

Energy

Boron in Nuclear Reactor

Acid-base titration by
Automatic Potentiometric Titrator

Standard

1. Abstract

Boron in coolant of nuclear reactor is measured by adding pure water to the sample and adjusting pH to 5.6 with 0.05mol/L Hydrochloric acid, and then mannitol to dissolve. Finally titrate with 0.1mol/L Sodium hydroxide up to pH8.5.

The concentration of Boron is calculated from titration volume of Sodium hydroxide.

2. Reference

- 1) JIS K 8863-2007 Boron (Reagent)
- 2) "Experiment and Calculation for Quantitative Analysis" –Vol.2 by Seiji Takagi from Kyoritsu Publishing Company

3. Cautions in measurement

- 1) Handle with care when you work on chemicals.

4. Post-measurement care

Rinse the electrode with pure water, and keep it dipped in a beaker filled with pure water to refrain from drying up.

5. Test equipment

Main unit : Automatic potentiometric titrator (Standard preamplifier STD-)

Electrode : Glass electrode

Ceramic type reference electrode

6. Reagent

Titrant : 0.1mol/L Sodium hydroxide (f=1.003)

Additive : Pure water

Reagent : 0.05mol/L Hydrochloric acid, Mannitol

7. Measurement procedure

—Measurement—

- 1) Deliver 5.0mL sample to a 100mL beaker, and add 50mL pure water.
- 2) Adjust pH to 5.6 with 0.05mol/L Hydrochloric acid.
- 3) Add 8g m Mannitol to dissolve.
- 4) Titrate with 0.1mol/L Sodium hydroxide up to pH8.5.

8. Formula

$$\text{Boron (ppm)} = (\text{EP1} - \text{BL1}) \times \text{FA1} \times \text{C1} \times \text{K1} / \text{SIZE}$$

EP1 : Titration volume (mL)

BL1 : Blank level (0.00mL)

FA1 : Factor of tyrant (1.003)

C1 : Concentration conversion coefficient (1.082mg/mL)

K1 : Unit conversion coefficient (1 000)

SIZE : Sample size (mL)

9. Example of measurement

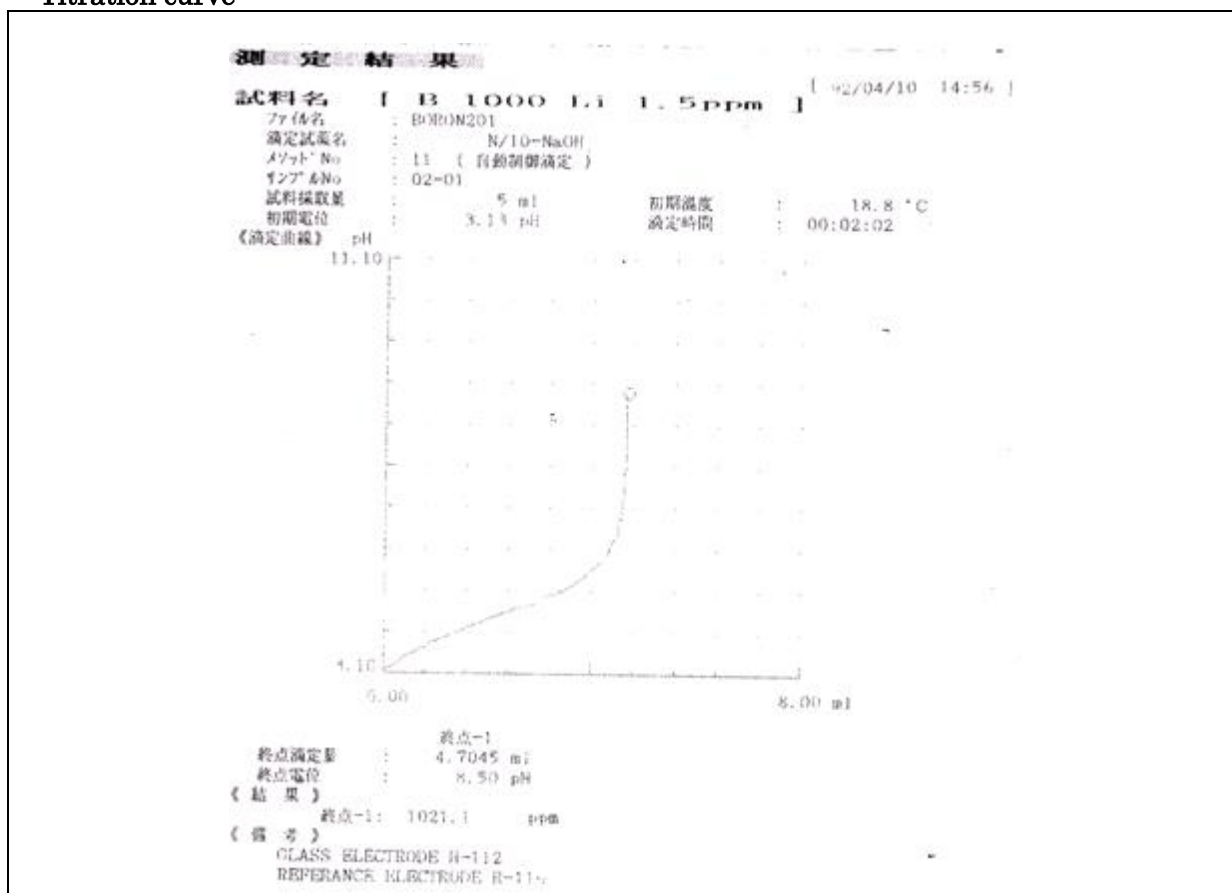
— Ambient condition —

| | | |
|--------------------------|-----------------|----------------|
| Room temperature : 25 °C | Humidity : 50 % | Weather : Fair |
|--------------------------|-----------------|----------------|

- Titration parameter -

| | | | |
|-----------------------|----------------|----------------------------|----------|
| [Titration parameter] | | | |
| Titration mode | : Auto control | Preamplifier unit | : pH |
| Titration form | : EP Stop | Max. volume of burette | : 20.0mL |
| Titration burette | : 01 | Auto stirrer | : Off |
| Reagent | : NaOH | Wait time before titration | : 0s |
| Detector number | : 1 | Titration direction | : Auto |
| [Control parameter] | | | |
| EP 1 potential | : 8.5 pH | Control speed | : 4.0 |
| EP 2 potential | : 8.5 pH | Data sampling potential | : 4.0mV |
| Over-titration | : 0.0mL | Data sampling volume | : 0.5mL |
| Gain | : 1 | | |

-Titration curve-



(The above printout data are obtained from titration by AT-410)

—Measurement results—

| n | Sample (mL) | Titration (mL) | Boron (ppm) |
|---|----------------|-------------------|----------------|
| 1 | 5.0 | 4.7045 | 1021.1 |

* The above test result was obtained by single test of the sample.

10. Summary

The ^{10}B isotope of Boron possesses a very large neutron absorption cross section and is used to control nuclear reaction, and its compound Boric acid is dissolved in primary coolant to control excessive reaction in pressurized water reactor.

The sample test shows a clear titration curve.

Precise and reliable measurement is assured by the automated potentiometry.