

Titration

Introduction

Even in this age of highly technical, instrumental, fine trace analysis, classical methods of titration remain in the standard programme of the analyst. Titrations are conducted in almost every analytical laboratory. The results of whole manufacturing processes often depend on the precision and reliability of the reagents and buffer solutions used in titrations. The production of these reagents must therefore be subject to strict quality criteria. Today, the range of Riedel-de Haën reagents for use in titrations encompasses:

- Acids/bases
- Buffer solutions
- Solutions of specific salts
- Complexing agents
- Indicators

FIXANAL® – the Concentrate

As early as 1924, the company then known as Riedel-de Haën AG became the first company in the world to market reagents in sealed ampoules for the production of solutions in precisely measured quantities. This was the birth of FIXANAL®, the volumetric concentrate which produced a balanced normal solution simply by diluting to 1000 ml. Even now, many customers throughout the world use FIXANAL® ampoules – but normality has been replaced by molarity.



Production and Quality Assurance

The production and quality assurance of FIXANAL® ampoules are subject to strict requirements. The continuous production monitoring and final examinations of the production lines provides a high degree of reliability for the specified titer guarantees. The special sealing process of the FIXANAL® ampoules leads to the best possible storage stability.

Handling the Ampoules

Every FIXANAL® ampoule contains precisely the amount of concentrate necessary for a ready-to-use reagent or buffer solution. It is only necessary to dilute the concentrate to the desired final volume. Usually, the concentrates are diluted to 1 liter for reagents and 0.5 liter for buffer solutions. Other concentrations of substances can be achieved by other dilution volumes. The ampoules are made of high-resistance polyethylene and have an attached funnel, (figure 1).

Simply twisting the ampoule opens the bottom outlet, a specially developed rinsing funnel facilitates the simple perforation of the diaphragm. The integrated deflector accelerates the complete

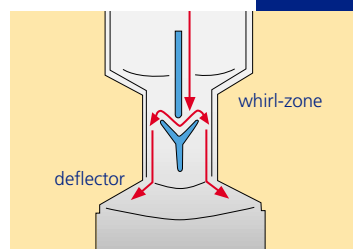


Figure 1:
View of the FIXANAL® -
washing zone

Contents:

- **FIXANAL® Concentrates**
- **Ready to Use Solutions**
- **Complexometry**
- **Buffer Solutions**
- **Indicators**
- **pH Papers**

rinsing of the concentrate. To make it easier for the user to mark the reagents, the ampoules are provided with self-adhesive labels, which can be easily attached to the storage vessel in the laboratory.

If made necessary by the chemical properties, the products are contained in black pigmented PE ampoules or in glass ampoules without the twist-opening mechanism. Naturally, all ready-to-use solutions and FIXANAL® concentrates are calibrated against independently produced reference standards. All chemicals and test equipment are examined according to the rules of DIN EN ISO 9001 and DIN EN ISO 14001.

Today, the range of FIXANAL® ampoules encompasses:

- Reagent solutions
- Buffer solutions
- Complexometry

Ready-to-Use Solutions

Increasing automation and the escalating requirements of existing quality monitoring systems make the use of ready-to-use solutions necessary in many applications. In comparison with FIXANAL® concentrates, ready-to-use solutions yield a higher titer precision, (figure 2), but can be used immediately.

Titer precision at 20°C

FIXANAL®-Concentrates	T= 1 ± 0.01 %
Ready-to-Use Solutions	T= 1 ± 0.02 %

Apart from the customary package sizes up to 5 liter, the Riedel-de Haën range also contains

special 10 liter VOLPAC® packages for requirements of larger quantities of ready-to-use solutions.

These containers consist of a rugged cardboard cube containing a flexible inner bag made of polyethylene with an outlet cock, (figure 3). When the solution is withdrawn, the polyethylene bag collapses without the entry of air, so that contamination by the air in the laboratory is prevented. Other advantages of this VOLPAC® package are the small storage space requirement, simple handling, low volume of packaging material and easy disposal.

Complexometry

In complexometric titration, metals react with complexing agents (chelating agents), to create soluble complexes. A large group of complexing agents is represented by the aminopolycarbonic acids, which Riedel-de Haën markets for different applications under the brand name IDRANAL®. These are based on ethylene-diamine-tetra-acetate complexes and similarly constituted complexes such as nitrilo-tri-acetate (NTA), diamino-cyclohexane-tetra-acetate (DCTA) and diethylene-triamino-penta-acetate (DTPA). The analytical applications are the determination of water hardness and special titrimetric determinations of metals. Complexometric titrations depend on the pH value. The metal content is determined by the quantity of consumed IDRANAL® solution, in which the point of equivalence is determined by metal indicators or by physical chemistry methods. IDRANAL® reagents are available as concentrates and ready-to-use solutions. Special complexometric FIXANAL® concentrates are available for volumetric solutions of the DEV (Deutschen Einheitsverfahren zur Wasser-, Abwasser- und Schlammuntersuchung, the German standard method for water, sewage and slurry analysis) for foundry laboratories, and for titration in non-aqueous solutions to determine water hardness.

Buffer Solutions

Many chemical and biological reactions depend on the concentration of hydrogen ions. In research and technology, it is important to know, and to adjust the pH value for a desired reaction. The pH value is stabilized against acid and alkaline influences by adding buffer substances or buffer solutions. Buffer substances are generally mixtures of weak acids and bases with their salts or the salts of multi-alkaline acids. By dissolving these buffer substances in water free of salts and carbon dioxide, buffer solutions are created whose pH values are reproducible and which remain stable for long periods even after the addition of substances which cause acid or alkaline reactions. The compensating reaction



Figure 3:
10 l VOLPAC® container

FIXANAL®-Concentrates	Ready-to-Use Solutions
Economical	High titer precision
Space-saving	Readily available
Individual concentrations	No preparation required

Figure 2:
Advantages of FIXANAL®-Concentrates
and Ready-to-Use Solutions

of hydrogen and hydroxide ions is based on the production of weak acids and bases due to the dissociation equilibrium. The quality of the Riedel-de Haën buffer solutions are ensured by exclusive use of initial substances «for analysis» and deionized water with extremely low conductivity, and calibration of the pH value with standard buffer solutions to DIN 19266.

Accuracy of buffer solutions at 20°C:

Buffer solutions with pH values 1-9: ± 0.02 pH

Buffer solutions with pH values 10-13: ± 0.05 pH

The buffers pH 2.00 to pH 7.00 contain a fungicide additive.

For precision measurements, and to calibrate pH meters, standard buffer solutions to DIN 19266 «pH measurement, standard buffer solutions» and color coded buffer solutions for the pH values pH 4.00 (red), pH 7.00 (green), pH 9.00 (blue) and pH 10.00 (violet) are available.

Indicators

The application for indicators is mainly volumetry. Indicators are usually organic compounds which change color in relation to the concentration of hydrogen ions. The change in the color is based on the absorption or release of protons. During this, the delocalizing capacity or mesomeric distribution of the π electron systems is changed. One of the properties of indicators is that they do not change color exactly at one pH value, but within a wide pH range. Within this transition range, which is different for every

indicator, the color of the indicator changes continuously. The transition point of an indicator is defined as the point at which the acid and alkaline forms of the indicator exist in equal concentrations.

For titration, Riedel-de Haën offers indicators as solids, dye solutions and as indicator papers with different transition ranges. Some applications are pH measurement, adsorption titration, metal titration, determination of the redox potential and redox titration.

pH Papers

The color reactions of pH papers are also based on the same reaction mechanism as the titration indicators. pH papers are absorptive cellulose papers saturated with acid and alkaline indicators. Riedel-de Haën provides two types of pH papers. Simple indicator papers, such as litmus paper, allow one to determine only whether a solution reacts as an acid or a base. pH papers, which are saturated with indicator mixtures, allow the differentiation between different pH values. This group includes the universal indicator papers and the highly accurate PEHANAL® and PANPEHA® papers.

Riedel-de Haën indicator papers are supplied in different forms, (figure 4). Apart from the test strips, diverse pH papers are also available by the roll. Another speciality are the universal and specific indicator test sticks, in which the color comparison zones are applied to special plastic sticks which have a very low tendency to bleed.

Figure 4:
Comparison of
Riedel-de Haën pH-papers

	Universal Indicator Paper	Specific Indicator Paper	PEHANAL®	PANPEHA®
Supplied form:	Roll/stick	Roll/Stick	Roll	Stick
Indication surfaces:	1/4	1	3	8
Measuring range:	0-14	diverse	1-11	0-14
Graduation:	1/1	0.2-0.5/0.2-0.5	1	0.5

Summary of Titration Products

FIXANAL® - Concentrates	Volumetric-precise Solutions	Buffer Solutions	Indicators	Reagent Papers/Sticks
acids	acids	pH 1.00 - 13.00	pH indicators	universal pH indicator paper
bases	bases	color coded buffers	adsorption indicators	universal pH indicator sticks
buffers	buffers	buffers ac. DIN** 19266	metal titration indicators	special pH indicator paper
salts	salts	special buffer solutions	redox indicators	special pH indicator sticks
			indicator solutions	PANPEHA® - pH indicator paper
				PEHANAL® - pH indicator paper
specially reagents:	specially reagents:	specially reagents:	specially reagents:	specially reagents:
ac. DEV*	according DEV*	indicator buffer tablets	IDRANAL® - indicator	lead acetate paper
for non-aqueous titration	for non-aqueous titration		buffer tablets	sulfite testing paper
IDRANAL® - for complexometry	soap solutions			litmus paper
	IDRANAL® - for complexometry			starch-potassium iodide paper

* DEV - Deutsche Einheitsverfahren - German Standard Method for Analysis

** DIN - Deutsche Industrienorm - German Industrial Norm

Riedel-de Häen also offers the following product groups:

- HYDRANAL® Karl-Fischer Titration
- PESTANAL® Standards for Residue Analysis
- AQUANAL® Rapid Water Analysis
- SODOSIL® Cleaning Agents
- High Purity Solvents
- Semiconductor Grade Chemicals

For detailed information about the product groups please contact

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