

Volumetric Titration



Riedel-deHaën

High-quality titration reagents

For all your needs in volumetric titration



- Titration reagents and solutions
- Packaging options
- Dilution of Concentrates
- Indicators

Titration reagents, solutions and indicators

An overview of the evolving Sigma-Aldrich portfolio



Almost every analytical laboratory carries out titrations of some sort, even in this age of highly complex technical instrumentation and trace level analysis. Often, whole manufacturing processes depend on the accuracy of titration results and, hence, on the quality of the titration reagents.

Because analysts depend on the quality of the titration reagents, manufacturers of the reagents must adhere to strict quality criteria. High-quality titration products from Sigma-Aldrich include:

- Volumetric solutions: Acid / Base solutions, Salt and Buffer solutions
- Buffer solutions: pH 1.00 – 13.00
Color-coded buffer pH 4, 7, 9, 10
High precision buffer according to DIN 19 266
- Indicators for all types of volumetric titrations
- Packaging types for volumetric solutions:
Concentrates
Ready-to-use solutions
VOLPAC® containers (5 and 10 L)
- Reagents for complexometry
Aminopolycarboxylic acids (EDTA/NTA analogs)
Buffer solutions, indicators and masking agents for complexometric titration

Reagents

Sigma-Aldrich offers a wide variety of volumetric acid, base and salt standard solutions in different concentrations that can be used for acidimetric, alkalimetric, redox and precipitation titration methods. Some are also available as concentrates; please find complete product tables on www.sigma-aldrich.com/titration. **Table 1** shows an example of Sigma-Aldrich titration products for hydrochloric acid.

Table 1 ... Selection of Hydrochloric acid titration solution products by Sigma-Aldrich

Cat. No.	Brand	Description	Package Size	Type
35334	Fluka	Hydrochloric acid standard solution 0.01 mol/L	1 L, 2.5 L	Ready-to-use
35320	Fluka	Hydrochloric acid standard solution 0.05 mol/L	500 mL, 1 L	Ready-to-use
35335	Fluka	Hydrochloric acid standard solution Ph. Eur. 0.1 mol/L	1 L, 5 L, 5 L (VP*), 10 L (VP)	Ready-to-use
35329	Fluka	Hydrochloric acid standard solution Ph. Eur. 0.5 mol/L	1 L, 5 L (VP), 10 L (VP)	Ready-to-use
35328	Fluka	Hydrochloric acid standard solution Ph. Eur. 1.0 mol/L	1 L, 5 L, 5 L (VP), 10 L (VP)	Ready-to-use
35327	Fluka	Hydrochloric acid standard solution 2 mol/L	1 L, 10 L (VP)	Ready-to-use
31087	Fluka	Hydrochloric acid standard solution 6 mol/L	1 L	Ready-to-use
38272	Fluka	Hydrochloric acid standard solution FIXANAL, pkg of 0.01 mol (0.3646 g HCl)	1 piece	Concentrate
38280	Fluka	Hydrochloric acid standard solution FIXANAL, pkg of 0.1 mol (3.646 g HCl)	1 piece	Concentrate
38287	Fluka	Hydrochloric acid standard solution FIXANAL, pkg of 0.2 mol (7.292 g HCl)	1 piece	Concentrate
38285	Fluka	Hydrochloric acid standard solution FIXANAL, pkg of 0.5 mol (18.231 g HCl)	1 piece	Concentrate
38282	Fluka	Hydrochloric acid standard solution FIXANAL, pkg of 1.0 mol (36.461 g HCl)	1 piece	Concentrate
38281	Fluka	Hydrochloric acid standard solution FIXANAL, pkg of 2 mol (72.922 g HCl)	1 piece	Concentrate
38283	Fluka	Hydrochloric acid standard solution FIXANAL, pkg of 10 mol (364.61 g HCl)	1 piece	Concentrate

* VP: this material is packaged in a VOLPAC container, see details on page 5.



pH Buffer solutions

Buffers keep the pH value of a solution within a specified range, an important consideration for chemical and biochemical reactions involving ionizable compounds. Buffers are typically mixtures of weak acids or bases with their salts or the salts of multi-alkaline acids. By dissolving buffer substances in water that is free of salts and carbon dioxide, buffer solutions are created with reproducible pH values that remain stable for long periods.

The accuracy of Sigma-Aldrich buffer solutions is ensured by careful choice of the buffer substances, the use of deionized water with extremely low conductivity, and subsequent calibration of the pH value with standard buffer solutions to DIN 19266.

Buffers offered by Sigma-Aldrich include:

- Buffers pH 1.00 – 13.00
- Color-coded buffers
- High precision buffers according to DIN 19266
- Available as ready-to-use solutions, tablets, concentrates

Accuracy of Sigma-Aldrich buffer solutions at 20°C is as follows:

- Buffer solutions with pH values 1-9: ± 0.02
- Buffer solutions with pH values 10-13: ± 0.05

Fluka buffers from pH 2 to 7 contain a fungicide additive. For precision measurements and to calibrate pH meters, standard buffer solutions according to DIN 19266 and color-coded buffer solutions for the pH values 4.00 (red), 7.00 (green), 9.00 (blue) and 10.00 (violet) are available.

Table 2 ... Buffer product examples for pH 4 and 7 by Sigma-Aldrich

Cat. No.	Brand	Description	Package Size	Type
33643	Fluka	Buffer solution pH 4.0 (20°C) with fungicide	100 mL, 500 mL, 1 L, 5 L (VP*), 10 L (VP)	Ready-to-use
33646	Fluka	Buffer solution pH 7.0 (20°C) with fungicide	100 mL, 500 mL, 1 L, 5 L (VP), 10 L (VP)	Ready-to-use
33665	Fluka	Buffer solution pH 4.0 (20°C) with fungicide, red colored	500 mL, 1 L, 5 L (VP), 10 L (VP)	Ready-to-use
33666	Fluka	Buffer solution pH 7.0 (20°C) with fungicide, green colored	500 mL, 1 L, 5 L (VP), 10 L (VP)	Ready-to-use
33593	Fluka	Buffer standard solution according to DIN 19266, pH 4.008 (25°C), with fungicide	1 L	Ready-to-use
33597	Fluka	Buffer standard solution according to DIN 19266, pH 7.413 (25°C), with fungicide	1 L	Ready-to-use
38743	Fluka	Buffer concentrate FIXANAL, pH 4.00, for 500 mL buffer solution	1 piece	Concentrate
38746	Fluka	Buffer concentrate FIXANAL, pH 7.00, for 500 mL buffer solution	1 piece	Concentrate
82560	Fluka	Buffer tablets pH 4.0, 1 tablet for 100 mL buffer solution pH 4.0 (20°C)	50 tablets per unit	Tablets
82561	Fluka	Buffer tablets pH 7.0, 1 tablet for 100 mL buffer solution pH 7.0 (20°C)	50 tablets per unit	Tablets

* VP: this material is packaged in a VOLPAC container, see details on page 5.

Reagents for complexometric titration

In complexometric titration, metals in the sample react with complexing agents (chelating agents) to create complexes. Typically, a color change determines the end-point of the titration. Analytical applications include the determination of water hardness and special titrimetric metal determinations.

Aminopolycarboxylic acids as complexing agents form stable and water-soluble complexes with different kinds of metal ions. Complexometric determinations can be carried out selectively by choosing the suitable complexing agent, indicator, pH value, titration type and auxiliary substances.

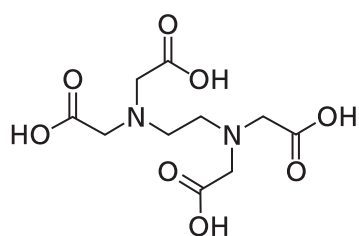


Figure 1 ... EDTA (Fluka 31064 IDRANAL II, puriss. p.a., $\geq 99.5\%$)

Sigma-Aldrich offers a selected range of aminopolycarboxylic acids (EDTA/NTA analogs) as reagents for complexometric titration under the trademark IDRANAL®. These reagents are stable at high temperatures, readily soluble in water and form stable chelates with most metal ions over a wide range of pH and temperature. They show hydrolytic stability in both acidic and alkaline conditions.

These complexometric reagents are available as solids, ready-to-use solutions and concentrates. In addition, buffer solutions, masking agents and indicators specially designed for complexometric titration are offered. Concentrates are available for preparation of DEV-volumetric solutions (German standard methods for water, sewage and slurry analysis) for foundry laboratories and titration in non-aqueous solutions to determine water hardness.



Packaging

The majority of Sigma-Aldrich's titration products are offered as both ready-to-use solutions and concentrates (FIXANAL® ampoules). The increasing automation and the escalating requirements of quality monitoring systems have created a need for ready-to-use solutions for many applications. The choice of concentrate vs. ready-to-use solution depends on your specific analytical requirements.

Advantages of ready-to-use solutions and concentrates

Ready-to-use solutions

- Contain exact amount in terms of concentration (e.g. 1 mol/L)
- Titer precision $1.000 \pm 0.1 \%$
- No further preparation required
- Also available in 5 and 10 L VOLPAC containers

Concentrates

- Contain exact amount of substance (e.g. 1 mol)
- Titer precision $1.000 \pm 0.2 \%$
- Economical and space-saving
- Final concentration is user-specified



Concentrates

FIXANAL, our volumetric concentrate, is designed to meet the customer's specific concentration requirement. The exact amount of the substance is always given, and by diluting the entire content of the ampoule to a desired volume, solutions of various concentrations can be prepared, knowing for certain that the absolute amount of the titration substance has been tested against a certified reference material.

For convenience, the ampoules are supplied with self-adhesive labels that can be easily attached to the storage vessel by the end-user. Depending on the content, the ampoules are made of different materials like high-resistance polyethylene (PE), black-pigmented PE or brown glass. The water used in dilution should be distilled and degassed, otherwise sluggish endpoints or changes of titer can occur.

Table 3... Dilution table for concentrates of acids, bases and salts

Amount of Substance (mol)	Concentration at different dilution volumes (mol/L)				
	0.5 L	1 L	2 L	5 L	10 L
0.005	0.01	0.005	0.0025	0.001	0.0005
0.01	0.02	0.01	0.005	0.002	0.001
0.025	0.05	0.025	0.0125	0.005	0.0025
0.1	0.2	0.1	0.05	0.02	0.01
0.2	0.4	0.2	0.1	0.04	0.02
0.25	0.5	0.25	0.125	0.05	0.025
0.5	1	0.5	0.25	0.1	0.05
1	2	1	0.5	0.2	0.1

Note: This table is not applicable for FIXANAL buffer concentrates; their final dilution volume is 500mL and should not be changed.



5L and 10L containers

Apart from the common package sizes up to 5 L, the Sigma-Aldrich portfolio also includes special 5 and 10 L VOLPAC containers when larger quantities of ready-to-use solutions are needed. VOLPAC containers consist of a rugged cardboard cube containing a flexible inner polyethylene bag with an outlet tap. As the solution is withdrawn, the polyethylene bag collapses, preventing influx and contamination by laboratory air. Also, because there is no ventilation of the vessel, the evaporation and condensation of water that increase the error of the titer is prevented. With each VOLPAC container, an adapter is provided for direct connection of the outlet tap to a titration tube.

Advantages of VOLPAC containers:

- Easy handling
- Titration without contamination
- High quality
- Low-volume packaging material
- Easy disposal

A complete list of all products that are available in VOLPAC containers can be found in **Table 4**. These products can be easily recognized as they are tagged with a '-VOLPAC' or '-VP' in their product number.

Table 4 ... Titration products by Sigma-Aldrich available in 5 or 10 L VOLPAC containers

Cat. No.	Brand	Description	Package Size	Type
35327	Fluka	Hydrochloric acid standard solution; 2.0 mol/L	10 L (VP)	Acid solution
35328	Fluka	Hydrochloric acid standard solution; Ph Eur 1 mol/L	5L (VP), 10 L (VP)	Acid solution
35329	Fluka	Hydrochloric acid standard solution; Ph Eur 0.5 mol/L	5L (VP), 10 L (VP)	Acid solution
35335	Fluka	Hydrochloric acid standard solution; Ph Eur 0.1 mol/L	5L (VP), 10 L (VP)	Acid solution
35348	Fluka	Sulfuric acid standard solution; 2.5 mol/L	5L (VP), 10 L (VP)	Acid solution
35354	Fluka	Sulfuric acid standard solution; Ph Eur 0.5 mol/L	5L (VP), 10 L (VP)	Acid solution
35355	Fluka	Sulfuric acid standard solution; Ph Eur 0.25 mol/L	5L (VP), 10 L (VP)	Acid solution
35357	Fluka	Sulfuric acid standard solution; Ph Eur 0.1 mol/L	5L (VP), 10 L (VP)	Acid solution
35358	Fluka	Sulfuric acid standard solution; Ph Eur 0.05 mol/L	5L (VP), 10 L (VP)	Acid solution
35116	Fluka	Potassium hydroxide standard solution; 0.5 mol/L	5L (VP)	Base solution
35125	Fluka	Potassium hydroxide standard solution; 0.1 mol/L	10 L (VP)	Base solution
35256	Fluka	Sodium hydroxide standard solution; Ph Eur 1 mol/L	5L (VP), 10 L (VP)	Base solution
35257	Fluka	Sodium hydroxide standard solution; 0.5 mol/L	5L (VP), 10 L (VP)	Base solution
31086	Fluka	Sodium hydroxide standard solution; 0.25 mol/L	5L (VP), 10 L (VP)	Base solution
35261	Fluka	Sodium hydroxide standard solution; 0.2 mol/L	10 L (VP)	Base solution
35263	Fluka	Sodium hydroxide standard solution; Ph Eur 0.1 mol/L	5L (VP), 10 L (VP)	Base solution
35262	Fluka	Sodium hydroxide standard solution; 0.01 mol/L	10 L (VP)	Base solution
34631	Fluka	Potassium dichromate standard solution; for COD determination according to DIN 38409, part 41; 0.02 mol/L	5L (VP)	Salt solution
35175	Fluka	Potassium iodide standard solution; 3 mol/L	5L (VP)	Salt solution
35375	Fluka	Silver nitrate standard solution; Ph Eur 0.1 mol/L	5L (VP), 10 L (VP)	Salt solution
34277	Fluka	Sodium carbonate standard solution; 0.5 mol/L	5L (VP), 10 L (VP)	Salt solution
34247	Fluka	Sodium fluoride standard solution; 40 g/L	10 L (VP)	Salt solution
34246	Fluka	Sodium oxalate solution; 25 g/L	10 L (VP)	Salt solution
35233	Fluka	Sodium thiosulfate standard solution; 0.2 mol/L	5L (VP)	Salt solution
34449	Fluka	Sodium thiosulfate standard solution; 0.05 mol/L	10 L (VP)	Salt solution
35224	Fluka	Sodium thiosulfate standard solution; for determination of iodine adsorption number according to ASTM D 1510; 0.0394 mol/L	5L (VP)	Salt solution
35245	Fluka	Sodium thiosulfate standard solution; Ph Eur 0.1 mol/L	5L (VP), 10 L (VP)	Salt solution
34544	Fluka	IDRANAL B (EDTA-Na ₂ solution with zinc complex added) for water hardness determination	5L (VP), 10 L (VP)	Complexometric solution
35102	Fluka	IDRANAL III (EDTA-Na ₂) standard solution; 0.2 mol/L	5L (VP), 10 L (VP)	Complexometric solution
34550	Fluka	IDRANAL III (EDTA-Na ₂) solution; Ph Eur 0.1 mol/L	5L (VP), 10 L (VP)	Complexometric solution
35103	Fluka	IDRANAL IV (CDTA-Na ₂) standard solution; Ph Eur 0.1 mol/L	5L (VP)	Complexometric solution
33643	Fluka	Buffer solution pH 4.0 (20 °C), with fungicide	5L (VP), 10 L (VP)	Buffer solution
33665	Fluka	Buffer solution pH 4.0 (20 °C), with fungicide, red colored	5L (VP), 10 L (VP)	Buffer solution
33646	Fluka	Buffer solution pH 7.0 (20 °C), with fungicide	5L (VP), 10 L (VP)	Buffer solution
33666	Fluka	Buffer solution pH 7.0 (20 °C), with fungicide, green colored	5L (VP), 10 L (VP)	Buffer solution
33648	Fluka	Buffer solution pH 9.0 (20 °C)	5L (VP), 10 L (VP)	Buffer solution
33667	Fluka	Buffer solution pH 9.0 (20 °C), blue colored	5L (VP), 10 L (VP)	Buffer solution
33668	Fluka	Buffer solution pH 10.0 (20 °C), violet colored	10 L (VP)	Buffer solution

These products are also available in other pack sizes. For complete product listings, please visit our website www.sigma-aldrich.com/titration.



Indicators

The endpoint of a titration can often be indicated only by using auxiliary substances. These so-called indicators are added to the titration medium and show the endpoint of the titration through easily recognizable visual changes like color change, clouding or fluorescence. Sigma-Aldrich provides indicator powders and solutions for acid-base, adsorption, redox and metal titration, as well as indicators for non-aqueous titration. A selection of these products is shown in **Table 5**. Please find a complete product list in our online product catalog www.sigma-aldrich.com/catalog under Analytical/Chromatography → Titration → Indicators.

pH papers and sticks

The color-changing reactions of pH paper are based on the same reaction mechanisms as the titration indicators. pH papers are absorptive cellulose papers that have been saturated with acidic or alkaline indicators. Sigma-Aldrich supplies two types of pH papers: first, simple indicator papers, such as litmus paper, that determine whether a solution is acidic or alkaline. Second, pH sticks saturated with indicator mixtures that differentiate between pH values. This latter group includes universal and specific indicator test sticks with colour comparison zones on low- or non-bleeding test sticks. A complete listing of test sticks can be found at the web address above.

Table 5 ... Selected Indicator products by Sigma-Aldrich

Cat. No.	Brand	Description	Package Size
33152	Fluka	1,5-Diphenylcarbazine puriss. p.a., Reag. Ph.Eur., ≥ 98 % (HPLC), for metal titration	10 g, 100 g
33135	Fluka	3,3'-Dimethylnaphthidine, for metal titration	1 g, 5 g
73000	Fluka	4-(4-Nitrophenylazo)-1-naphthol p.a., for determination of Mg	10 g
11090	Fluka	Arsenazo III, p.a., for determination of Th, Zr, U Cd, Zn, Ca	5 g, 25 g
32642	Fluka	Bromocresol Purple indicator, Reag. Ph.Eur.	5 g, 25 g
32712	Fluka	Bromophenol Blue indicator, Reag. Ph.Eur.	5 g, 25 g
21030	Fluka	Calcein disodium salt, for complexometry	1 g, 5 g, 100 g
33108	Fluka	Chromaeazuroil S, for metal titration	25 g, 1 kg
33153	Fluka	Diphenylcarbazone puriss. p.a., for determination of Cd, Cr, Cu, Fe, Hg, Mo	5 g, 10 g, 100 g
45260	Fluka	Eosin B, for microscopy (Fl., Hist.), adsorption and fluorescent indicator	25 g, 100 g
32751	Fluka	Eriochrome® Black T, Reag. Ph.Eur., for metal titration	25 g, 100 g, 1 kg
45690	Fluka	Erythrosin extra bluish, for microscopy (Bact., Hist.), adsorption and fluorescent indicator	10 g, 50 g
46270	Fluka	Ferrouin indicator solution, 0.025 mol/L, puriss. p.a., redox indicator	50 mL, 250 mL
32615	Fluka	Fluorescein free acid, puriss. p.a., Reag. Ph.Eur.	25 g, 100 g
46960	Fluka	Fluorescein sodium salt, for fluorescence	25 g, 100 g, 500 g
31283	Fluka	Indicator buffer tablets (IDRANAL), for complexometry	1 unit (1000 tablets)
32624	Fluka	Methyl Orange indicator, Reag. Ph.Eur.	100 g, 250 g
32654	Fluka	Methyl Red indicator Reag. Ph.Eur.	25 g, 100 g
33414	Fluka	Murexide, for complexometry	5 g, 10 g, 25 g
11950	Fluka	Rose Bengal sodium salt, adsorption indicator, for microscopy (Bact., Fl., Hist.)	10 g, 50 g
89360	Fluka	Thymolphthalein indicator, ACS reagent	10 g, 50 g



Traceability and reference materials

Assuring the traceability of reagents is an elaborate and often difficult process. In order to help analytical customers with this laborious task, Sigma-Aldrich offers accurate and traceable volumetric solutions tested against certified reference materials. Certified reference materials are reliable, readily quantifiable substances of high purity, low reactivity and hygroscopicity, high solubility and high equivalent weight. Major international organizations for reference materials, accreditation and certification.

- BAM German Federal Institute for Materials Research and Testing
- EMPA Swiss Federal Laboratories for Materials Testing and Research
- NIST National Institute of Standards and Technology, USA

All Sigma-Aldrich volumetric standard solutions are tested against reference materials.

For any further questions and information, please visit our website www.sigma-aldrich.com/titration.



HYDRANAL® Reagents for Water Determination by Karl Fischer Titration

Sigma-Aldrich is a pioneer in the supply of safe, reliable and easy-to-use pyridine-free Karl Fischer reagents:

Advantages of HYDRANAL Reagents

- High-speed titration
- Stable end points
- Accurate results
- No unpleasant odor
- Lower toxicity for increased safety and decreased environmental impact
- Long shelf life
- Broad application range

HYDRANAL Product Line at a Glance

HYDRANAL-Composite	The most frequently used pyridine-free Karl Fischer reagent for one-component volumetric titration
HYDRANAL-Solvent / Titrant	Volumetric titration with two-component reagents for higher accuracy and stability
HYDRANAL-Coulomat	Coulometric titration for samples with low water contents
HYDRANAL-Coulomat Oil	Coulometric water determination in oils
HYDRANAL-Methanol Rapid	Contains accelerants that speed up the reaction compared to methanol alone
HYDRANAL-K Types	Specially designed reagents for determining water in ketones and aldehydes
HYDRANAL-E Types	Ethanol-based reagents with reduced toxicity for both volumetric and coulometric titrations
HYDRANAL-Water Standards	Standards with certified water content for titer determination, monitoring precision and accuracy, validation and inspection of Karl Fischer titrators

For more information on HYDRANAL products for Karl Fischer Titration please visit us at sigma-aldrich.com/hydranal, where you can find application support in form of application notes and videos.

HYDRANAL® going green Non-toxic Karl Fischer titration with HYDRANAL E-type reagents

Visit our website for an E-type application list and find out how you can transfer your method, and eliminate toxic reagents from your KF determinations!

Also, take advantage of our extensive application database, and our expertise gained from over twenty-five years of experience on KF titration.

Features of HYDRANAL E-reagent line:

- Reduced toxicity
- Replacement for many methanolic KF methods
- Suitable for both volumetric and coulometric KF titrations
- Compatible with most instruments
- Improved solubility for hydrophobic samples
- CompoSolver E allows for the titration of several ketones without side reactions

NEW! Application list for non-toxic KF titration methods
Visit our website
sigma-aldrich.com/hydranal-e-types



For a comprehensive overview on titration products and support material visit us at sigma-aldrich.com/titration or contact our local technical service.

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