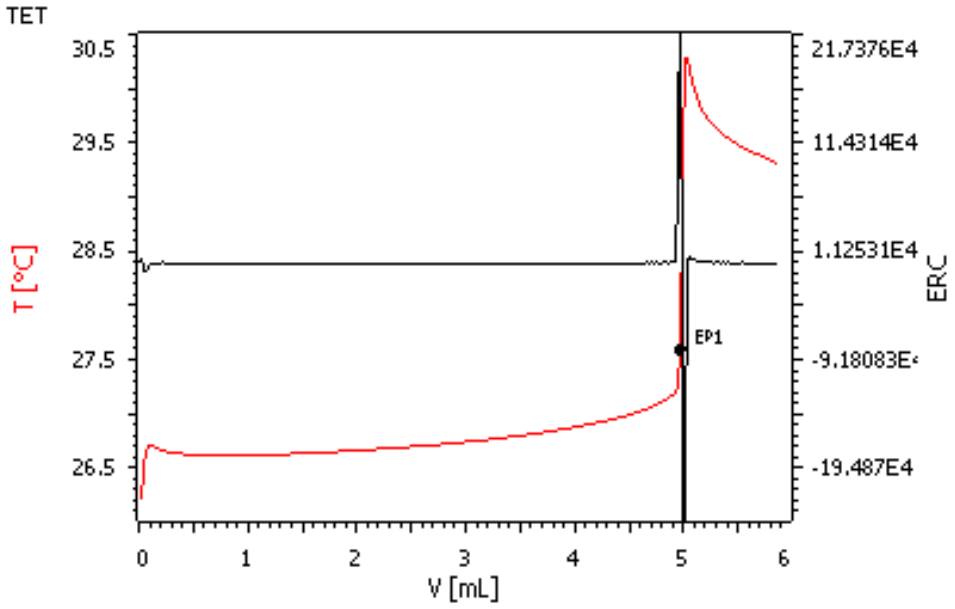
Titration Application Note H-129

Determination of weak bases in nonaqueous media by catalyzed endpoint thermometric titrimetry (CETT)



Weak organic bases soluble in nonaqueous solvents (including nonpolar solvents) may be determined by titration with strong acids such as anhydrous perchloric or trifluoromethanesulfonic acid in glacial acetic acid. The endpoint of such titrations may be determined thermometrically, if a suitable thermometric endpoint indicator is used. Isobutyl vinyl ether (IBVE) has been found to be very suitable for this purpose.

Metrohm

Method description

Principle

The determination of weakly basic organic compounds soluble only in nonaqueous solvents, particularly nonpolar solvents, may present difficulties when employing titration techniques other than thermometric titrimetry. While enthalpies of neutralization may be too low to obtain a satisfactory thermometric titration endpoint unaided, the use of a thermometric indicator enables very sharp endpoints to be obtained. Isobutyl vinyl ether (IBVE) has been found to be particularly suitable as such an indicator (Greenhow and Spencer, 1973). When all weak base has been neutralized by the titrant acid, the first trace of excess acid catalyzes the strongly exothermic polymerization of IBVE, thus marking the titration endpoint.

Organic bases tested

1. Piperidine, $(CH_2)_5NH$ Fluka cat. no. 80640
   ≥ 99%, $pK_a = 11.2$
2. Isoquinoline, C_9H_7N Aldrich cat. no. 128208
   97%, $pK_a = 5.5$

Configuration

Basic equipment list for automated titration

814 USB Sample Processor	2.814.0030
859 Titrotherm	2.859.0010
Sample rack 24 x 75 mL	6.2041.340
Thermoprobe	6.9011.020
Sample beaker 75 mL	6.1459.400
802 Stirrer	2.802.0010
Stirring propeller 104 mm	6.1909.020
3 × 800 Dosino	2.800.0010
1 × Dosing unit 50 mL	6.3032.250
1 x Dosino unit 10 mL	6.3032.210
1 × Dosing unit 5 mL	6.3032.150
tiamo™	6.6056.222

Solutions

Titrant	c(CF_3SO_3H) = 0.1 mol/L trifluoromethanesulfonic acid, Fluka cat. no. 35317)
Solvent	Toluene or xylene
Thermometric indicator	Isobutyl vinyl ether Aldrich cat. no. 278351

Analysis of samples

Approximately 4 mmol of organic base is weighed directly into a clean, dry 200 mL volumetric flask previously tared on an analytical balance. The contents are made to volume with toluene or xylene. A 25 mL aliquot is pipetted into a clean, dry titration vessel, and 5 mL of toluene or xylene added. An automated *tiamo*™ titration program adds 1 mL isobutyl vinyl ether before the dosing of titrant. The titration proceeds to an endpoint marked by a sudden and strong evolution of heat. The titration program allows for a titrant predose, which may be used to speed up the determination when slow titrant dose rates are employed.

Determination of blank

(This determination need only be performed before testing a new product) Aliquots of 10, 15, 20, 25, and 30 mL of a solution prepared as above are titrated and a regression analysis performed on the results, with sample mass plotted on the x axis and titration volume on the y-axis. The y-intercept is the systematic error of the determination and is used as the "blank" in the calculation.

Titration parameters

Sample aliquot size, mL	10–30
Titrant dose rate, mL/min	2
Digital filter factor	55
Endpoint inflection	type endothermic
Endpoint criterion	20,000

Calculations

% base (w/w) = ((EP + PD − blank) × C001 × C002 × 0.1)/(C00)

EP	= endpoint volume of titrant, mL
PD	= predose volume, mL
blank	= systematic error of determination, mL
C001	= molarity of titrant
C002	= molecular mass of base
C00	= sample mass, g

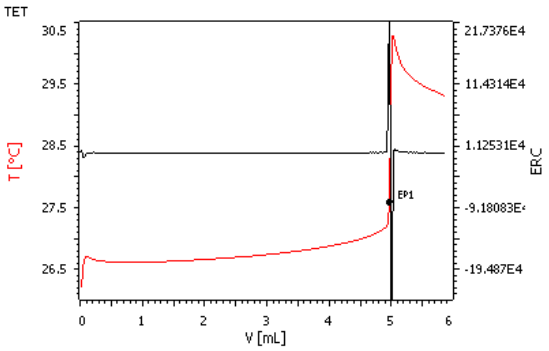
Examples

Base	*% (w/w)*	
	Label value	*CETT*
Piperidine	≥ 99	99.2 ± 0.4
Isoquinoline	97	100.0 ± 0.1

Metrohm

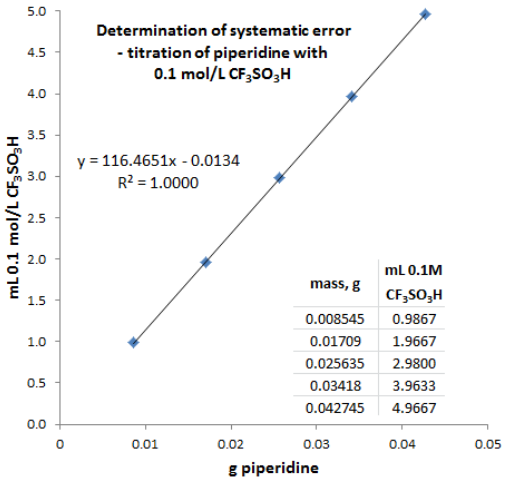
Method description

Titration plot



CETT titration of piperidine with 0.1 mol/L CF_3SO_3H

Blank determination



mass, g	mL 0.1M CF_3SO_3H
0.008545	0.9867
0.01709	1.9667
0.025635	2.9800
0.03418	3.9633
0.042745	4.9667

Reference

E. J. Greenhow and L. E. Spencer (1973) *Ionic polymerisation as a means of endpoint indication in non-aqueous thermometric titrimetry. Part 1. The determination of organic bases.* Analyst, **98**, 81–89.

Metrohm