Application Note AN-T-237

Determination of phosphoric acid with sodium hydroxide

Fast and accurate potentiometric titration with NaOH

Phosphoric acid (H_3PO_4) is one of the most important inorganic acids in use today. This strong acid is triprotic, meaning it has three dissociable protons. It can be used for many purposes, e.g., as a raw material for the production of phosphate fertilizers, in detergents and rust removers, as an electrolyte in phosphoric acid fuel cells, and for the passivation of iron and zinc to protect against corrosion. In the food and beverage industry, phosphoric acid is used in diluted form as a preservative, acidifier in soda, as an acidity regulator in general, and as an antioxidant in sausages and other meats.

Since H_3PO_4 is also used to produce buffer solutions (phosphate buffers) in various laboratories, its accurate analysis is indispensable.

This Application Note presents an acid-base titration where the concentration of phosphoric acid is determined over all three of its dissociable protons by titrating it with sodium hydroxide.

SAMPLE AND SAMPLE PREPARATION

This application is demonstrated on phosphoric acid. Sample preparation is not required.

EXPERIMENTAL

The determinations are carried out on an Eco Titrator equipped with a Unitrode with integrated Pt1000 (Figure 1). The H_3PO_4 (acid solution) reacts with NaOH (strong base) via the following neutralization reaction mechanism:

$H_3PO_4 + 3\ NaOH \rightarrow Na_3PO_4 + 3\ H_2O$

An appropriate amount of sample is pipetted into the titration beaker and then deionized water and sodium chloride are added. Afterwards, the solution is titrated until after the third endpoint with standardized sodium hydroxide.

Figure 1. Eco Titrator equipped with a Unitrode with integrated Pt1000.

RESULTS

This method offers very accurate results, as displayed in Table 1. One exemplary H_3PO_4 titration curve with NaOH is shown in Figure 2.

Table 1. Results of the potentiometric titration of H3PO4 calculated via the second endpoint (n = 10).

Sample (n = 10)	NaOH in mL	H_3PO_4 in mol/L	Recovery in %
Mean value	3.998	0.999	99.99
SD(abs)	0.00	0.00	0.10
SD(rel) in %	0.07	0.05	0.10

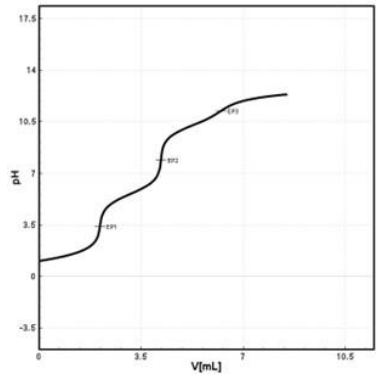

Figure 2. Phosphoric acid titration curve with three equivalence points (EP) shown.

CONCLUSION

The potentiometric titration of phosphoric acid with sodium hydroxide solution is routine in many laboratories.

It is normally only possible to titrate the first two protons of phosphoric acid in aqueous solution. By increasing the ionic strength, H_3PO_4 can completely dissociate. Thanks to the special properties of the Unitrode from Metrohm, it is possible to detect the third proton for the most accurate results.

This kind of acid-base titration is perfect for the Eco Titrator with its integrated magnetic stirrer and touch-sensitive user interface. This system offers customers low-priced, simple handling within a compact footprint (approximately DIN A4). Pre-installed methods on the Eco Titrator enable users without laboratory experience to get right to work without complications. The Eco Titrator gives fast, reliable, precise, and GLP-compliant results in a small user-friendly package.

CONTACT

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CONFIGURATION

Eco Titrator

The compact Eco Titrator with integrated magnetic stirrer and touch-sensitive User Interface is ideal for routine analysis. It provides GLP-compliant results with minimum space requirements at all times (approx. DIN A4).

Universally compatible with almost all potentiometric titrations, such as, for example, for

- Food products: Acid content, chloride, Vitamin C, iodine and peroxide number in fats
- Water analysis: Carbonate and Ca/Mg hardness, chloride, sulfate, permanganate index
- Petrochemistry: Acid/base number, sulfide & mercaptans, chloride, bromine number
- Electroplating: Total acid, metal content, chloride
- Surfactant analysis: Anionic, cationic and non-ionic surfactants
- Photometry with the Optrode: p and m value, metals, water hardness