pH and Acidity in Tomato Sauce

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Endpoint potentiometric titration
Scope and application: Tomato sauce

1. Introduction

This working procedure refers to the determination of titratable acidity in tomato sauce.

2. Principle

The protocol rests on a weak acid titration by a strong base.

The equivalent volume is determined from the pH jump in endpoint mode. By default, the endpoint pH value is set to 8.1.

Acidity is given in mmol of H^+ per 100 g of product and in g of a chosen acid per 100 g of product.

3. Electrode and reagents

Electrodes: Intellical combined pH electrode with integrated temperature sensor, PHC725

Titrant: NaOH 0.1 eq/L. Use a commercial solution or dissolve 4.00 g of sodium hydroxide in 1 L of CO_2-free boiled water.

Standard for titrant calibration: Dihydrate oxalic acid, molar weight = 126.07 g/mol

pH standards: Colored 4.01, 7.00, 10.01 (part numbers 2283449, 2283549, 2283649)

Deionized water

4. Ranges and settings

4.1. Default parameters

The working procedure is described using the following parameters:

- m sample = 2.500 g
- Syringe volume = 10 mL

4.2. Working range

For most samples, 1 syringe (10 mL) of titrant should be sufficient to reach the equivalent point. It provides the following range:

Veq (mL)	1.0	9.5
Acidity in mmol H^+ /100g	4	38

The syringe is allowed to refill once during titration, so the range is widened:

Veq (mL)	1.0	19
Acidity in mmol H^+ /100g	4	76

For low-concentrated samples, it is recommended to analyze more than 2.5 g of product (up to 10 g) in order to obtain a sufficient equivalent volume.

4.3. Settings

4.3.1. pH in tomato sauce

Name	Default parameter	Unit
Probe		
Recommended probe	PHC725	
Stirring		
Stirring speed	15	[%]
Time	15	[s]
pH measurement		
Stirring speed	0	[%]
Measured parameter		[pH]
Stability criteria	0.05	[pH/min]
Stability max time	120	[s]

4.3.2. Acidity in tomato sauce

Name	Default parameter	Unit
Sample		
Name	Tomato sauce	
Amount	2.500	[g]
Amount min	0	[g]
Amount max	10	[g]
Probe		
Recommended probe	PHC725	
Titrant		
Name	NaOH	
Titrant concentration	0.1000	[eq/L]
Syringe	Syringe 1	
EP titration		
Stirring speed	20	[%]
Measured parameter		[pH]
Predose	0	[mL]
Max volume stop point	20	[mL]
Stop on last EQP	True	
Delay	10	[s]
Min increment size	0.15	[mL]
Max increment size	1.5	[mL]
EP Ordinates	8.1	[pH]
Result 1 name	Acidity (mmol/kg)	
R1 hide	Yes	
Result 2 name	Acidity	
R2 hide	No	
R2 unit	mmol of H^+/100g	
R2 resolution	1 decimal	
R2 min	0	[mmol/100g]
R2 max	75	[mmol/100g]
R2 QC min	0	[mmol/100g]
R2 QC max	75	[mmol/100g]
Result 3 name	Acidity	
R3 hide	No	
R3 unit	g of acid/100g	
R3 resolution	2 decimals	
R3 min	0	[g/100g]
R3 max	7	[g/100g]
R3 QC min	0	[g/100g]
R3 QC max	7	[g/100g]

4.4. Modification of the settings

The parameters are defined in order to have the best compromise between accuracy and titration time.

For higher concentration with a high titrant volume, titration time can be reduced with an addition of titrant (predose) at the beginning of the titration. Enter the predose volume (in mL) and the stirring time after the addition in the application edit window.

5. Titration procedure

Rinse the pH probe with deionized water.

Weigh around 2.5 g of product in the 50 mL polypropylene beaker. Use a graduated cylinder to add 30 mL of deionized water. Put in a magnetic stir bar, dip the probe and the delivery tip in the solution. Start the application. When prompted, type in the exact weighed amount of the product. At the end of the titration, a first window displays the result. A second window displays the titration curve and the equivalent point coordinates.

After the titration, there are two possibilities:

- Replicate the sample. This is used to study the repeatability by analyzing several samples successively. At the end of each titration, a window displays the average value, the standard deviation (SD) and the relative standard deviation (RSD in %).
- Analyze a new sample. Another titration can be started but no Standard Deviation and RSD value will be made.

6. Results

6.1. Result calculation

The calculations used are:

$$\text{Acidity (mmol H+/100g)} = \frac{C_{titrant}\ (eq/L) \times V_{titrant}\ (mL)}{n_{e\text{- H+}} \times n_{e\text{- titrant}} \times m_{sample}\ (g)} \times \frac{1000}{10}$$

$$= \frac{0.1\ (eq/L) \times V_{titrant}\ (mL)}{1 \times 1 \times m_{sample}\ (g)} \times \frac{1000}{10} = G1$$

$$\text{Acidity (g acid /100g)} = G1 \times FX$$

The factor FX (0.070 by default) has to be chosen depending on the required unit:

Acid	Factor
Citric acid monohydrate	0.070
Malic acid	0.067
Oxalic acid	0.045
Tartaric acid	0.075
Sulfuric acid	0.049
Acetic acid	0.060
Lactic acid	0.090
Citric acid	0.064

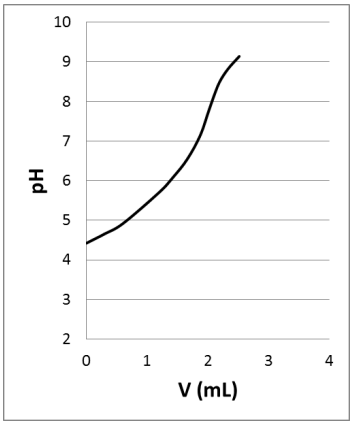
6.2. Experimental results

These results are indicative and have been obtained for a given sample of tomato sauce for ten successive determinations.

Measurement	Parameter	Unit
Mean concentration	7.8	[mmol H^+ /100g]
Standard deviation	0.01	[mmol H^+ /100g]
Relative standard deviation	0.1	[%]
Mean titration duration	51	[s]
Mean analysis duration (pH + delay + acidity)	82	[s]

6.3. Example of a titration curve

This curve has been obtained during the analysis of one of the 10 samples.



7. Recommendations

Always rinse the pH probe and the delivery tip between measurements.

Refill the electrode regularly with KCl saturated solution to maintain the level of internal solution around 1 cm (0.4 inches) below the refill hole.

8. Bibliography

- *Standard ISO 750:1998*

9. Appendices

9.1. Electrode calibration

For the precision of the titration, it is recommended to calibrate the probe with pH standards at the same temperature as the samples. For calibration, the pH is compensated at 25 °C.

Pour a sufficient amount of the first buffer into a 50 mL beaker and add a magnetic stir bar. Place it on the titrator under the probe holder and dip the probe into the beaker. Start the electrode calibration sequence. Rinse the probe between two buffers. Repeat this operation for each buffer (at least two buffers are recommended).

At the end of the calibration, the results of the slope and offset are displayed and the user can accept or reject this result.

Default settings for electrode calibration

Name	Setting	Unit
Stirring speed	25	[%]
Stability criteria	0.05	[pH/min]
Stability max time	300	[s]
Slope limit min	97	[%]
Slope limit max	102	[%]
Offset limit min	29	[mV]
Offset limit max	89	[mV]

9.2. Titrant calibration

The sodium hydroxide solution can be calibrated. The exact concentration can be determined from an acid-base titration using an oxalic acid solution.

Weigh 25 to 40 mg of dihydrate oxalic acid in a 50 mL beaker and use a graduated cylinder to add 30 mL of deionized water. Put in a stir bar, dip the probe and the delivery tip into the solution and launch the titrant calibration sequence. When prompted, type in the exact weighed amount (three digits). At the end of the titrant calibration, titer (eq/L) is displayed and the user can reject, replicate, or save the result.

Default settings for titrant calibration

Name	Default parameter	Unit
Titrant		
Name	NaOH	
Titrant concentration	0.1000	[eq/L]
Syringe	Syringe 1	
Standard		
Name	Oxalic acid	
Amount	30	[mg]
Amount min	25	[mg]
Amount max	40	[mg]
Molar weight	126.07	[g/mol]
EP titration		
Stirring speed	25	[%]
Measured parameter		[pH]
Predose	2	[mL]
Max volume stop point	8	[mL]
Stop on last EQP	True	
Delay	0	[s]
Min increment size	0.08	[mL]
Max increment size	0.8	[mL]
EP Ordinates	8.55	[pH]
Result name	Titer	
Result resolution	4 decimals	
Result min	0.09	[eq/L]
Result max	0.11	[eq/L]

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