Method 9.8 – Water and effluent: conductivity

1. Rationale

This method is applicable to boiler water, boiler feed water and effluent and determines the conductivity of the sample.

2. Principle

The specific conductivity of a water sample is determined at room temperature and compared to the specific conductivity of water.

3. Definitions

3.1 Cell constant

The cell constant of a conductivity meter depends on the area of the two platinum plates and their distance apart. Since both these dimensions are fixed, but vary from one cell to another, it is necessary to determine this constant for each cell and for different types of samples. The constant should be checked once a month or whenever either of these two dimensions may have changed.

4. Apparatus

4.1 **Oven** operating at 105°C

4.2 **Conductivity meter**

4.3 **Volumetric flasks**: 2 × 1 000 cm³

4.4 **Beakers**: 2 × 50 and 250 cm³

4.5 **Analytical balance** readable to 0.0001 g

4.6 **Top pan balance** readable to 0.01 g

4.7 **Water bath** operating at 20.0 ± 0.2°C

4.8 **Watch glass**

5. Reagents

5.1 Purified water

Use twice-distilled or de-ionised water with a specific conductance of less than 2 µS/cm for the preparation of all solutions.

5.2 **Potassium chloride** (0.01 M)

Dry the potassium chloride (KCl) in an oven at 105°C for 3 hours and cool in a desiccator.

Weigh 745.56 mg of dried potassium chloride, dissolve in water in a 1 000 cm^3 volumetric flask and make to the mark. This solution has a conductivity of 1277.96 µS/cm at 20°C after the specific conductivity of the water has been subtracted.

5.3 **Potassium chloride** (0.0025 M)

Dilute 250 cm^3 of the 0.01 M KCl solution in a 1 000 cm^3 volumetric flask and make to the mark. This solution has a conductivity of 328 µS/cm at 20°C after the specific conductivity of the water has been subtracted.

6. Procedure

6.1 Determination of the cell constant

Place a 250 cm^3 beaker with 100 cm^3 of the 0.0025 M KCl solution in the water bath at 20.0°C for 30 minutes. Cover the beaker with a watch glass to minimise evaporation. Read the conductivity of the 0.0025 M KCl solution.

Calculate the cell constant according to 7.1. If the measurements cannot be made at 20.0°C a temperature correction must be applied to the theoretical conductance of the KCl solution according to 7.2. A new cell constant must be determined every month.

6.2 Sample conductivity

Cool the sample in the water bath at 20.0 ± 0.2°C for 30 minutes together with a 250 cm^3 beaker of purified water (5.1) which will be used as a blank.

Rinse the conductivity cell twice with the purified water. Transfer a fresh portion of the purified water to a 50 cm^3 beaker and measure the conductivity at 20.0 ± 0.2°C. Rinse the conductivity cell twice with the sample solution. Transfer a fresh portion of the solution to a 50 cm^3 beaker and measure the conductivity at 20.0 ± 0.2°C. If the readings cannot be taken at 20.0 ± 0.2°C a temperature correction must be applied according to 7.4.

7. Calculations

7.1 Cell constant

Deduct the specific conductivity of the purified water from the conductivity of the KCl solution.

$$\text{cell constant (/cm)} = \frac{\text{theoretical conductivity } (\mu S/cm)}{\text{conductivity of KCl solution } (\mu S)}$$

7.2 Temperature correction for KCl solution

If the KCl solution is not at 20.0°C the theoretical conductivity of the solution must be adjusted according to the equation below. This adjustment must be made before the cell constant is calculated and is only valid in the range 20 ± 5°C.

$$\text{KCl conductivity at T°C } (\mu S/cm) = \text{Conductivity at 20.0°C} \times [1 + 0.021 \times (T - 20)]$$

7.3 Sample conductivity

conductivity = conductivity reading - conductivity of purified water

7.4 Temperature adjustment for sample

$$\text{conductivity at 20.0°C (µS)} = \frac{\text{conductivity at T°C}}{[1 + 0.021 \times (T - 20.0)]}$$

where T ≡ Temperature in °C

8. Example

8.1 Cell constant

The conductivity of the 0.0025 M KCl solution at 24.0°C is 371.17 µS and the conductivity of the purified water is 1.17 µS. The theoretical conductivity of the 0.0025 M KCl solution at 24.0°C is:

KCl conductivity at 24.0°C = 328 × [1 + 0.021 × (24.0 - 20.0)]
= 356 µS

$$\text{cell constant} = \frac{356\ \mu S/cm}{370\ \mu S}$$
= 0.962 /cm

8.2 Sample conductivity

conductivity of water at 25.0°C = 1.17 µS
conductivity of sample at 25.0°C = 320.87 µS

conductivity at 25.0°C = (320.87 - 1.17) µS
= 319.70 µS

$$\text{conductivity at 20.0°C} = \frac{319.70\ \mu S}{[1 + 0.021 \times (25.0 - 20.0)^{\circ}C]}$$

= 289.32 µS

Report as 289 µS

9. References

ICUMSA (1994). Conductivity ash in raw sugar, brown sugar, juice, syrup and molasses. *ICUMSA Methods Book,* Method GS1/3/4/7/8/-13.

SASTA (1985). *Laboratory Manual for South African Sugar Factories*. 3rd Edition: 156 - 157.

SMRI (2002). The determination of conductivity ash in raw sugar, brown sugar, juice, syrup and molasses. *SMRI Test Methods,* TM066.