

HIRANUMA APPLICATION DATA	Automatic Titrator	Data No.	O6	Feb. 03, 2022
Factor standardization	Standardization of sodium acetate titrant			

1. Abstract

Non-aqueous titration using a 0.1 mol/L perchloric acid-acetic acid solution (hereinafter referred to as perchloric acid titration) has been used for test methods such as *JIS K2501 "Petroleum products and lubricants – Determination of neutralization number"* and determination of purity for some substance in the *Japanese Pharmacopoeia*. Weakly basic components that hardly react with a titrant in water can be quantified by neutralization titration with the perchloric acid titration. When a clear inflection point is not obtained with normal perchloric acid titration, back titration method combined with perchloric acid titration is used.

In the back titration method of perchloric acid titration, 0.1 mol/L sodium acetate-acetic acid solution is used as the titrant. An excessive amount of 0.1 mol/L perchloric acid-acetic acid solution is added to the sample to react with target component, and the remaining perchloric acid is titrated with sodium acetate-acetic acid solution to indirectly quantify the target component. Therefore, it is necessary to standardize the sodium acetate-acetic acid solution before performing the back titration.

A standardized perchloric acid-acetic acid solution is used for the factor determination of the sodium acetate-acetic acid solution. Please refer to the application Data No. B20 for the method of standardizing perchloric acid-acetic acid solution.

The method for preparing and standardizing the sodium acetate-acetic acid solution is different between the *Japanese Pharmacopoeia* and *JIS K2501*. In the *Japanese Pharmacopoeia*, sodium acetate-acetic acid solution is added to the titration vessel as a sample and titrated with perchloric acid-acetic acid solution. On the other hand, in *JIS K2501*, perchloric acid-acetic acid solution is used as a sample and titrated with sodium acetate-acetic acid solution. Moreover, *JIS K2501* describes two procedures, A and B, in which the amount of titration solvent is different in the standardization. In this report, the factors of the sodium acetate-acetic acid solution were standardized by two different method in reference to the *Japanese Pharmacopoeia* and *JIS K2501* (Procedure A), respectively. 1 mol of perchloric acid and 1 mol of sodium acetate react quantitatively according to formula (1), and the titration curve shows an inflection point at the end point.



- 1) Japanese Pharmacopoeia Eighteenth Edition
- 2) Japanese Industrial Standard JIS K2501

2. Configuration of instruments and reagents

(1) Configuration of instruments

Main unit	: Automatic Titrator	COM Series
	Optional buret	1 unit

Electrodes : Glass electrode GE-101B
Reference electrode RE-201Z
Inner solution of RE-201Z is replaced to a saturated sodium perchlorate-acetic acid solution.

* It can also be applied to glass-reference combination electrode GR-511BZ.

(2) Reagents

Titrant : 0.1 mol/L (0.1 N) sodium acetate-acetic acid solution (Buret No. 2)

Preparation procedure on Japanese Pharmacopoeia

Dissolve 8.2 g of sodium acetate anhydrous in acetic acid, and dilute to 1 L with acetic acid.

Preparation procedure on JIS K2501

Dissolve 5.3 g of sodium carbonate anhydrous in acetic acid, and dilute to 1 L with acetic acid.

Standard sample : 0.1 mol/L (0.1 N) perchloric acid-acetic acid solution (f = 1.000, Buret No.1)

Titration solvent : Acetic acid (Japanese Pharmacopoeia)
Mixture of 500 mL of glacial acetic acid and 1 L of toluene (JIS K2501)

3. Measurement procedure

(1) Standardization procedure according to Japanese Pharmacopoeia.

- i) Add 50 mL of acetic acid and a stirrer bar to a 100 mL beaker.
- ii) Immerse the electrodes and start the measurement.
- iii) 10 mL(*a) of 0.1 mol/L sodium acetate-acetic acid solution is added to the beaker by the buret dispensing.
- iv) Titration is subsequently performed with 0.1 mol/L perchloric acid-acetic acid solution. The inflection point on the titration curve is detected as the end point.
- v) Perform a blank test by the same operation except iii).

*a: It is described as 25 mL in Japanese Pharmacopoeia. In this report, it was set to 10 mL to save reagents.

(2) Standardization procedure according to JIS K2501 with procedure A.

- i) Add 120 mL(*b) of titration solvent and a stirrer bar to a 200 mL tall beaker.
- ii) Immerse the electrodes and start the measurement.
- iii) 10 mL(*c) of 0.1 mol/L perchloric acid-acetic acid solution is added to the beaker by the buret dispensing.
- iv) Titration is subsequently performed with 0.1 mol/L sodium acetate-acetic acid solution. The inflection point on the titration curve is detected as the end point.
- v) Perform a blank test by the same operation except iii).

*b: It is described as 120 mL in the procedure A and 60 mL in the procedure B of JIS K2501.

*c: It is described as 8 mL in the procedure A and 4 mL in the procedure B of JIS K2501. In this report, it was set to 10 mL in order to make it same to as (1).

4. Measurement conditions and results

Examples of titration conditions

(1) Blank of Japanese Pharmacopoeia

M. File	1		
Cndt No.	1		
Method	Auto	ConstantNo.	1
Buret No.	1	Size	0 mL
Amp No.	1	Blank	0 mL
D. Unit	mV	Molarity	0.1 mol/L
S-Timer	5 Sec	Factor	0
C.P. mL	0.0 mL	K	0
T Timer	0 sec	L	0
D.P. mL	0.0 mL		
End Sens	200	Unit	mL
Over mL	0.50 mL	Formula	D
Max.Vol.	1 mL	Digits	4
		Mode No.	16 *1
		Pre Int	0 sec
		Del K	0
		Del Sens	0 mV
		Int Time	3 sec
		Int Sens	5 mV
		Brst Speed	2
		Pulse	16

*1: Since the maximum change in electrode potential is shown at the first drop of this blank titration, the end point is detected in the first drop or less volume. To detect this maximum change as an end point, set Mode No. to which the blank mode function is assigned, Mode No.12-19 for COM-A19.

(2) Factor standardization of Japanese Pharmacopoeia

M. File	2+3		
Cndt No.	2		
Method	Disp		
Buret No.	2		
S-Timer	5 sec		
Disp Vol.	10 mL		
Cndt No.	3		
Method	Auto	ConstantNo.	3
Buret No.	1	Size	10 mL
Amp No.	1	Blank	0.01 mL
D. Unit	mV	Molarity	0.1 mol/L
S-Timer	5 sec	Factor	1.000 *2
C.P. mL	0 mL	K	0
T Timer	0 sec	L	0
D.P. mL	1.0 mL		
End Sens	200	Unit	Fact
Over mL	0.5 mL	Formula	(D-B)/S*F
Max.Vol.	20 mL	Digits	4
		Mode No.	21
		Pre Int	0 sec
		Del K	5
		Del Sens	0 mV
		Int Time	3 sec
		Int Sens	5 mV
		Brst Speed	2
		Pulse	40

*2: Factor of 0.1 mol/L perchloric acid-acetic acid solution

(3) Blank of JIS K2501

M. File	4		
Cndt No.	4		
Method	Auto	ConstantNo.	4
Buret No.	2	Size	0 mL
Amp No.	1	Blank	0 mL
D. Unit	mV	Molarity	0.1 mol/L
S-Timer	5 Sec	Factor	0
C.P. mL	0.0 mL	K	0
T Timer	0 sec	L	0
D.P. mL	0.0 mL		
End Sens	200	Unit	mL
Over mL	0.50 mL	Formula	D
Max.Vol.	1 mL	Digits	4
		Mode No.	16 *3
		Pre Int	0 sec
		Del K	0
		Del Sens	0 mV
		Int Time	3 sec
		Int Sens	5 mV
		Brst Speed	2
		Pulse	16

*3: Since the maximum change in electrode potential is shown at the first drop of this blank titration, the end point is detected in the first drop or less volume. To detect this maximum change as an end point, set Mode No. to which the blank mode function is assigned, Mode No.12-19 for COM-A19.

(4) Factor standardization of JIS K2501

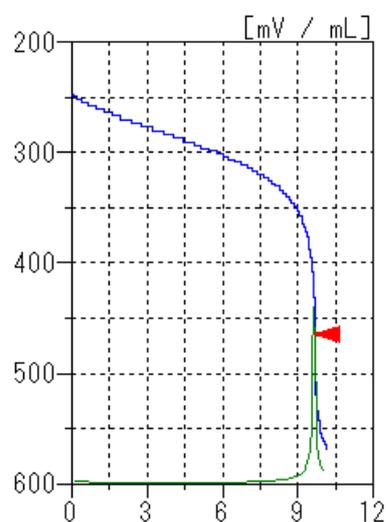
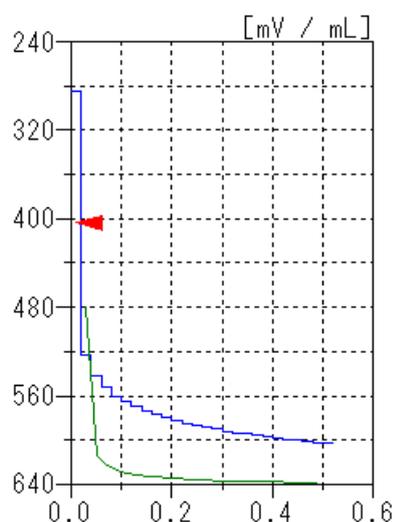
M. File	5+6		
Cndt No.	5		
Method	Disp		
Buret No.	1		
S-Timer	5 sec		
Disp Vol.	10 mL		
Cndt No.	6		
Method	Auto	ConstantNo.	6
Buret No.	2	Size	10 mL
Amp No.	1	Blank	0.01 mL
D. Unit	mV	Molarity	0.1 mol/L
S-Timer	5 sec	Factor	1.000 *4
C.P. mL	0 mL	K	0
T Timer	0 sec	L	0
D.P. mL	1.0 mL		
End Sens	200	Unit	Fact1
Over mL	0.5 mL	Formula	$S/(D-B)*F$
Max.Vol.	20 mL	Digits	4
		Mode No.	21
		Pre Int	0 sec
		Del K	5
		Del Sens	0 mV
		Int Time	3 sec
		Int Sens	5 mV
		Brst Speed	2
		Pulse	40

*4: Factor of 0.1 mol/L perchloric acid-acetic acid solution

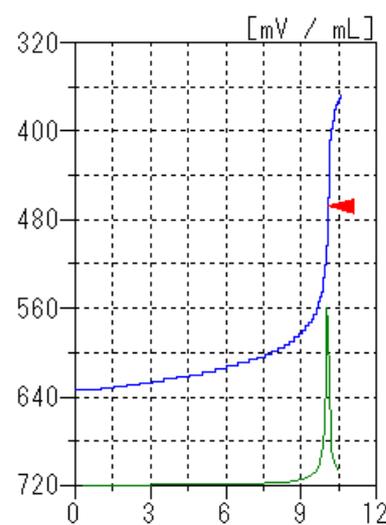
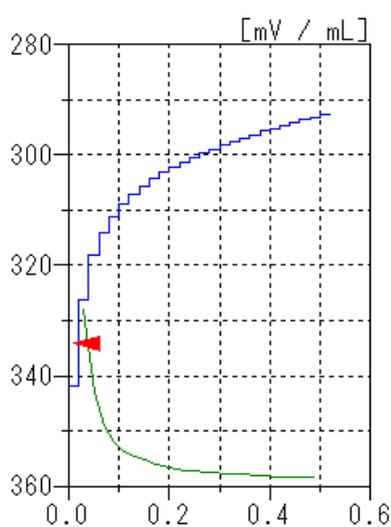
Measurement results

Measurement result of factor standardization for sodium acetate-acetic acid solution

Procedure	Sample	Measurement No.	Sample size (mL)	Titrant volume (mL)	Factor	Statistic calculation	
Japanese Pharmacopoeia	Blank	1	-	0.010	-		
	Factor	1	10	9.628	0.9618	Avg.	0.962
		2	10	9.630	0.9620	SD	0.000 ₁
		3	10	9.629	0.9619	RSD	0.01 %
JIS K2501	Blank	1	-	0.010	-		
	Factor	1	10	10.034	0.9976	Avg.	0.997
		2	10	10.039	0.9971	SD	0.000 ₄
		3	10	10.042	0.9968	RSD	0.04 %



Japanese Pharmacopoeia (Left)Blank、(Right)Factor



JIS K2501 (Left)Blank、(Right)Factor

Examples of titration curves

5. Note

(1) About the factor calculation formula of the sodium acetate-acetic acid solution of the Japanese Pharmacopoeia

In measurement of the factor standardization, there are many case examples of titrating a standard material using the titrant to be standardized. In the Japanese Pharmacopoeia procedure for sodium acetate-acetic acid solution, the titrant and the sample are reversed. The perchloric acid-acetic acid solution is used as the titrant, and the sodium acetate-acetic acid solution to be standardized is used as the sample for titration.

In this case, the factor calculation formula is set as $[(D-B)/S \cdot F]$. This formula is not initially installed in the titrator and must be set using the formula editing function.

The calculation formula is derived based on the following relational formula (2). The left side (subscript s) is the titrant of perchloric acid-acetic acid solution and has already been standardized preliminary, and the right side (subscript t) is the sample of sodium acetate-acetic acid solution to be standardized.

$$n_s \times M_s \times F_s \times (D - B) = n_t \times M_t \times F_t \times S \quad \cdot \cdot \cdot (2)$$

Perchloric acid		Sodium acetate	
n_s	: Valence (1)	n_t	: Valence (1)
M_s	: Molar concentration (0.1)	M_t	: Molar concentration (0.1)
F_s	: Factor (Known)	F_t	: Factor (Unknown)
D-B	: Titrant volume (mL)	S	: Sample size (mL)

(2) Tips for perchloric acid titration

Perchloric acid titration is a non-aqueous titration, so if water gets into the sample solution, the inflection point on titration curve at the end point become unclear. Therefore, it is necessary to replace the inner solution of the reference electrode from potassium chloride aqueous solution to the saturated sodium perchlorate-acetic acid solution.

Since the perchloric acid-acetic acid solution and sodium acetate-acetic acid solution consist of organic solvents, the volume expansion due to temperature change is 0.11% per 1 °C, which is larger than that of the aqueous solution. Therefore, it is important to keep the same temperature as much as possible through the standardization of perchloric acid standard solution, the standardization of sodium acetate standard solution, and the measurement of the sample. Please refer to Application Data No. B19 and 20, which explain this in detail.

Keywords : Factor standardization, Non-aqueous titration, Perchloric acid titration, Back-titration, Sodium acetate, JIS K2501, Japanese Pharmacopoeia