Karl Fischer, Refill pack	500 mL	Glass bottle	1.88026.0001

*1 set consisting of: 100 mL Titrant (Glass bottle), 500 mL Solvent (Glass bottle), 1 Syringe, 1 Measuring flask 1 set consisting of: 100 mL Titrant (Glass bottle), 500 mL Solvent (Glass bottle), 1 Syringe, 1 Measuring flask.



Water standards in ampoules

The Aquastar® product range offers water standards in ampoules with different water contents. The standards consist of solvent mixtures with a defined water content. They are tested against standard reference material from NIST – National Institute of Standards and Technology, Gaithersburg, USA. Each package contains a batch-specific certificate with the exact measured water content of the batch, uncertainty data, measuring method, the NIST batch, and minimum shelf-life.

Water standard 1% is recommended for the use of titer determination with the volumetric method with one component and two component reagents. The two water standards 0.01% and 0.1% are used for the coulometric method.

Water standard oven 1%

This standard is an entirely solid standard for the Karl Fischer oven method. In contrast to other solid standards like lactose, citrate or tartrate, this standard has a considerably lower water content of only 1% and can be used over a wide temperature range from 140–400 °C. The composition of the solid standard is based on an inorganic substance, which is stable even at high temperatures. In contrast, with organic substances decomposition reactions with formation of water may already set in at temperatures above 150 °C, leading to erroneous results. The low water content of 1% is particularly suited when using the Karl Fischer oven with a coulometer. Each package contains a batch-specific certificate with the exact measured water content of the batch, uncertainty data, measuring methods — Karl Fischer method and thermogravimetry — and minimum shelf-life.

Ordering information

Product	Content	Packaging	Ord. No.
Water standard 0.01%, 1 g contains 0.10 mg H ₂ O	10 x 8 mL	Glass ampoule	1.88050.0010
Water standard 0.1%, 1 g contains 1.0 mg H ₂ O	10 x 8 mL	Glass ampoule	1.88051.0010
Water standard 1%, 1 g contains 10 mg H ₂ O	10 x 8 mL	Glass ampoule	1.88052.0010
Water standard oven 1%, solid standard for KF oven method	5 g	Glass bottle	1.88054.0005
Water standard oil, standard for oil samples for coulometric Karl Fischer titration (15 – 30 ppm)	10 x 8 mL	Glass ampoule	1.88055.0010
Lactose standard 5%, for volumetry and KF oven method	10 g	PE bottle	1.12939.0010
Sodium tartrate dihydrate, volumetric standard for water determination according to Karl Fischer, contains 15.66% H ₂ O	100 g	PE bottle	1.06664.0100
Water standard 5 mg/mL, 1 mL contains 5 mg water	250 mL	Glass bottle	1.09259.0250

Water standard oil 15 – 30 ppm

This standard is especially designed for users who need to measure the water content in oil samples. The water standard exactly corresponds to the low water content and the matrix of oil samples and the exact value for each batch is stated in the certificate. Practical ampoules ensure ease of handling.

Lactose standard 5%

The Aquastar® lactose standard is a further solid standard with a water content of about 5%. The batch-specific Certificate of Analysis states the exact value measured in the respective batch. The lactose standard can be applied universally. Due to its ease of solubility in methanol and its water content, this standard is suitable as a solid standard for both coulometric and volumetric Karl Fischer titrations. It is especially suitable if the working medium used consists of solvent mixtures in which sodium tartrate dihydrate is only slightly soluble. But it can also be used as an oven standard in a temperature range preferably from 140–160 °C.

Sodium tartrate dihydrate 15.66%

Sodium tartrate dihydrate is the volumetric standard for Karl Fischer titration. Under normal conditions it is stable and non-hygroscopic. Sodium tartrate dihydrate has a stoichiometric water content of 15.66% and is primarily used for titer determination in volumetry.

Water standard 5 mg/mL

This liquid water standard is based on a long-chain alcohol. Under normal conditions the adjusted water content is maintained after opening the bottle. This 5 mg/mL water standard can be used for daily titer control, but is not recommended for exact titer determinations.



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- Massenanteil von Irtitersubstanzen
- Massenanteil von Wasser in Wasserstandards und Urthern

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Registrierungsnummer der Urkunde: D-K-15185-01-00

Braunschweig, 24.02.2016

A. Wolf
Im Auftrag
Dr. Michael Wolf
Abteilungsleiter



Bitte beachten auf der Rückseite

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